Coexistence or Conflict? Understanding Human–Macaque Encounters in Delhi's Urban Sanctuary

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Abstract

Urban–wildlife conflicts present critical challenges for biodiversity conservation and community well-being, particularly in rapidly urbanizing landscapes. This study examines human–rhesus macaque (*Macaca mul*) conflicts around Asola-Bhatti Wildlife Sanctuary, New Delhi, by applying a structured conflict classification framework, Dispute, Underlying Conflict, and Deep-rooted Conflict, to quantify conflict depth and guide targeted interventions. Between April and June 2024, we surveyed 200 households at the sanctuary margin, assessing perceptions across five domains (Perception, Situation, History, Willingness, Authority Views) using Likert scales. Statistical analyses comprised Pearson's chi-square tests to identify significant associations and conditional inference trees to reveal primary predictors of attitudes and conflict severity. Composite indices aggregated responses to represent each conflict level. Findings reveal that macaque encounters are widespread (88%), resulting in property damage (44.5%), increased workload (93%), and physical injuries (39%). Religious and cultural beliefs foster positive attitudes and drive provisioning behaviors, while aggressive macaque actions and dissatisfaction with wildlife authorities (67.5%) exacerbate tensions. Composite indices indicate that most conflicts align with the Underlying Conflict level (OCI = 1.632), with Perception and Situation measures nearing Deep-rooted Conflict, whereas History, Willingness, and Authority Views correspond to Dispute levels. These results underscore the necessity for level-specific mitigation strategies, combining practical dispute resolution, community reconciliation, and institutional trust-building, to promote sustainable human–wildlife coexistence in urban ecosystems.

Keywords: human–wildlife conflict; rhesus macaque; urban biodiversity; conflict classification; community perceptions; mitigation strategies

1. Introduction

Macaques are among the most successful members of the primate family; after humans, they are the most widespread nonhuman primates, occupying an exceptional geographical range that includes Northeast, Africa, Southeast Asia, southern China, and India, with *Macaca mulatta* (rhesus macaque) having the broadest distribution among primate species [Priston & McLennan, 2012; Tiwari & Mukherjee, 1993]. In India, nonhuman primates inhabit environments ranging from dense montane forests to open lands and urban settlements.

Historically, macaques adapted to diverse habitats, from natural forests to heavily human-modified landscapes. However, immense ecological and anthropogenic pressures, such as agricultural expansion, deforestation, and industrialization, have led to significant habitat loss [Southwick & Lindburg, 1986; Southwick & Siddiqi, 1994].

The first systematic survey by Southwick et al. (1965) estimated approximately two million macaques in northwestern India; subsequent reports documented a drastic 90 percent decline during the 1960s and 1970s, primarily linked to large-scale exports for laboratory experiments [Chakraborty, 1965; Southwick & Siddiqi, 1968, 1988, 2011].

In the 1980s, populations began to recover following India's 1978 export ban and the Green Revolution (1966), which boosted food resources for people and wildlife, spurring rebounds across northern India, including New Delhi [Southwick et al., 2011]. Continued deforestation and agricultural encroachment, however, forced macaques into urban areas [Bowonder, 1982]. Their adaptability enabled survival in human-dominated landscapes but also led to increased tensions. In New Delhi, negative interactions, including house raiding, attacks, property damage, and fatalities, became common in the early 2000s [Down-To-Earth, 2023].

Public frustration prompted a Delhi High Court order in 2007 banning public feeding and mandating translocation to Asola-Bhatti Wildlife Sanctuary. By 2014, 18 000 macaques had been relocated, but insufficient natural food and continuous provisioning (costing ~INR 1 crore/year) sustained high densities and unrest [Nulkar, 2017; Ganguly & Chauhan, 2018]. Lacking predators, macaque numbers continued to grow, driving troop movements into adjacent villages and escalating human–macaque conflict [Ganguly et al., 2018; Ganguly & Chauhan, 2019].

Conflict escalation influences community perceptions of macaques and views of management authorities, affecting mitigation effectiveness [Anand et al., 2018; Anand & Radhakrishna, 2020; Chauhan & Pirta, 2010; Gopalan & Radhakrishna, 2022; Saraswat et al., 2015]. Crucially, human–wildlife conflict is shaped by a complex interplay of socioecological dynamics, including cultural beliefs, socioeconomic status, encounter frequency, historical management, and stakeholder relationships [Hill, 2021; IUCN, 2023]. Focusing solely on physical risks can obscure deeper social roots and undermine sustainable coexistence [Madden & McQuinn, 2014; Redpath et al., 2013].

To address this complexity, we apply a structured "levels of conflict" framework, originally developed by the Canadian Institute for Conflict Resolution and advanced by Madden & McQuinn (2014), which categorizes wildlife conflict as Dispute, Underlying Conflict, or Deep-rooted Conflict. Disputes involve visible, tangible problems; Underlying Conflicts stem from management dissatisfaction; Deep-rooted Conflicts center on identity, values, or feelings of disempowerment [Madden & McQuinn, 2014]. Understanding these conflict levels at Asola-Bhatti's boundary is essential. This study thus (1) categorizes human–rhesus macaque conflicts into Dispute,

Underlying, and Deep-rooted levels, and (2) proposes level-specific interventions for more effective and lasting coexistence.

1. Materials and Methods

2.1 Study Area

The Asola Bhatti Wildlife Sanctuary (ABWLS) is a 32.71 km² protected area in the southeastern South Delhi Ridge of the Aravalli Hills (28°28′34″N, 77°13′48″E). It uniquely represents the northeastern flat-topped Precambrian Aravalli range in India's network of 565 sanctuaries [Chaudhary et al., 2023; Sharma & Chaudhry, 2017]. Biogeographically, ABWLS falls within the northern tropical thorn forest zone [Champion & Seth, 1968; Delhi Forest Department, n.d.]. Historically, open-cast mining for quartzite ("Bajri") occurred until a 1990 ban, leaving abandoned pits now converted into perennial water bodies [Kushwaha et al., 2014; Sharma & Chaudhry, 2017] (Fig. 1).

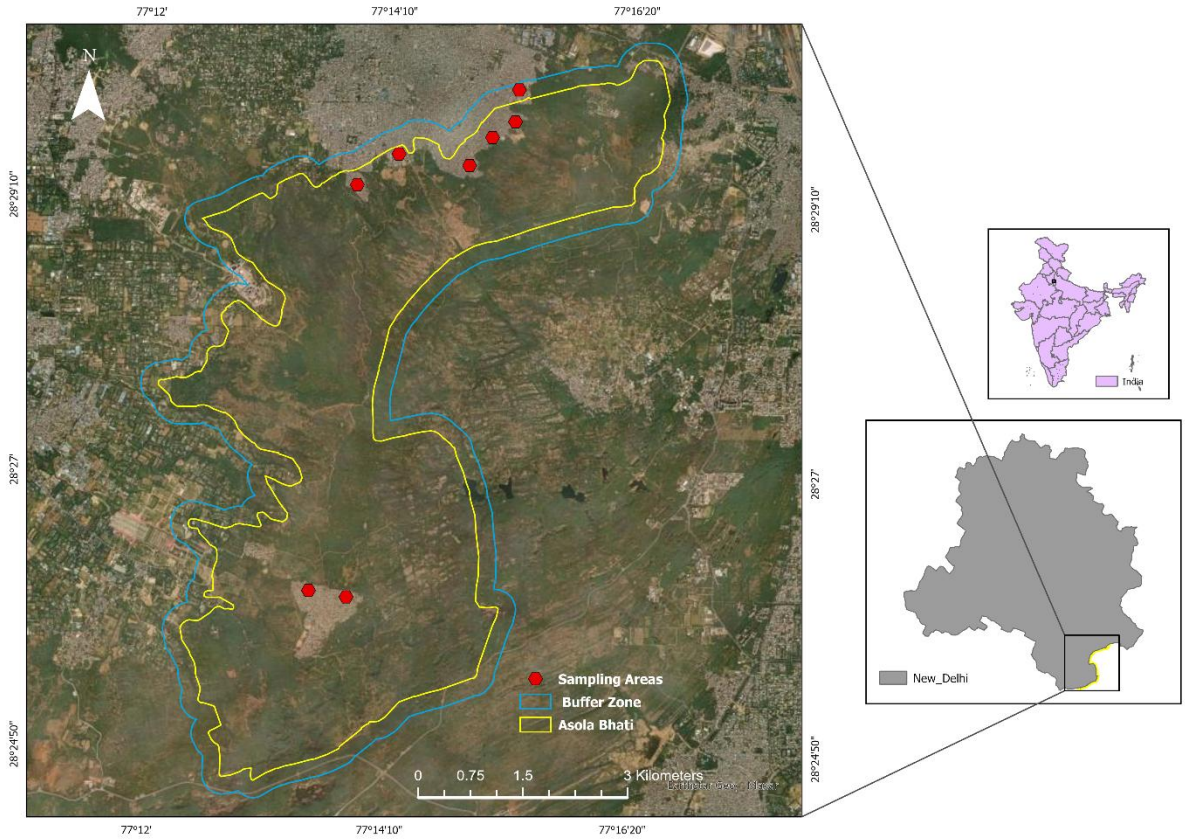

Figure 1: Study area map

ABWLS borders diverse human-dominated landscapes: Sanjay Nagar (dense settlement) to the south; Sangam Vihar (large informal settlement) to the north; Sainik Farms (affluent residential) to the west; and contiguous forest tracts toward Faridabad and Gurgaon, Haryana, to the south and east [Kushwaha et al., 2014].

Following reconnaissance revealing frequent negative human–macaque interactions, we selected Sangam Vihar's periphery for detailed study based on proximity to ABWLS, community dependence on sanctuary resources, and availability of field assistants. A non-random, opportunistic sampling design was employed, appropriate for exploratory case-study theory testing rather than representative prevalence estimation [IUCN, 2023; Zimmermann, 2014].

Data were collected April–June 2024 from seven purposively selected blocks (M2, L2, I, H, G, J, Gupta Colony) and the ABWLS head office area (approx. 28°33′39″N, 77°16′E), chosen for resource availability, macaque troop presence, provisioning behaviors, waste disposal practices, and socioeconomic variation.

Ethical Statements and Declarations

(a) Consent to Participate

Prior to conducting interviews, informed consent was obtained verbally from each participant after explaining the purpose and nature of the study. Participation was entirely voluntary, and individuals were assured of their right to decline or withdraw at any point without any consequences. Although formal ethical committee approval was not obtained for this study, all procedures followed ethical standards for research involving human subjects.

2.2 Survey Design and Data Collection

The questionnaire was designed in English based on objectives and literature [IUCN, 2023; Sangay et al., 2019; Thinley et al., 2019, 2021; Zimmermann, 2014, 2020], piloted, and translated into Hindi by a subject expert. It comprised 44 items in two parts (Appendix 1).

Part 1 captured demographics, residence duration, attitudes toward macaques, physical-harm experiences, cultural/religious significance, current conflict situations, past mitigation attempts, and solution perspectives. Both closed and open-ended questions generated quantitative and qualitative data.

Part 2 applied Zimmermann et al.'s (2020) human–wildlife conflict framework (Figure. 3; Table 1), segmenting conflict into five domains. Based on this model, targeted questions measured conflict perceptions and intensity; responses were scored to generate composite conflict indices for subsequent predictive analyses.

112 **2.2.1 Questionnaire and Response Measurement**

113 We employed five-point Likert scales (1 = Strongly disagree to 5 = Strongly agree) across all conflict domains
114 (Table 1), enhancing granularity over three-point scales. A total of 200 households were surveyed, achieving
115 gender balance among respondents (Table 1).

116 **Table 1:** Broader categories and key areas of questions for the Likert five-point scale

Category	**Likert Statements**
(a) Perceptions about the species that is being blamed in the conflict	Macaques significantly affect my economic stability.
	My feelings toward macaques are generally positive.
	Macaques play an important role in my cultural or religious practices.
(b) Questions about the apparent situation itself	Macaques frequently cause damage to my property.
	The conflict with macaques is severe and affects my daily life significantly.
	I am concerned about physical harm from macaques.
(c) Questions about the history of previous attempts (by any party) to address the conflict	Government had taken many steps to mitigate this conflict
	The government is handling human-macaque conflicts well.
(d) The extent of willingness to engage in attempts to find solutions	I would support community initiatives aimed at mitigating conflicts with macaques.
	I believe that peaceful coexistence with macaques is possible in the future.
(e) Views about others involved in, or trying to assist with the situation, such as authorities or other third parties	Macaques should live with us in colonies.
	I trust the local wildlife authorities to handle macaque-related issues.

117 **2.3 Data Analysis**

118 All analyses were conducted in R v4.2 (R Studio 2024.04.2). We began with descriptive statistics to summarize
119 key variable distributions. To test associations between attitudes, experiences, and demographic predictors, we
120 used Pearson's chi-square tests of independence with Yate's continuity correction (chisq.test in the MASS

package). For predictive modeling, we employed conditional inference trees (ctree in the partykit package), a non-parametric recursive partitioning method that hierarchically identifies significant explanatory variables without strict distributional assumptions, handles nonlinear interactions, and is robust to multicollinearity and small sample sizes. Built-in statistical stopping criteria reduce overfitting and multiple-testing risks, making this approach well suited for exploratory socioecological data (Zimmermann, 2014; Sangay et al., 2020; Thinley et al., 2019, 2021).

Although logistic regression and generalized linear models can adjust for confounders and estimate effect sizes, our focus was on identifying the hierarchical ordering of predictors rather than marginal effects. We evaluated five survey domains, Perception, Situation, History, Willingness, and Authority Views, by coding Likert responses (1 = Strongly Disagree to 5 = Strongly Agree) and generating composite scores. The Category Score for domain *i* was computed as the average of all item scores in that domain, and the Overall Composite Index (OCI) as the mean of the five domain scores.

Category Score for category *i:* $\text{Category Score}_i = \frac{1}{n_i}\sum_{j=1}^{n_i} S_{ij}$

where: $\mathbf{S_{ij}}$ = Score for the j^{th} question in category 'i'

$\mathbf{n_i}$ = Number of questions in category 'i'

Overall Composite Index (OCI): $\text{OCI} = \frac{1}{5}\sum_{i=1}^{5} \text{Category Score}_i$

Likert categories were combined where necessary to ensure expected cell counts ≥5, and all sampling limitations (non-random, purposive design) are acknowledged as constraining generalizability and framing results as hypothesis-generating. Composite scores were equidistantly grouped: 1–1.8 = Dispute, 1.81–2.6 = Underlying Conflict, and 2.61–3 = Deep-rooted Conflict. Graphical outputs, including hierarchical trees, stacked bars, and box plots, illustrate variable importance, distributions, and conflict levels (Zimmermann et al., 2020; IUCN, 2023).

3 Results

3.1 Socio-Demography

A total of 200 household respondents participated in the survey, providing a gender-balanced sample: 49.5 (n = 95) male and 50.5 percent (n = 105) female. Age distribution spanned 16 to 74 years, with the largest proportion in the 36–55 years group (40 percent), followed by 18–35 years (19 percent), 56–65 years (16 percent), 66–75

years (16 percent), and 16–18 years (11 percent). In terms of residence duration near Asola-Bhatti Wildlife Sanctuary, 33.5 percent (n = 67) reported over 20 years, 31 percent (n = 62) 11–20 years, 27.5 percent (n = 55) 6–10 years, and 8 percent (n = 16) 1–5 years. This diversity of ages and long-term local residency offers robust contextual insight into human–macaque interactions at the sanctuary's periphery.

3.2 Frequency and Impact of Human–Macaque Encounters

Daily macaque encounters were reported by the vast majority of respondents ($p < 0.001$), with 88 percent (n = 176) experiencing such interactions weekly and 12 percent (n = 24) less frequently. Notably, 67 percent (n = 136) reported macaques entering their houses, while 32 percent (n = 64) described macaques moving through their colonies without entering homes.

Damage from these incursions was widespread and multifaceted: kitchen damage (31 percent, n = 62); rooftop water-tank destruction (29 percent, n = 58); dustbin theft or disturbance (27.5 percent, n = 55); and damage to household electronics (12.5 percent, n = 25).

All respondents reported some impact. Primary impacts included property damage (44.5 percent, n = 89), disruption of daily routines (40.5 percent, n = 81), and adverse effects on farming/agriculture (15 percent, n = 30). Moreover, 93 percent (n = 186) indicated that macaque presence significantly increased household workload, through property defense and repairs, compared to 7 percent (n = 14) reporting no additional burden.

Physical safety concerns were significant: 39 percent (n = 78) reported harm from macaques. Among these, the majority were scratched or charged (34.5 percent, n = 69), and 6 percent (n = 12) were bitten, leaving 61 percent (n = 122) unharmed.

Finally, rhesus macaques held strong cultural and religious significance for 68 percent (n = 136) of respondents, associated with the deity Hanuman, while 32 percent (n = 64) reported no such affiliation, indicating a nuanced spectrum of local attitudes affecting both perceptions and management strategies.

3.3 Perception of the Species: Drivers of Attitudes Toward Macaques

Nearly half of respondents (49.5 percent, n = 99) reported liking rhesus macaques, significantly more than those who disliked them (22 percent, n = 44) or remained neutral (28.5 percent, n = 57) ($p < 0.001$). Drivers of these attitudes varied: religious importance motivated 49 percent (n = 98), aggressive macaque behavior influenced 23 percent (n = 46), and attributes such as appearance, intelligence, or human-like behavior underpinned neutral attitudes in 28 percent (n = 56).

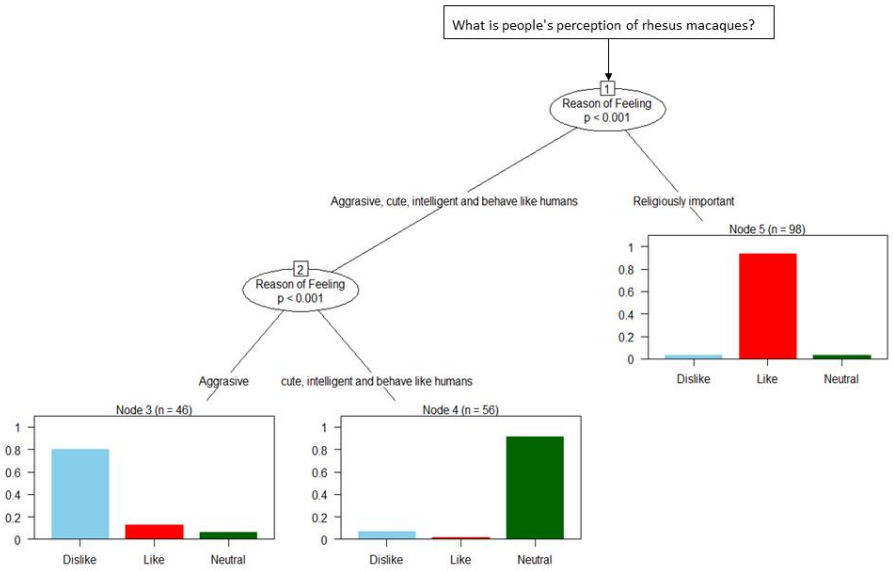

Figure 2: Conditional inference tree showing "reason of feeling" as the primary significant predictor of local people's attitude toward the rhesus macaques (*Macaca mulatta*) in ABWLS. Statistical significance of the tree split is indicated by *p* values.

"Feeling Toward Macaques" emerged as the strongest predictor of overall attitude in the conditional inference tree (Figure. 2) ($p < 0.001$). Among those citing religious significance, 91.8 percent (n = 90) liked macaques, with only 5.1 percent (n = 5) neutral and 3.1 percent (n = 3) disliking. Conversely, respondents viewing macaques as aggressive predominantly disliked them (84.8 percent, n = 39), with 8.7 percent neutral (n = 4) and 6.5 percent liking them (n = 3). Among those describing macaques as cute, intelligent, and human-like, 87.5 percent (n = 49) were neutral, 7.1 percent disliked (n = 4), and 5.4 percent liked them (n = 3), reflecting ambivalence shaped by specific interactions.

3.4 Provisioning of Rhesus Macaques and Views on Penalties

Provisioning was widespread: 90 percent (n = 180) of respondents had fed macaques, compared to 10 percent (n = 20) who had never done so ($p < 0.001$). Regarding penalties for feeding imposed by the forest department, 71 percent (n = 142) opposed them ($p < 0.001$), while 16 percent (n = 32) supported penalties and 13 percent (n = 26) were uncertain, highlighting potential enforcement challenges without community engagement.

3.5 Community Perspective on Conflict

Human–macaque conflict was regarded as very severe by 64 percent (n = 128), moderately severe by 26 percent (n = 52), and mild by 10 percent (n = 20); no respondent considered it unproblematic ($p < 0.001$). Primary perceived drivers were garbage dumps attracting macaques (47 percent, n = 94) and lack of natural food and water (30.4 percent, n = 61), with additional factors of population pressure (13 percent, n = 26) and shelter-seeking behavior (9.6 percent, n = 19).

To cope, 94.5 percent (n = 189) installed sharp metal fencing around dwellings or water tanks; 5.5 percent (n = 11) used dogs or other guarding methods. Fencing and food scarcity were viewed as primary human-provoked causes of macaque attacks (47.5 percent, n = 95), followed by macaques trapped in colonies (34 percent, n = 68), teasing by humans (16.5 percent, n = 33), and unprovoked attacks (2 percent, n = 4), illustrating multidimensional conflict triggers.

3.6 History of Previous Attempts to Address Conflict

Awareness of official conflict management efforts was extremely limited. A significant majority of respondents (91.5%, n = 183; $p < 0.001$) reported being unaware of any actions by authorities to reduce macaque conflict. Among the very few who were aware (8.5%, n = 17), the only known strategy involved the capture and translocation of macaques from colonies to forested areas; no respondents identified supplementary feeding within the sanctuary. This reveals a striking communication gap between authorities and the community.

Similarly, institutional support channels were poorly recognized: 86% (n = 172) of respondents were not aware of any helpline for reporting wildlife-related issues, compared to just 14% (n = 28) who indicated awareness of such services. This further highlights the perceived lack of institutional engagement and accessible assistance.

3.7 Views about Authorities and Other Stakeholders

Community dissatisfaction with authorities was widespread. Most respondents (67.5%, n = 135; $p < 0.001$) characterized the forest department's response as very late, while 25.1% (n = 50) reported receiving no response at all. Only a small minority (7.4%, n = 15) considered the department's response to be swift.

Key reasons given for delays or lack of response included the encroached or informal status of their communities (46.5%, n = 93), perceptions of departmental apathy or inertia (26.5%, n = 53), the belief that macaques are not considered a relevant wildlife concern by the authorities (15.0%, n = 30), and general uncertainty regarding the causes (12.0%, n = 24).

3.8 Future Perspectives on Conflict and Management Preferences

A strong majority of respondents (76%, n = 152; $p < 0.001$) anticipated that conflicts with macaques will intensify in future, expecting that management will become increasingly challenging. Only 15% (n = 30) expected a reduction in conflict, while 9% (n = 18) anticipated no change, often believing the conflict has already reached its maximum level (see Figure 3).

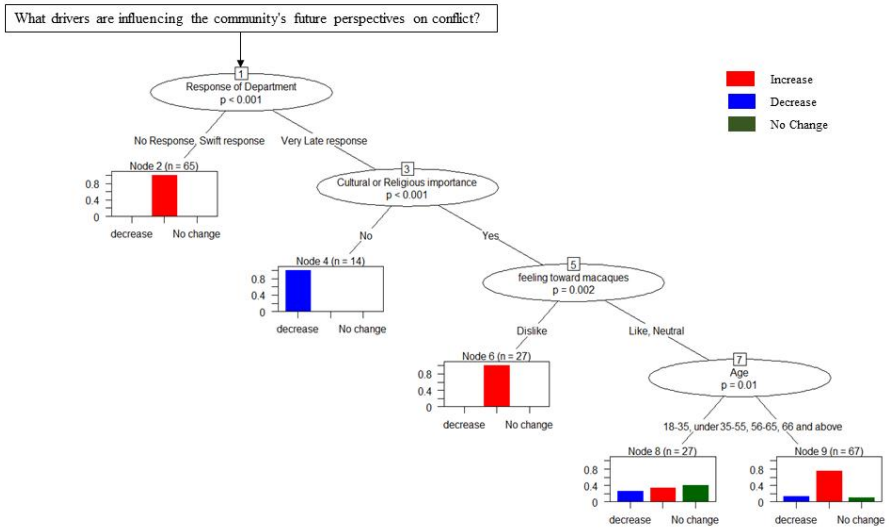

Figure 3: Conditional inference tree showing "response of department" as the primary significant predictor of local people's opinion on future with macaques in ABWLS. Statistical significance of the tree split is indicated by *p* values.

Perceptions about likely future trends in conflict were significantly shaped by views on the department's responsiveness. Among those perceiving no response from authorities, 69.2% (n = 45) expected conflict to escalate. For respondents who perceived a delayed departmental response, cultural or religious importance of macaques emerged as a significant moderator: those not assigning cultural/religious significance nearly all (92.9%, n = 13) believed conflict would decrease. In contrast, among those for whom macaques have cultural or religious importance, opinion split further by attitude and age, respondents disliking macaques (81.5%, n = 22) were especially likely to expect increased conflict, while among those with positive or neutral feelings, younger individuals (18–35 years) generally predicted no change and older respondents (56–65 years) anticipated escalation.

3.9 The Extent of Willingness to Engage in Attempts to Find a Solution

Most community members (62.5%, n = 125) expressed unwillingness to participate in community-based conflict mitigation initiatives; a minority (21%, n = 42) were willing, with 16.5% undecided. The principal determinant for willingness was again the perceived "response of the department" ($p < 0.001$). For those perceiving the department's response as "very late," encounter frequency significantly shaped willingness: respondents facing daily macaque encounters were more reluctant (64.9%, n = 72 not willing), while those with weekly encounters were more inclined to participate (54.2%, n = 13), though a substantial subset still opted out (45.8%, n = 11). For individuals perceiving departmental response as absent or swift, higher uncertainty around participation was reported (Figure 4).

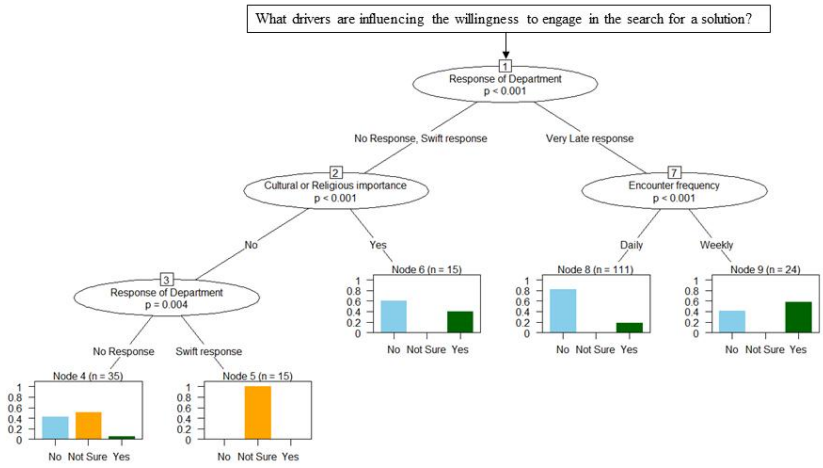

Figure 4: Conditional inference tree showing "response of department" as the primary significant predictor of local people's willingness to participate in the management of conflict in ABWLS. Statistical significance of the tree split is indicated by *p* values.

Cultural or religious significance of macaques further modified willingness: among those attributing such significance, 46.7% (n = 7) were more willing to engage, while 53.3% (n = 8) still leaned toward nonparticipation; when macaques held no such significance, respondents displayed even greater uncertainty. Motivations for reluctance included the belief that conflict management should be handled by the forest department (15%, n = 30), doubts about effectiveness due to lack of forest habitat for macaques (28.5%, n = 57), distrust in authorities (25%, n = 50), acceptance of communal responsibility (21%, n = 42), and lack of time (10.5%, n = 21). These patterns reflect the multifaceted barriers shaping community engagement in mitigation efforts.

3.10 Identification of Conflict Levels

To assess the depth and character of human–macaque conflict within the community, additive scores from survey responses were computed across five analytic domains. These indices, ranging from 3 to 15, were grouped equidistantly: scores of 3–7 defined the "Dispute" level, 8–11 "Underlying Conflict," and 12–15 "Deep-rooted or Identity-based Conflict." This classification revealed substantial variation in conflict level by category (Figure 5).

The overall composite index (OCI = 1.632) indicates that most conflict is situated at the Underlying level. However, there are notable contrasts between domains: higher values for Perceptions (OCI = 2.445) and Situational assessments (OCI = 2.09) indicate Deep-rooted Conflict, reflecting fundamental disputes over species identity and persistent negative experiences. In contrast, History (OCI = 1.15), Willingness to Engage (OCI = 1.145), and Views about authorities (OCI = 1.33) correspond more to Dispute-level conflict, suggesting community engagement with or satisfaction about interventions and authorities remains relatively superficial (Figure 5).

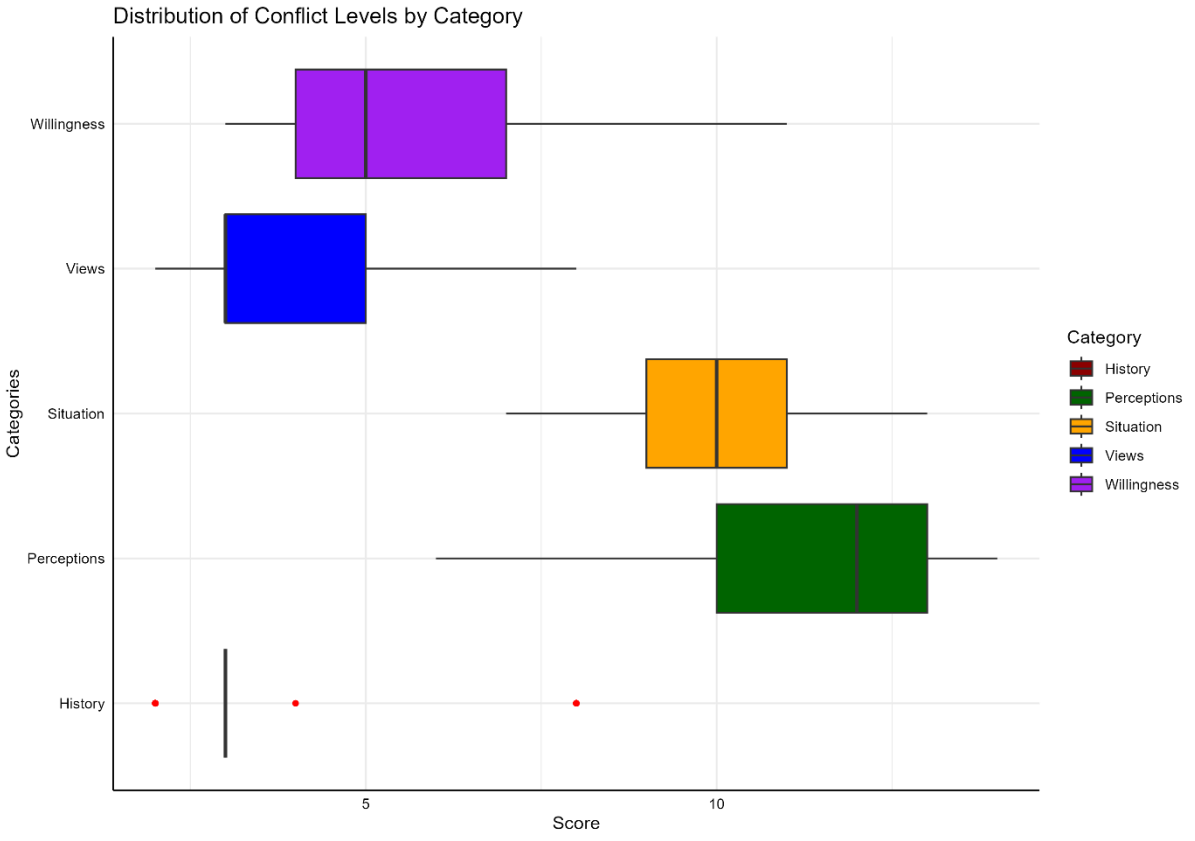

Figure 5: Overall composite indices (OCI) showing the scores of each of the five categories.

When examining proportions within each category:

- For “Perception about Species,” a majority (51.0%, n = 102) fell into the Deep-rooted level, 42.5% (n = 85) were at the Underlying level, and only 6.5% (n = 13) registered a Dispute, pointing to fundamental issues rooted in community identity, values, and beliefs.

- Regarding "Questions about the Apparent Situation," 78.0% (n = 156) were classified as Underlying, 15.5% (n = 31) as Deep-rooted, and 6.5% (n = 13) as Dispute, indicating the day-to-day situation remains persistently problematic and is escalating for many.

- In “History of Previous Attempts,” an overwhelming 92.5% (n = 185) were categorized as Dispute and only 7.5% (n = 15) as Deep-rooted, reflecting a generally superficial community recognition of past management efforts, often perceived as ineffective.

- For “Willingness to Engage,” most responses (85.5%, n = 171) were at the Dispute level, with only 14.5% (n = 29) at Underlying and almost none at Deep-rooted, indicating generalized reluctance to participate in resolution efforts.

- With "Views about Others Involved" (authorities and third parties), 68.0% (n = 136) were Dispute, 31.0% (n = 62) Underlying, and just 1.0% (n = 2) Deep-rooted, showing dissatisfaction with authorities is common but rarely reaches entrenched or identity-based opposition (Figure 6).

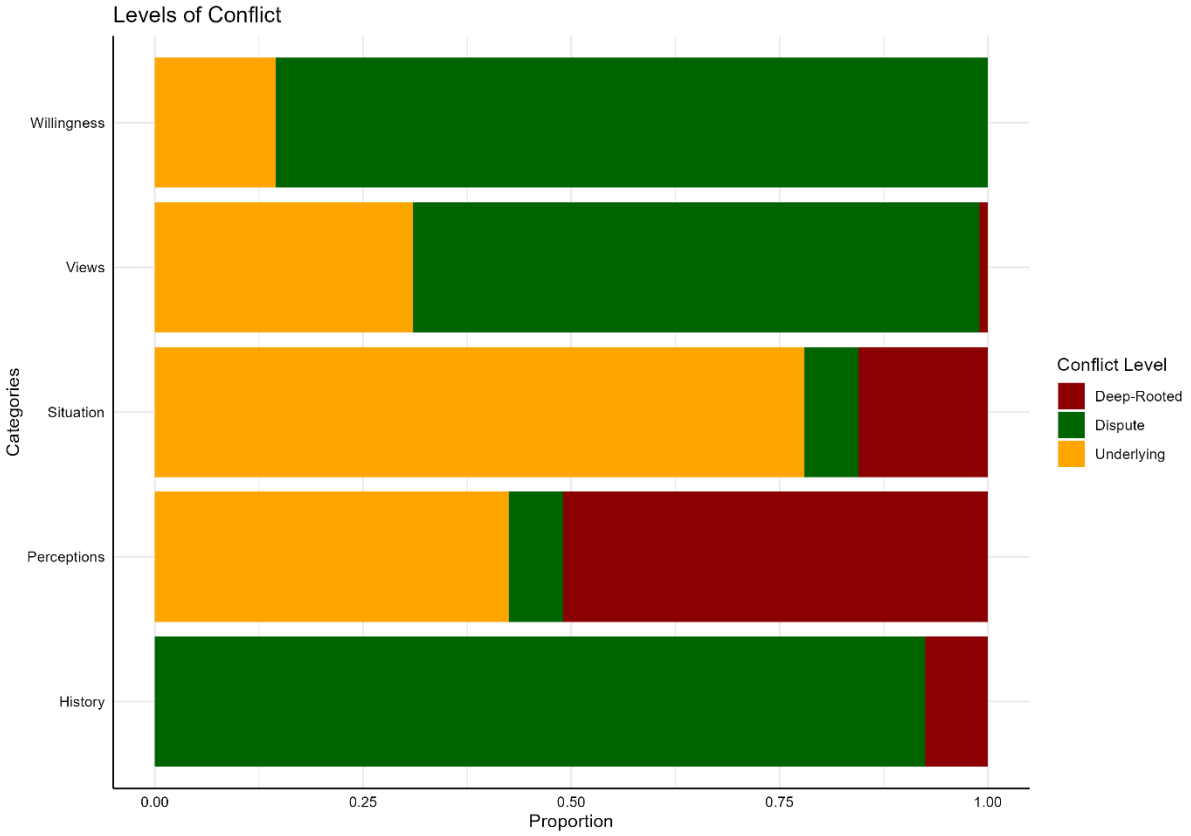

Figure 6: Level of conflict across each of the five categories.

Collectively, these findings illustrate that while some conflict has reached deep-rooted levels, particularly regarding perceptions of macaques and the lived situation, most areas, especially related to historical interventions, willingness to participate, and views on authorities, remain at a more surface, dispute-oriented stage. This layered conflict profile highlights the pressing need for interventions tailored not only to resolve visible disputes but also to address the less visible underlying and identity-based dimensions to achieve long-term coexistence.

4. Discussion

This case study at the periphery of Asola-Bhatti Wildlife Sanctuary, New Delhi, investigated community attitudes and perceptions concerning rhesus macaques, park managers, and existing management efforts, with the primary aim of identifying the prevailing level of human–wildlife conflict. By surveying 200 local residents, we deepened understanding of the complex dynamics underlying these persistent interactions.

Our results are consistent with previous research documenting frequent negative encounters between people and macaques, such as attacks, injuries, food snatching, property damage, and household intrusions, which together

increase community anxiety and workload (Ganguly & Chauhan, 2019; Ganguly et al., 2018; Nulkar, 2017). In this study, 88 percent of surveyed participants reported frequent negative interactions with rhesus macaques, including significant property damage (44.5 percent), disruption of daily activities (40.5 percent), and increased workload (93 percent). The majority of these incidents were driven by macaques' search for provisioned food, as well as persistent human fear of personal attack, a dynamic reflected in both our data and the wider literature.

Sengupta and Radhakrishna (2018) emphasize that provisioning alters macaque dietary behavior, leading to reduced natural foraging and decreased dietary diversity, ultimately increasing macaques' reliance on human-modified habitats. Parallel findings by Beisner et al. (2015) indicate that greater food availability intensifies human–macaque conflict, while Solomon (2013) reports that fear of macaque aggression prompts defensive human responses, perpetuating a recurring cycle of tension.

4.1 Perceptions of the Species Blamed in the Conflict

In our study, negative encounters and macaque aggression were found to substantially shape unfavorable community perceptions of rhesus macaques. Yet, despite the significant economic impact and disruption caused by these primate interactions, a remarkable level of tolerance persists within the community. This tolerance reflects a complex, sometimes paradoxical relationship, strongly influenced by cultural values and practical realities. For many, macaques hold deep cultural and religious meaning, particularly as manifestations of Lord Hanuman, a connection that not only shapes local attitudes but also affects approaches to conflict management (Riley, C.M., 2013; Radhakrishna, 2018).

Notably, cultural and religious importance emerged as the primary driver of positive attitudes in our results: 49 percent of respondents cited this factor and, among these, 91.8 percent reported positive views toward macaques. Conversely, aggressive macaque behaviors were associated with a high rate of dislike (84.8 percent among those citing aggression), aligning with previous findings on how threatening animal behaviors negatively impact perception (Beisner et al., 2015).

Beyond these two groups, our study identified a substantial subset (28 percent) of the community that assigns neither religious nor cultural importance to macaques. This group generally perceives macaques as "cute, intelligent, and human-like," with most (87.5 percent) expressing neutral attitudes. This suggests that, for these individuals, perceptions are less rooted in entrenched beliefs or direct conflict and more in the frequency and quality of everyday interactions. This pattern reflects findings from Singapore, where Sha et al. (2009) showed that neutral attitudes toward long-tailed macaques, based on human-like behavior, can shift rapidly depending on

the nature of interactions. Recognizing such perceptual diversity is critical for designing conflict resolution approaches suited to local values.

Regardless of whether their perspectives arose from religious, cultural, or neutral frames, the vast majority of respondents (90 percent) reported feeding macaques. This provisioning is widely accepted, as shown by the 71 percent opposition to penalties for provisioning. Such behaviors are strongly intertwined with personal beliefs and community norms. Regional patterns mirror these findings: in Goa, provisioning is more common among non-Hindu groups, whereas in Himachal Pradesh, Hindus are most likely to feed macaques (Sengupta & Radhakrishna, 2020).

4.2 Assessment of the Apparent Situation

The practice of provisioning has complex consequences for both macaque behavior and the broader dynamics of human–primate interaction. While food handouts can, under certain circumstances, strengthen human–animal relations, they also drive greater ecological and social stress in shared landscapes. Prolonged provisioning elevates macaque presence in human-dominated areas, increases aggressive interactions within and between species, and ultimately amplifies the likelihood and severity of conflict (Peng, 2008). Despite these risks, most residents continue to see provisioning as either benign or culturally sanctioned, a perspective underscored by widespread community resistance to penalties for feeding, a pattern consistent with observations from other regions (Sengupta & Radhakrishna, 2020).

Negative human–macaque interactions remain a central concern: 90 percent of respondents viewed such encounters as very or moderately severe. The main factors attracting macaques into residential zones were poorly managed garbage dumps (47 percent) and the lack of accessible natural food and water resources (30.4 percent). This trend is reinforced by similar findings from other studies, where unmanaged waste sites attract macaque groups and foster proximity to people and conflict-prone spaces (Rai & Rai, 2024; Pemadasa, 2022). The scarcity of natural resources further compels macaques to depend on human foods, escalating competition and complicating efforts at peaceful coexistence.

4.3 Evaluation of Previous Attempts to Address Conflicts

Effective management of human–rhesus macaque conflict necessitates close coordination among stakeholders, including the Forest Department, local authorities, NGOs, researchers, and community representatives. Historically, interventions have ranged from translocation of macaques to continued food provisioning within

sanctuary limits (Delhi Forest Department, 2014; Radhakrishna & Sinha, 2010). However, these steps have not succeeded in reducing conflict frequency or improving community satisfaction, as shown by persistent feelings of frustration and disillusionment along the sanctuary's edge.

A particularly striking finding from our study was the severe lack of local awareness regarding conflict management efforts: 91.5 percent of respondents reported no knowledge of official actions, and 86 percent could not name any wildlife helpline or reporting resource (Ilham et al., 2023). Such widespread unawareness points to a serious gap in institutional outreach and community engagement, which in turn erodes trust and thwarts collaborative approaches for conflict mitigation. Comparable patterns have been documented in other settings, where high-profile interventions are rarely followed by ongoing communication or support, leaving communities ill-informed and marginalized from management processes (Stevens et al., 2024).

Furthermore, our study did not uncover evidence of sustained or systematic efforts, such as public awareness campaigns or actionable follow-up plans, by the Forest Department since the initial, large-scale macaque translocation. This absence of ongoing outreach and dialog likely compounds the persistence and escalation of underlying and deep-rooted conflict dynamics along the urban–sanctuary boundary.

4.4 Perceptions about Authorities and Third Parties Involved

Gaps in communication and management visibility have contributed to consistently negative community perceptions of government authorities involved in macaque conflict mitigation. Our findings show that 88.6 percent of respondents reported either no response or very delayed response from the department during conflict situations. Similar patterns have been documented by Ganguly and Chauhan (2019) and Solomon (2013), who highlighted disconnects between communities and wildlife management authorities, with responsiveness often influenced by the community's informal or encroached status. In this study, 46.5 percent of residents attributed the department's lack of timely response to the unofficial status of their settlement, a pattern consistent with Solomon (2013).

Additional negative perceptions were linked to beliefs that the department is unwilling or lacks motivation to address conflict (26.5 percent of respondents), indicating broader institutional challenges. For a minority (15 percent), uncertainty about whether rhesus macaques are officially classified as "wild" contributed to ambiguity and further eroded trust in authorities' engagement and accountability.

4.5 Willingness to Engage in Conflict Resolution Efforts

Community willingness to participate in conflict mitigation efforts is strongly influenced by perceptions of departmental responsiveness and broader attitudes toward macaques. Senthilkumar et al. (2024) observe that effective and timely government actions are critical for building public trust; conversely, delayed or inadequate responses foster beliefs that conflicts will worsen and become more difficult to resolve. Consistent with this, our study finds that 76 percent of respondents expect future escalation of human–macaque conflict, especially those perceiving poor departmental response, holding negative attitudes toward macaques, or belonging to older age groups (56–65 years).

Research underscores that perceptions of fairness, effectiveness, and responsiveness in management directly shape conservation attitudes and willingness to collaborate (Madden & McQuinn, 2014; Pebsworth et al., 2021). Negative and distrustful views reduce tolerance and hinder support for nonlethal or participatory strategies. Global perspectives emphasize community involvement and adaptive management as essential elements for successful conflict mitigation (Madden, 2004).

Reflecting this, 62.5 percent of respondents expressed unwillingness to engage in community-led mitigation programs. Primary reasons for non-participation included shifting responsibility to the forest department (15 percent), doubts about local participation efficacy due to limited habitat for macaques (28.5 percent), and lack of confidence in managing authorities (25 percent). Conversely, respondents willing to participate often cited communal responsibility, though practical limitations such as time constraints posed barriers.

These diverse perspectives emphasize the necessity for inclusive and context-sensitive management strategies. Building trust between communities and authorities, clarifying program goals, and addressing logistical constraints are critical to enhance participation and cooperation (Dickman, 2010). Ultimately, grasping the factors driving both willingness and reluctance is essential for crafting sustainable, community-driven conflict resolution efforts.

4.6 Existing Level of Conflict

Our findings indicate that perceptions of inadequate departmental response, deepening distrust, and limited community involvement, alongside widespread expectations of worsening conflict, emphasize the importance of assessing not only the presence but also the depth of tensions between people and rhesus macaques. Using composite indices to categorize conflicts into three levels, we found that most cases in the study area corresponded to Level 2, the 'Underlying conflict' category (OCI = 1.632).

This underlying level is defined by visible disputes that arise from a legacy of repeated, unresolved incidents. Such a history creates escalating frustration and entrenched divisions, as what managers may see as "resolved" disputes often remain lasting sources of resentment for affected residents (Zimmermann et al., 2020; Madden & McQuinn, 2014). The persistence of this divide represents a classic "them versus us" dynamic, which further complicates effective intervention.

For example, Govindrajan (2019) described a comparable situation in Uttarakhand, where relocation of macaques from urban to rural areas, intended as a solution, instead triggered new conflict and community backlash. These patterns underscore the essential need for collaborative conflict resolution that addresses historic grievances and actively incorporates local voices (IUCN SSC, 2018; IUCN, 2023).

4.6.1 Addressing Underlying Conflicts (Level 2)

Resolving Level 2 conflicts requires more than just technical or practical fixes; it demands strategies that acknowledge the historical baggage of disputes and proactively identify common ground. Conflict resolution should involve reframing issues, discussing past grievances, and explicitly recognizing the relevant social context (Zimmermann, 2014; Zimmermann et al., 2020).

Effective negotiation skills and stakeholder relationship-building are vital to moving beyond partial or conditional alignments of interest. Prioritizing shared goals, like community safety, access to resources, or conservation objectives, can support stronger collaboration (Kumar & Sethi, 2005). Experiences from Japan and other settings suggest that community-based approaches, rather than top-down mandates, are more effective at aligning management with local perceptions and needs (Suzuki & Muroyama, 2010; Hockings & Humley, 2009; Anand & Radhakrishna, 2020). Meaningful community engagement in decision-making, acknowledgment of historical grievances, and adaptation of solutions to the specific social context are critical steps to build trust and facilitate long-term coexistence.

4.7 Conclusion: The Need for Long-Term, Community-Centered Solutions

A nuanced understanding of conflict levels, ranging from surface disputes to deeply rooted divides, enables a deeper diagnosis of the dynamics driving human–macaque tensions. By exploring perceptions, management histories, and socioeconomic factors, this study underscores the importance of community-centered approaches. True progress requires the involvement of local voices, historical reconciliation, and culturally sensitive solutions to move beyond recurring disputes.

This research is not without limitations. Conducted within a single geographic region, the findings may not be universally generalizable. Self-reported data introduce potential biases, the cross-sectional design limits temporal insights, and the absence of direct behavioral observation means that some conflict dynamics may remain hidden. Future studies should expand geographic scope, incorporate longitudinal and observational methods, and integrate community-based participatory frameworks to strengthen both analysis and recommendations.

Addressing these conflicts calls for a deliberate shift from short-term fixes to sustained, inclusive efforts. Building trust, improving communication, and targeting root causes, rather than symptoms, are essential to achieving durable solutions. By equitably balancing the needs and priorities of both wildlife and local communities, this work offers a practical pathway for more holistic management of human–wildlife conflicts and points toward policy innovations suited to India's rapidly changing urban–wildlife interface.

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The authors declare no competing interests.

Data Availability Statement:

The data supporting this study are not publicly available due to confidentiality agreements with participants and restrictions imposed by the funding institution. However, access to the dataset can be granted upon request to the corresponding author or via the Wildlife Institute of India's data repository, subject to approval.

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References

Anand, S., Binoy, V.V., Radhakrishna, S., 2018. The monkey is not always a God: Attitudinal differences toward crop-raiding macaques and why it matters for conflict mitigation. *Ambio* 47, 711–720. https://doi.org/10.1007/s13280-018-1033-3

Anand, S., Radhakrishna, S., 2020. Is human–rhesus macaque (*Macaca mulatta*) conflict in India a case of human–human conflict? *Ambio* 49, 1685–1696. https://doi.org/10.1007/s13280-020-01395-1

Beisner, B.A., Heagerty, A., Seil, S.K., Balasubramaniam, K.N., Atwill, E.R., Gupta, B.K., McCowan, B., 2015. Human–wildlife conflict: Proximate predictors of aggression between humans and rhesus macaques in India. *Am. J. Phys. Anthropol.* 156, 286–294. https://doi.org/10.1002/ajpa.22650

1. Bowonder, B., 1982. Deforestation in India. *Int. J. Environ. Stud.* 18, 223–236. https://doi.org/10.1080/00207238208709894

Chakraborty, S., 1965. Rhesus monkeys in north India. In: DeVore, I. (Ed.), *Primate Behavior: Field Studies of Monkeys and Apes*. Holt, Rinehart & Winston, New York, pp. 111–159.

Chauhan, A., Pirta, R.S., 2010. Public opinion regarding human-monkey conflict in Shimla, Himachal Pradesh. *J. Hum. Ecol.* 30, 105–109. https://doi.org/10.1080/09709274.2010.11906315

Delhi Forest Department, 2014. *Asola Bhatti Wildlife Sanctuary Management Plan*. Government of National Capital Territory of Delhi. Available at: https://forest.delhi.gov.in/sites/default/files/generic_multiple_files/management_plan_of_ashola_bhati.pdf (accessed 13 February 2025).

Dickman, A.J., 2010. Complexities of conflict: The importance of considering social factors for effectively resolving human–wildlife conflict. *Anim. Conserv.* 13, 458–466. https://doi.org/10.1111/j.1469-1795.2010.00368.x

DownToEarth, 2023. Human behaviour to blame for dog, monkey and pigeon numbers becoming unmanageable in urban landscape. *DownToEarth*, 16–30 June 2023. Available at: https://www.downtoearth.org.in (accessed 13 February 2025).

Ganguly, I.G., Chauhan, N.S., 2018. Daily behavioural activity patterns and reproductive ecology of urban rhesus macaques (*Macaca mulatta*) in human-dominated landscapes and its implication in management. *J. Appl. Nat. Sci.* 10, 1101–1108. https://doi.org/10.31018/jans.v10i4.1946

Ganguly, I.G., Chauhan, N.S., 2019. How perception of local people towards rhesus macaque (*Macaca mulatta*) can influence decision-making in human-macaque conflict mitigation? *J. Wildl. Biodivers.* 3, 52–62. https://doi.org/10.5281/zenodo.3267241

Ganguly, I., Chauhan, N.S., Verma, P., 2018. Assessment of human–macaque conflict and possible mitigation strategies in and around Asola–Bhatti Wildlife Sanctuary, Delhi NCR. *Environ. Ecol.* 36, 823–827.

Gopalan, R., Radhakrishna, S., 2022. Moving from coexistence to conflict: A political ecology perspective on human-rhesus macaque conflict in Himachal Pradesh, India. *Hum. Ecol.* 50, 463–476. https://doi.org/10.1007/s10745-022-00350-7

Govindrajan, R., 2019. *Animal Intimacies: Interspecies Relatedness in India's Central Himalayas*. University of Chicago Press, Chicago.

Hill, C.M., 2021. Conflict is integral to human–wildlife coexistence. *Front. Conserv. Sci.* 2, 734314. https://doi.org/10.3389/fcosc.2021.734314

Hockings, K., 2009. *Best Practice Guidelines for the Prevention and Mitigation of Conflict between Humans and Great Apes* (No. 37). IUCN, Gland, Switzerland.

Ilham, K., Rizaldi, R., Tsuji, Y., Wu, C.Y., Su, Y.C., 2023. Assessing farmers' experience and perception of crop-feeding long-tailed macaques in West Sumatra, Indonesia: Implication for coexistence and conservation. Unpublished manuscript.

IUCN SSC, 2018. IUCN SSC position statement on the culling of the Mauritius fruit bat *Pteropus niger*. IUCN, Gland, Switzerland. Available at: http://www.iucn.org/theme/species/publications/policies-and-position-statements (accessed 13 February 2025).

IUCN, 2023. *IUCN SSC Guidelines on Human–Wildlife Conflict and Coexistence*, First edition. IUCN, Gland, Switzerland.

Kumar, R., Sethi, A.K., 2005. Negotiating and resolving conflicts in India. In: Doing Business in India: A Guide for Western Managers. Routledge, London, pp. 130–139.

Madden, F., 2004. Creating coexistence between humans and wildlife: Global perspectives on local efforts to address human–wildlife conflict. *Hum. Dimens. Wildl.* 9, 247–257. https://doi.org/10.1080/10871200490505675

Madden, F., McQuinn, B., 2014. Conservation's blind spot: The case for conflict transformation in wildlife conservation. *Biol. Conserv.* 178, 97–106. https://doi.org/10.1016/j.biocon.2014.07.015

Nulkar, G., 2017. Silent conflicts–Human–wildlife interactions in urban spaces. *J. Ecol. Soc.* 29, 34–43.

Pebsworth, P.A., Gawde, R., Bardi, M., Vijayan, B.V., Radhakrishna, S., 2021. To kill or not to kill? Factors related to people's support of lethal and nonlethal strategies for managing monkeys in India. *Hum. Dimens. Wildl.* 26, 541–558. https://doi.org/10.1080/10871209.2021.1958041

Pemadasa, D.G.C.L., 2022. The human-macaque conflict and management strategies of Sri Lanka (with special reference to Uva Paranagama Divisional Secretariat Division in Badulla District). *Vidyodaya J. Humanit. Soc. Sci.* 7, 1–12.

Peng, Z.H., 2008. Effects of provisioning on the social-ecological aspects of nonhuman primates. *Acta Anthropol. Sin.* 27, 274.

Priston, N.E., McLennan, M.R., 2012. Managing humans, managing macaques: Human–macaque conflict in Asia and Africa. In: Radhakrishna, S., Huffman, M.A., Sinha, A. (Eds.), *The Macaque Connection: Cooperation and Conflict between Humans and Macaques*. Springer, New York, pp. 225–250.

Radhakrishna, S., 2018. Primate tales: Using literature to understand changes in human–primate relations. *Int. J. Primatol.* 39, 878–894. https://doi.org/10.1007/s10764-018-0059-1

Radhakrishna, S., Sinha, A., 2010. Dr Jekyll and Mr Hyde: The strange case of human-macaque interactions in India. *Curr. Conserv.* 4, 39–40.

Rai, S., Rai, R., 2024. Monkey menace in Nepal: An analysis and proposed solutions. *J. Multidiscip. Sci.* 6, 26–31.

Redpath, S.M., Young, J., Evely, A., Adams, W.M., Sutherland, W.J., Whitehouse, A., Gutierrez, R.J., 2013. Understanding and managing conservation conflicts. *Trends Ecol. Evol.* 28, 100–109. https://doi.org/10.1016/j.tree.2012.08.021

Riley, C.M., 2013. Book review: The Macaque Connection: Cooperation and Conflict between Humans and Macaques, by Sindhu Radhakrishna, Michael A. Huffman, and Anindya Sinha. Springer, New York, 2013, xii+255 pp. ISBN 978-1-4614-3966-0. *Am. J. Primatol.* 75, 1080–1082.

Saraswat, R., Sinha, A., Radhakrishna, S., 2015. A god becomes a pest? Human-rhesus macaque interactions in Himachal Pradesh, northern India. *Eur. J. Wildl. Res.* 61, 435–443. https://doi.org/10.1007/s10344-015-0913-7

549 Sengupta, A., Radhakrishna, S., 2018. The hand that feeds the monkey: Mutual influence of humans and rhesus
550 macaques (*Macaca mulatta*) in the context of provisioning. *Int. J. Primatol.* 39, 817–
551 830. https://doi.org/10.1007/s10764-018-0060-8

552 Sengupta, A., Radhakrishna, S., 2020. Factors predicting provisioning of macaques by humans at tourist sites. *Int.*
553 *J. Primatol.* 41, 471–485. https://doi.org/10.1007/s10764-020-00158-4

554 Senthilkumar, K., Mathialagan, P., Manivannan, C., 2024. A case study on conflict between humans and monkeys
555 at Chengalpet District, Tamil Nadu. Unpublished report.

556 Sha, J.C.M., Gumert, M.D., Lee, B.P.H., Jones-Engel, L., Chan, S., Fuentes, A., 2009. Macaque–human
557 interactions and societal perceptions of macaques in Singapore. *Am. J. Primatol.* 71, 825–
558 839. https://doi.org/10.1002/ajp.20711

559 Solomon, D.A., 2013. Menace and management: Power in the human-monkey social worlds of Delhi and Shimla.
560 Doctoral dissertation, University of California, Santa Cruz.

561 Southwick, C.H., Lindburg, D.G., 1986. The primates of India: Status, trends, and conservation. In: Benirschke,
562 K. (Ed.), *Primates: The Road to Self-Sustaining Populations*. Springer, New York, pp. 171–187.

563 Southwick, C.H., Siddiqi, M.F., 1988. Partial recovery and a new population estimate of rhesus monkey
564 populations in India. *Am. J. Primatol.* 16, 187–197. https://doi.org/10.1002/ajp.1350160302

565 Southwick, C.H., Siddiqi, M.F., 1994. Population status of nonhuman primates in Asia, with emphasis on rhesus
566 macaques in India. *Am. J. Primatol.* 34, 51–59. https://doi.org/10.1002/ajp.1350340106

567 Southwick, C.H., Siddiqi, M.F., 2011. India's rhesus populations: Protectionism versus conservation management.
568 Unpublished report.

569 Southwick, C.H., Siddiqi, M.R., 1968. Population trends of rhesus monkeys in villages and towns of northern
570 India, 1959–65. *J. Anim. Ecol.* 37, 199–204. https://doi.org/10.2307/2716

571 Stevens, M., Rawat, S., Satterfield, T., 2024. Care, conflict, and coexistence: Human–wildlife relations in
572 community forests. *People Nat.* https://doi.org/10.1002/pan3.10532

573 Suzuki, K., Muroyama, Y., 2010. Resolution of human–macaque conflicts: Changing from top-down to
574 community-based damage management. In: Nakagawa, N., Nakamichi, M., Sugiura, H. (Eds.), *The*
575 *Japanese Macaques*. Springer, Tokyo, pp. 359–373.

576 Tiwari, K.K., Mukherjee, R.P., 1993. Population census of rhesus macaque and Hanuman langur in India—a status
577 survey report. *Rec. Zool. Surv. India*, 349–369.

578 Vijayaraghavan, G., Tate, V., Gadre, V., Trivedy, C., 2022. The role of religion in One Health: Lessons from the
579 Hanuman langur (*Semnopithecus entellus*) and other human–non-human primate interactions. *Am. J.*
580 *Primatol.* 84, e23322. https://doi.org/10.1002/ajp.23322

581 Zimmermann, A., 2014. Jaguars and people: A range-wide review of human–wildlife conflict. Doctoral
582 dissertation, University of Oxford, UK.

583 Zimmermann, A., McQuinn, B., Macdonald, D.W., 2020. Levels of conflict over wildlife: Understanding and
584 addressing the right problem. *Conserv. Sci. Pract.* 2, e259. https://doi.org/10.1111/csp2.259