Primate Conservation 2018 (32): 205-215

Understanding Perceptions of People Towards Lion-Tailed Macaques in a Fragmented Landscape of the Anamalai Hills, Western Ghats, India

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Abstract: The fragmentation of the rainforests of India's Western Ghats mountains has left the endemic lion-tailed macaque surviving in numerous forest patches in a mosaic of commercial tea and coffee plantations. On the Valparai Plateau, Anamalai Hills, some macaque groups have evidently altered their behavior, becoming habituated to people, suffering from frequent roadkill, and facing problems related to people feeding them and their use of open waste dumps. We carried out a questionnaire survey around three rainforest fragments (Puthuthottam, Korangumudi, Old Valparai) and the town of Valparai to understand people's perceptions towards macaques, and to identify appropriate conflict-mitigation measures. Macaques near Korangumudi and Old Valparai rarely ventured near residences, and most people were unaware of their presence. Respondents in and around Puthuthottam were aware of the macaques, and most (68%) had negative perceptions of them because the macaques often visited houses in the area. Most respondents (87%) believed that macaques visited houses in search of food and garbage, and 84% reported that macaques were doing this only over the last 10 years. Housing conditions influenced people's perceptions: people living in tiled-roof houses that were vulnerable to incursions by the macaques had higher negative perceptions (84.5%) compared to people living in asbestos-roof and concrete structures. To reduce negative interactions with people and promote harmonious human-macaque co-existence, we suggest implementing a combination of measures that would involve plantation management, conservation organizations, and the state forest and municipal authorities. The measures include cost-effective monkey-proofing of houses, regular garbage collection, preventing open waste disposal and the feeding of macaques, mitigating the effects of roads, and promoting people's awareness, rainforest restoration, and the use of native shade trees in plantations.

Key Words: *Macaca silenus*, Western Ghats, human-wildlife conflict, forest fragmentation, perceptions

Introduction

Interactions between human and non-human primates such as wild macaques occur in a variety of landscape and cultural contexts around the world (Lee and Priston 2005; Fuentes 2012; Sinha and Mukhopadhyay 2013; Sinha and Vijayakrishnan 2017). Many macaque groups that occur in cities, rural settlements, and the forest-agriculture interface have adapted well to human-modified conditions, while sometimes coming into conflict with people due to crop-raiding, entering homes in search of food, or injuring people (Radhakrishna *et al*. 2013). The pervasive occurrence of such interactions where humans and macaques share social and ecological spaces has triggered much recent ethnoprimatological research and conservation efforts designed to reduce conflicts and promote human-primate coexistence (Riley 2007; Fuentes 2012; Gumert *et al*. 2011). Conservation efforts that aim to modify human-macaque interactions require examining peoples' perceptions of, and attitudes towards, the species, in order to understand the nature of the interactions and identify suitable mitigation measures (Hill and Webber 2010). Peoples' attitudes and perceptions of conflict depend on factors such as the nature and intensity of the conflict, their economic status and gender, and their cultural and religious tolerance, besides levels of education or awareness about macaque species (Anand *et al*. 2018; Gursky and Fields 2018).

The lion-tailed macaque (*Macaca silenus*), endemic to the rainforests of the Western Ghats in India, is listed as Endangered on the *IUCN Red List of Threatened Species*, is in Appendix I of CITES, and is protected under Schedule I of India's Wildlife Protection Act (Kumar *et al.* 2008). Habitat fragmentation is a major threat to the species that has population of only around 4,000 individuals in the wild (A. Kumar *et al*. 2008). Kumara *et al.* (2014) estimated a population of

1,108 lion-tailed macaques in 63 groups in the Anamalai Hills of the southern Western Ghats. Of these, at least nine groups and over 200 individuals occur in rainforest fragments surrounded by tea and coffee plantations on the Valparai Plateau (Singh *et al.* 2002; Mudappa and Raman 2007; Sridhar *et al*. 2008; Umapathy *et al*. 2011). While lion-tailed macaques are largely confined to forest interiors, in recent years, groups in rainforest fragments close to developed areas and penetrated by roads have shown behavioral changes, becoming habituated to people (Singh *et al.* 2001). As a result, roadkill has increased (Jeganathan *et al.* 2018), as have incidents of conflict due to people feeding them or because they enter houses or visit open waste dumps.

In a questionnaire-based study, we surveyed awareness about lion-tailed macaques and the perceptions of people who live near rainforest fragments frequented by lion-tailed macaques on the Valparai Plateau of the Anamalai Hills. We scored their perceptions as positive, neutral, or negative, and examined how these varied in relation to housing conditions, employment category, and frequency of interactions with macaques in different locations. We also assessed people's perceptions of the history and causes of negative interactions and recorded measures they had themselves implemented to reduce conflict with the macaques. We use our findings to identify appropriate measures that can enable the conservation of this species and provide a model for building a harmonious human-macaque coexistence across similarly fragmented tropical landscapes.

Methods

Study area

The study was carried out on the Valparai Plateau, Anamalai Hills, southern Western Ghats. The plateau is surrounded by the Anamalai Tiger Reserve in the state of Tamil Nadu to the north and east, and Parambikulam Tiger Reserve and Reserved Forests in Kerala state to the west and south. The Valparai Plateau occupies 220 km², mostly under plantations of tea, coffee, and eucalyptus, besides roads and human settlements. There are over 40 rainforest fragments embedded in these private plantations (Mudappa and Raman 2007). The natural vegetation of the region is mid-elevation tropical wet evergreen forest (Pascal 1988). Lion-tailed macaques occur in eight forest patches surrounded by plantations. They are affected by habitat degradation due to fragmentation and past logging, while three fragments also have linear intrusions, such as roads and powerlines passing through them that cause occasional deaths due to roadkill or electrocution (Jeganathan *et al.* 2018; Raman 2011). Our study focused on these three fragments, namely Puthuhtottam, Korangumudi, and Old Valparai, with special attention to Puthuthottam, which has the largest population (122 lion-tailed macaques in three groups; Umapathy *et al*. 2011).

Puthuthottam population

Conservation threats are particularly pronounced in the 92-ha Puthuthottam forest patch. It adjoins abandoned coffee and active tea plantations of the Puthuthottam Estate. The fragment abuts the densely populated Valparai town (population: 19,865, according to Census of India 2011) and has two human settlements (87 households) on the estate. The macaques range over the forest fragment and abandoned coffee areas. In the past, this forest fragment had cardamom in the understorey. In 1989−1990 and 1997−1998, part of the adjoining coffee plantation was converted to a tea plantation, trees were felled (Singh *et al.* 2001; pers. obs.), and the forest continues to face chronic firewood collection by local people, particularly from the adjoining towns of Valparai and Rottikadai. In recent years, the main highway to Valparai, which passes through and bisects the fragment and coffee area, has been widened, and vehicular traffic and tourist influx have increased.

The continuous degradation of the forest has affected the ecology and behavior of the lion-tailed macaques. Because of reduced canopy height, cover, and food tree availability, the percentage of time that these arboreal macaques spend in trees has declined from 95.4% in 1990–1991 to 70.7% in 1999–2000 (Singh *et al.* 2001). The monkeys are increasingly seen on the ground, on the main highway, and in adjoining human settlements. In the last 10 years, at least 10 lion-tailed macaques were killed on the road through Puthuthottam as they were forced to cross on the ground due to gaps in the tree canopy. At least four monkeys have been electrocuted while attempting to cross on powerlines passing through their habitat (pers. obs.).

Questionnaire survey

Between January and May 2015, we conducted household level perception surveys in the settlements in and near three rainforest fragments, namely Puthuthottam, Korangumudi, and Old Valparai (earlier known as Tata Finley), where lion-tailed macaques occur. We also conducted this survey in a part of Valparai town, close to Puthuthottam, which lion-tailed macaques are known to frequent (Fig. 1).

A questionnaire for residents was prepared to identify perceptions and score attitudes (ranging from positive and neutral to negative) towards these primates (see Appendix 1). We also categorized respondents by gender and employment (estate worker, home maker, managerial staff, non-managerial staff, and others), and noted details such as the nature of conflict incidents, the frequency and history of visits of lion-tailed macaques near their settlements, response to the presence of lion-tailed macaques near their residence, and other stakeholder responses and solutions offered. The type of roof (tile, asbestos, and concrete) of the respondent's residences was also noted.

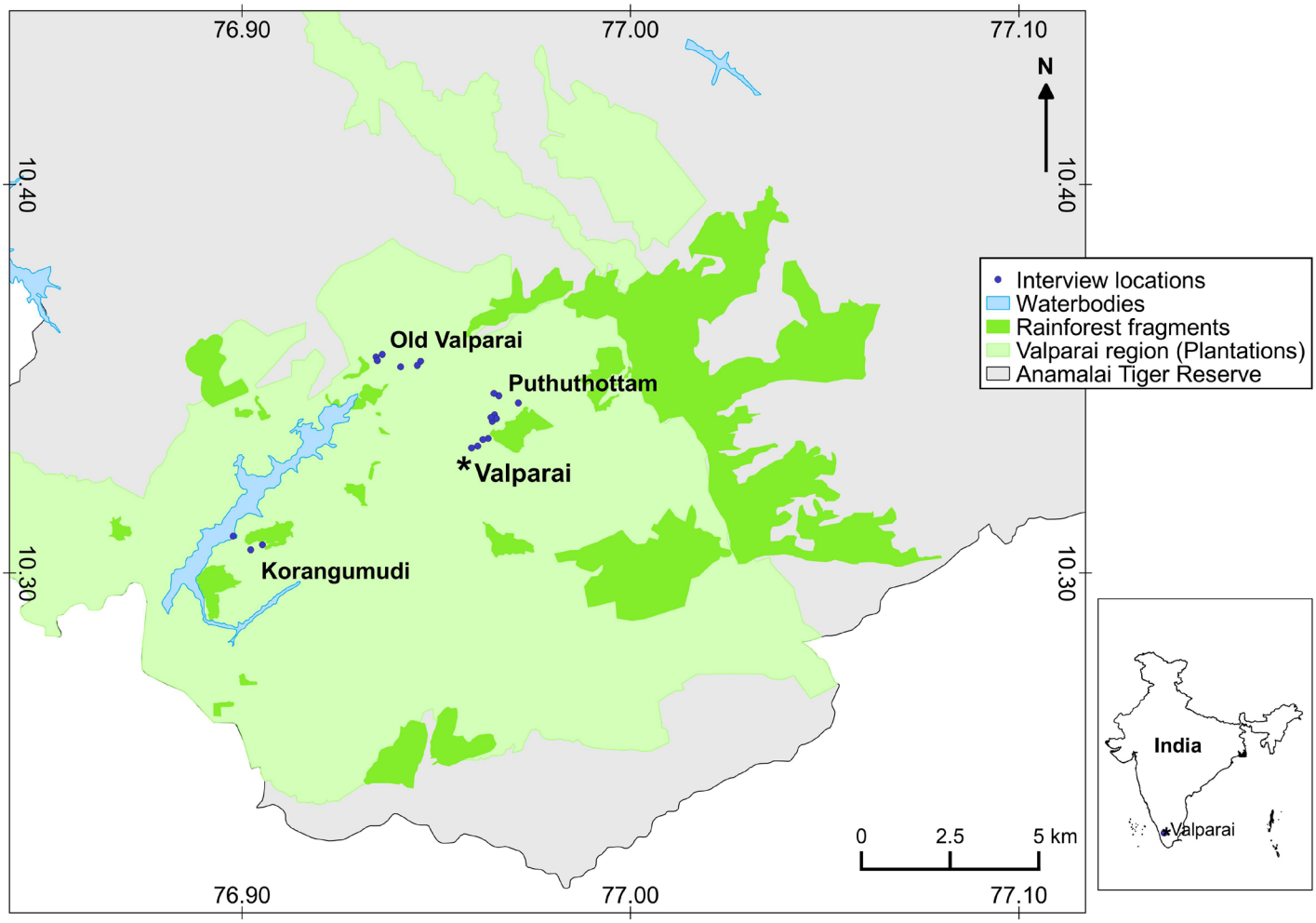

Figure 1. The Valparai plateau in the Anamalai Hills, Western Ghats, India, showing the locations of forest patches and the sites where the survey was conducted.

Surveys were conducted mostly during the evening or late evening or on Sundays when local people were at their homes, as most work in tea estates during the day. We obtained approval from the ethics committee of the Nature Conservation Foundation for the study and questionnaire. The interviews were conducted only if the interviewees were willing to participate, ensuring informed consent and maintaining anonymity. All interviews were conducted by one person (PJ) and in the local language, Tamil. In a few cases (less than 3%), the interview was conducted in Hindi as the respondents were workers from other parts of India where Hindi was spoken. Although there was a set of questions asked directly to obtain certain details, the interview was conducted mostly in the form of a dialogue from which the interviewer noted down and scored for attitudes.

The respondent's perception was inferred and scored based on the responses during the dialogue, noting his/her general perception of the lion-tailed macaques, reactions to the presence of macaques near their homes, and their behavior and activities when the macaques come close their houses. For instance, during the dialogue, based on the connotations of words like "nuisance" or "problem" and the intensity with which these words or statements were made, responses were scored as '–1' indicating negative perception. Positive statements about macaques, such as "they are not to blame" and "no problem with them around", were scored as '+1' indicating a positive attitude. People who were indifferent to the macaques' presence near their houses or those who did not make statements that were positive or negative and those not aware of the presence of the macaques were scored as '0' indicating a neutral attitude. Interviews with Puthuthottam respondents tended to be longer as macaques frequented this area more and because other aspects such as frequency of interactions, boldness of individual macaques, and measures implemented to avoid macaques were described by and discussed with respondents.

Results

We interviewed people from 34 households in Korangumudi, 50 in Old Valparai and 136 in the Puthuthottam area. The Puthuthottam survey area included 87 households fringing the forest fragment in the Puthuthottam estate, 19 households in the Parambikulam Aliyar Project Colony (hereafter PAP colony), and 30 households in the town of Valparai adjoining the estate.

Awareness about lion-tailed macaques

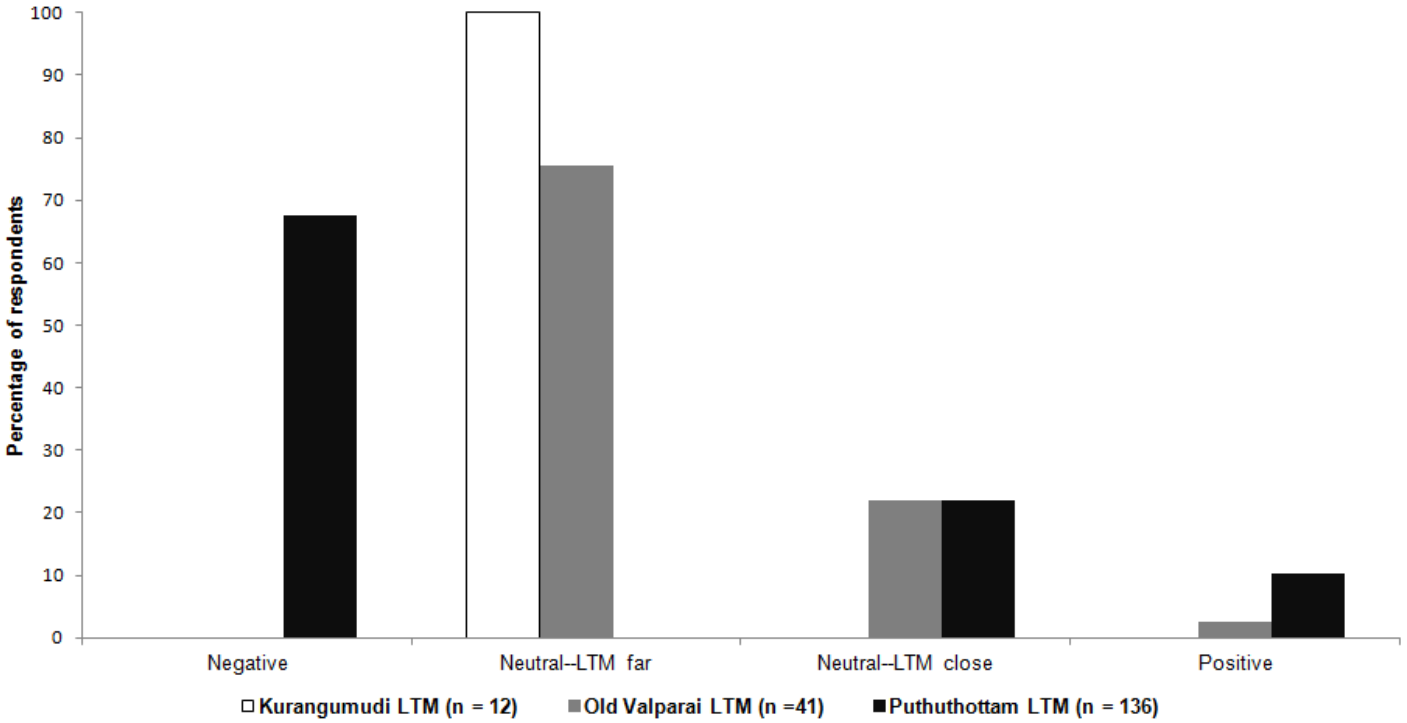

Figure 2. Perceptions towards lion-tailed macaques in three study locations in the Valparai landscape, Anamalai Hills. N = number of respondents.

Of the 220 respondents, 97.2% were unaware of the importance, status and distribution of the lion-tailed macaques. Interestingly, 14% were not aware of the existence of the lion-tailed macaque. These respondents were mainly from Korangumudi and Old Valparai area. Of 34 respondents interviewed in Korangumudi, only 12 (35%) were aware of the existence of lion-tailed macaques in the area, but they had not seen them in the Korangumudi forest or near their houses, instead recalling seeing them in forest far from their residences. Most (82%) of the respondents in Old Valparai were aware of lion-tailed macaques, but they too knew of them in forests far from their residences.

Perceptions towards lion-tailed macaques

Perceptions towards macaques varied across sites and also in relation to whether macaques had been seen near or far away from their homes. In Korangumudi, where respondents had not seen the lion-tailed macaques near human habitations, they were neutral in their perception (Fig. 2). In Old Valparai, 41 respondents were aware of lion-tailed macaques and although there was some variation in perception among them, 97.6% were neutral. A majority (75.6%) of these respondents had not seen lion-tailed macaques close to their houses. The remainder (22%) had seen two individual lion-tailed macaques that sometimes approached houses in the area. Two respondents (3%) were positive towards macaques and had come across the two individuals. In Puthuthottam area, the majority (67.6%) of the 136 respondents were negative about the presence of lion-tailed macaques, but 22% of the respondents were neutral, and 10.2% had positive perceptions towards the lion-tailed macaques (Fig. 2).

Influence of housing condition on perceptions

As lion-tailed macaques have learned to remove/move the tiles on the roof to enter the houses to gain access to food, especially when the residents are away from home, we examined the effects of different roofs on houseowners' perceptions towards the macaques. Of the 87 occupied houses in Puthuthottam estate where the interviews were conducted, 55.2% had tiled roofs and the rest (44.8%) were asbestos. Overall, across 136 households in the Puthuthottam area (Puthuthottam, the PAP colony, and town of Valparai), most (84.5%) of the 58 respondents living in tiled-roof houses were negative in their general perception towards lion-tailed macaques (Fig. 3). Respondents (n = 67) living in asbestos-roof houses also had negative perceptions towards the lion-tailed macaques, although relatively less (61.2%) when compared to the respondents with tiled-roof houses. Interestingly, some respondents (both in tiled-roof and asbestos-roof houses) also had positive attitudes. Respondents living in concrete-roofed housing were largely neutral (81.8%) but some were negative. The residents' perceptions towards the lion-tailed macaques were strongly influenced by their housing conditions ($\chi^2 = 8.7$, df = 4, P <0.0000). This pattern was accentuated in peoples' perceptions towards troublesome incidents due to lion-tailed macaques. Irrespective of housing condition, most respondents (>50%, all roof types) had a negative

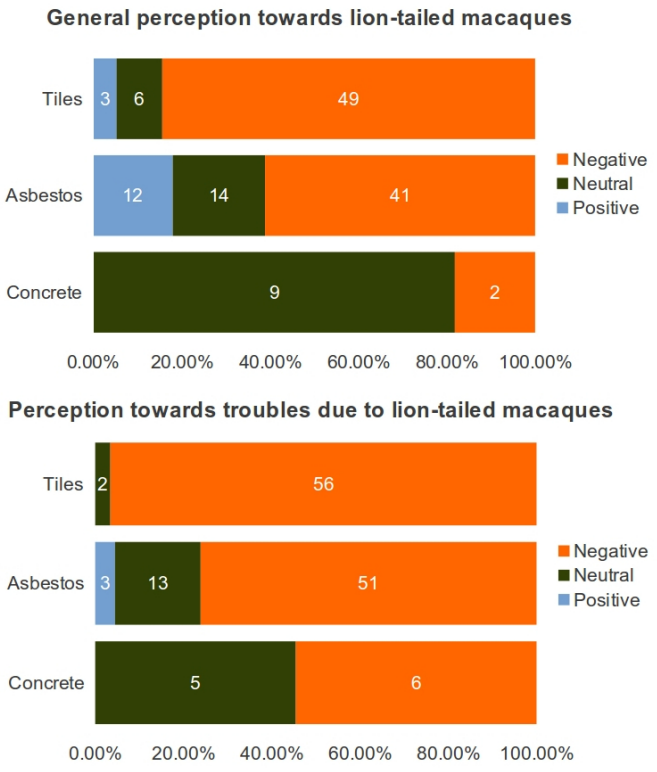

Figure 3. Housing conditions and the perceptions of residents towards lion-tailed macaques in general and specifically in response to conflict or troublesome incidents in Puthuthottam and Valparai area, Anamalai Hills.

perception towards macaques in relation to trouble incidents ($\chi^2 = 20.0$, df = 4, P <0.0005, Fig. 3).

We also examined differences in responses between estate and town residents. More respondents (87.4%) living in Puthuthottam tended to be negative than in the neighboring areas of Valparai (32.7%), where several respondents were neutral or positive. Perceptions may have also been related to the frequency of encounters with lion-tailed macaques near habitations. Of 136 respondents, most (122) believed the macaques come near human habitation every few days, while 11 respondents said once in a fortnight, and just three said every day. Over three-quarters of the respondents who encounter the lion-tailed macaques near their houses every few days or every day tended to have more negative perceptions of the species, whereas over 80% of those who encountered macaques only once a fortnight tended to hold neutral perceptions (Fig. 4).

Macaque visitation: reasons and history

When residents were asked their opinion on the reasons for lion-tailed macaques visiting human habitations, most (87%) mentioned that the macaques are in search of food and garbage. A few respondents (8%) said that they were seen close to human habitations because tourists, photographers and, in one case, a researcher were either feeding the macaques directly or discarding food that attracted the

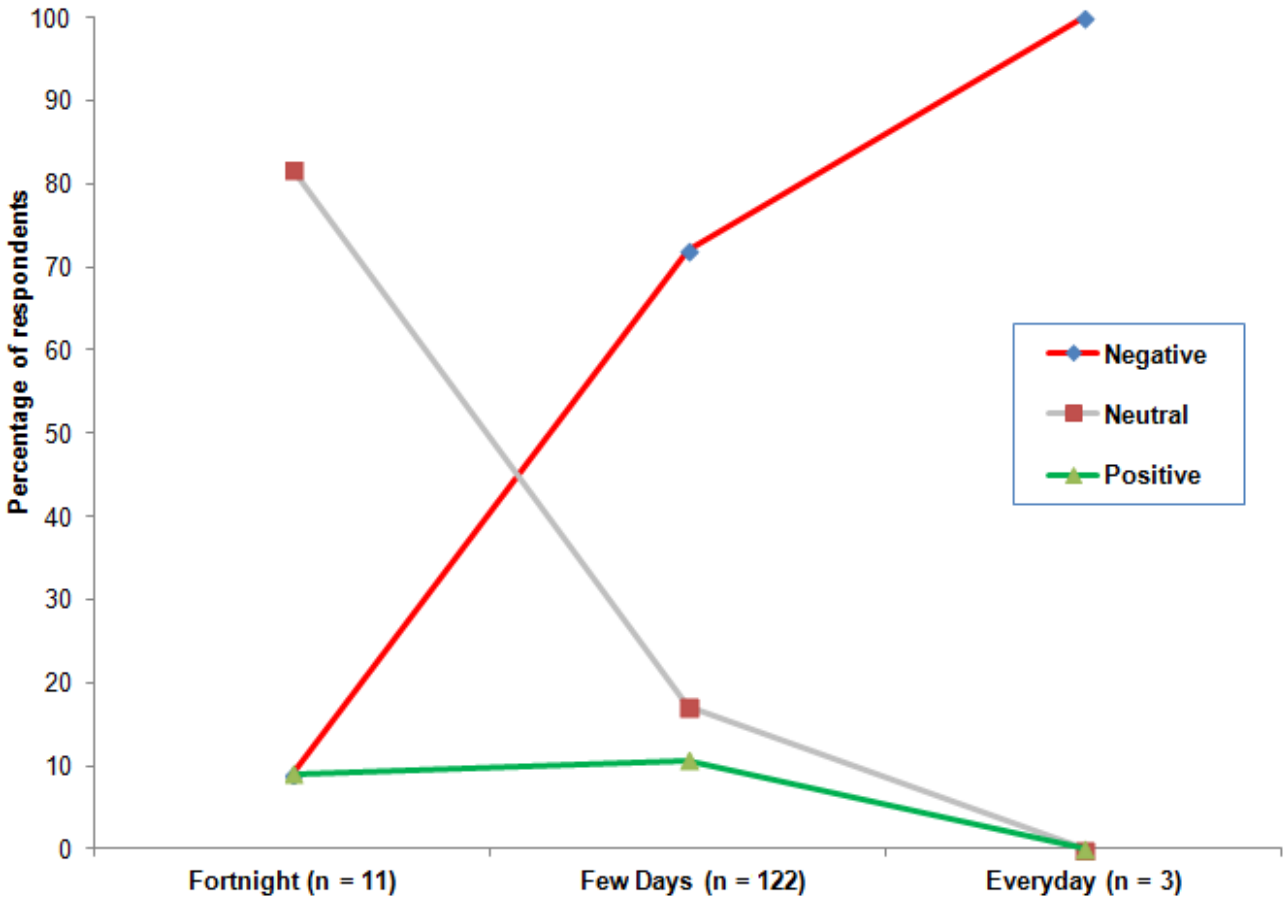

Figure 4. Influence of frequency of encountering lion-tailed macaques near habitation on people's perceptions in the Puthuthottam area, Anamalai Hills.

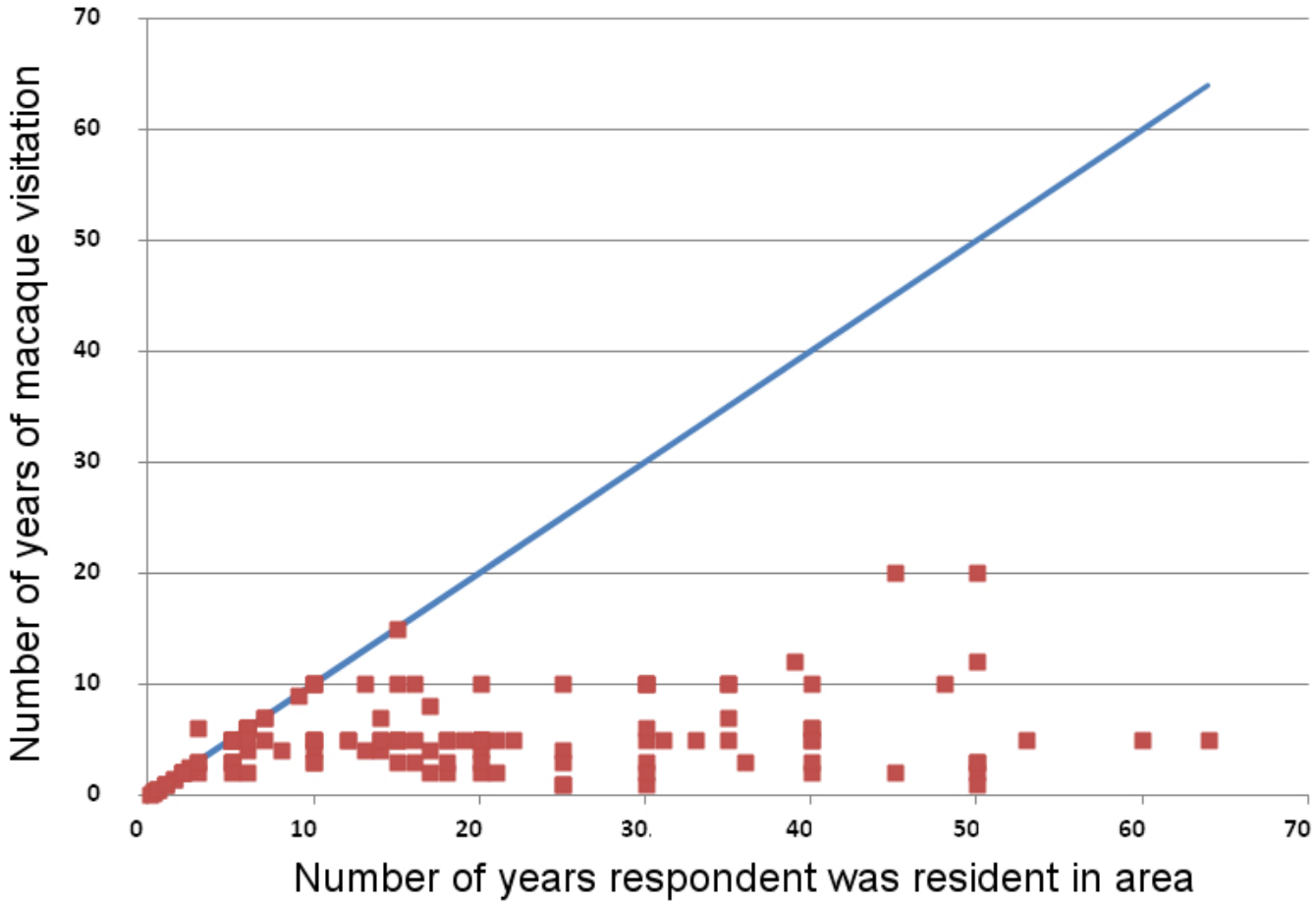

Figure 5. Respondents' duration of residence in Puthuthottam and nearby areas in relation to their perception of the history of visits by lion-tailed macaques near habitats. Most points fall below the straight line (y = x) which indicates that even though a majority of people have been resident for over a decade, most of them report macaques near habitations only within the last 10 years.

macaques. A couple of lion-tailed macaques (adult males) were reported by a few respondents as having become bold, apparently approaching people without fear to seek food, and one of them even snatching food and garbage from people's hands. Answering the question of how many individuals showed such behavior, 60% of the respondents mentioned that only a few showed a lack of fear in this way. Thirty-eight percent of the respondents said that none of them show this boldness in their behavior. Of 136 respondents, only 2% said that many of the macaques are apparently fearless.

We also asked respondents in Puthuthottam about how long they had lived there, and also the number of years that macaques have been visiting habitations and since when negative interactions had been occurring. Most (84%) of the 136 respondents mentioned that lion-tailed macaques had been frequenting human habitations only within the last 10 years (within the last year: 4%; last 1–4 years: 37%; last 5–9 years: 43%). Only two respondents (1%) mentioned that macaques had been frequenting the area over the last 20 years; possibly because both these respondents lived close to the forest edge in a place called Pathu-acre Padi ('Padi' means 'Colony' in Tamil) and would have seen macaques near their houses for a longer period when compared to the other residents. Two respondents did not know how long the macaques had been visiting their area, and one reported a 15–20 year period. Virtually all respondents reported macaques over a period that fell within their own duration of residence in the area. It was clear, however, that most respondents that had been resident there for a long time (from 10 to 64 years) reported that lion-tailed macaques had been seen in the vicinity of human habitations only within the last 10 years (Fig. 5).

Discussion

Perceptions of people toward lion-tailed macaques were influenced by multiple factors including the frequency of encounters with monkeys in the vicinity of their houses, the occurrence of negative interactions, the housing conditions (roofs), and environmental factors such as presence of roads and improper garbage disposal. The study indicates multiple anthropogenic influences on human-macaque interactions in the landscape. Increased anthropogenic pressures may cause a variety of changes in primate biology and behavior, such as increased risk of population declines and extinction (Estrada *et al*. 2017), higher physiological stress (Rangel-Negrín *et al*. 2014), inbreeding (Peterson and Riley 2013), bi-directional disease transmission due to feeding by tourists (Russon and Wallis 2014), and increase in social tension among individuals

Figure 6. Canopy bridge of rubberized canvas installed across the road in the Puthuthottam rainforest, Anamalai Hills, and used by lion-tailed macaques. Photo by Ganesh Raghunathan, NCF.

within groups due to provisioning (Ram *et al*. 2003). Primates such as macaques may alter their time-activity budgets and foraging behavior due to habitat alteration or degradation (Singh *et al.* 2001) or become exposed to greater interactions with people, provisioned foods, parasites, and a higher mortality from roadkill or electrocution as a result of linear infrastructure such as roads and powerlines that pass through their habitats (S. Kumar *et al.* 2018; Raman 2011).

In our study in the Western Ghats rainforests, such effects of habitat degradation and fragmentation on the endemic lion-tailed macaque are most acute in the case of the Puthuthottam fragment near Valparai. The lack of tree canopy connectivity in many places especially across the road, forced lion-tailed macaques to go to the ground, despite being a largely arboreal species that rarely ventures to the ground or goes close to habitation in the other study sites (Singh *et al*. 2001; Sushma and Singh 2006). Canopy bridges have been put up and maintained by conservation groups since 2011 to enable the movement of arboreal mammals across highways and thereby reduce the risk of roadkill (Fig. 6).

Along Puthuthottam and near Valparai, poor garbage disposal (tourists throwing food away by the side of the road, residents throwing out food close to human habitations) attracted macaques and brought them into greater contact with human foods and habitations. Residents reported that deliberate or careless feeding of macaques by tourists/visitors along the road and improper/open garbage disposal were primary reasons for the macaques visiting housing areas. Conflicts are, as a result, most serious in the Puthuthottam estate and adjoining colonies in Valparai, which contributes to negative perceptions towards the macaques among residents. This was in contrast to Koramgumudi and Old Valparai, where people remained mostly neutral or even positive, probably because the groups there are relatively shy and mainly known to inhabit the canopy and interior of the nearby rainforest fragment and coffee estates. Our observations are consistent with earlier studies that show that feeding primates increases conflict with humans (Biquand *et al.* 1994; Sengupta *et al.* 2015). Improper garbage management can also increase the risk of pathogen infections and poisoning for animals (Hussain *et al*. 2013; Plaza and Lambertucci 2017) and this is another concern in the area, particularly for the Puthuthottam groups.

An important finding of this study is the strong connection found between housing conditions and negative attitudes towards lion-tailed macaques. Macaques in search of food entered houses through open doors and windows, and by removing roof tiles in Puthuthottam estate colonies and in Valparai. Retaliatory measures by residents, such as chasing them using firecrackers and throwing sticks or stones indicate a decreased tolerance towards macaques, which until recently

had been high. These results suggest that measures to improve housing (particularly roofs) to make them monkey-proof are likely to reduce conflict incidents and enhance positive perception towards the macaques. Similar suggestions have been provided for resolving human-primate conflicts in Sri Lanka (Cabral *et al.* 2018). It should be noted that simple, cost-effective measures (sheet roofs, fixing ceiling, closing gaps at the eaves) appear to be available, and some have already been deployed by local people.

Around the world much of the human-wildlife conflict involving macaques and other primates is due to crop damage and tourism (Priston and McLennan 2013), and rarely involves damage to infrastructure (Cabral *et al*. 2018). Conflict between humans and primates increases with the close proximity of humans, as shown in several studies (Nahallage and Huffman 2013). As the respondents of Puthuthottam settlements reported, the lion-tailed macaques are frequently seen near human habitations in search of food, and this phenomenon is recent (within the last 10 years). This corresponds to a period of increased influx of casual tourists to Valparai along the main highway (widened in recent years) passing through the rainforest fragment. This suggests that reducing the attractors to the highway, especially discarded human foods, and education and awareness to avoid feeding macaques need to be key components of any planned mitigation. In addition, there has been an increased movement of the macaques away from the forest fragment into the townships of Valparai and Rottikadai in the last year (pers. obs.).

Our survey and continued observations thus indicate the urgency for action using five broad measures that will help mitigate conflict and facilitate coexistence between people and the endangered lion-tailed macaque:

1. *Improving housing through monkey-proofing measures:* Specific houses which are frequently visited by macaques in Puthuthottam need to be made monkey-proof, with the joint involvement of residents, estate management, the forest department, and researchers. Existing methods for monkey proofing used by the residents should be continued with modifications as they are likely to gain better acceptance by the community. The effectiveness of these measures to reduce or prevent macaque incursions into houses needs to be assessed.

2. *Better garbage disposal:* Tourists and residents of Puthuthottam should be made aware of the ill effects of open garbage disposal and be encouraged to improve waste disposal through awareness, training for residents, and support to manage solid and organic waste. Measures need to be taken by estate management to prevent monkeys from accessing medical waste pits and garbage around hospitals, and to regularly remove garbage produced around roadside stalls located in the estates. The local municipalities need to provide closed garbage bins and collect garbage regularly from the Puthuthottam estate colonies.

3. *Building awareness on macaque feeding and conservation status:* Local stakeholders (residents, tourists, researchers, wildlife photographers) should be educated on the ill effects of feeding lion-tailed macaques. Estate managers and conservationists need to educate the residents, particularly of Puthuthottam estate and the town of Valparai on the importance, conservation status, and distribution of the lion-tailed macaque. Continuous awareness and training is also required on waste segregation and disposal practices.

4. *Ecological restoration of rainforest fragments and retention of native shade trees in plantations:* To reverse the effects of historical habitat degradation, a key long-term need is to facilitate the recovery of rainforest vegetation (especially food species of lion-tailed macaques) through appropriate ecological restoration measures in the rainforest fragments, particularly Puthuthottam and Korangumudi. The restoration of tree canopy structure, continuity, and diversity of native tree species will assist this arboreal primate to meet its food and ranging requirements (M. A. Kumar *et al*. 2018), and minimize the incidence of macaques coming to the ground to feed and consequently engage in negative interactions with humans. An ongoing long-term rainforest restoration project in the region has developed effective protocols and identified a suitable mix of native rainforest trees and other woody plant species for such ecological restoration (Mudappa and Raman 2010). There are also many native shade trees, including *Artocarpus heterophyllus* and *Cullenia exarillata*, in the old coffee areas and recent tea fields. These trees should be protected from felling, and future shade planting in coffee and tea areas could more frequently include suitable native trees.

5. *Mitigating effects of roads on macaques:* The negative effects of roads and highways passing through or alongside rainforest fragments (Old Valparai, Puthuthottam Korangumudi) need to be mitigated. Government authorities should prohibit the widening of roads in the sections passing through or along rainforest fragments and also install speed breakers at regular intervals. The continued maintenance of existing canopy bridges (at Puthuthottam and Old Valparai) and encouraging natural tree canopy connectivity to form overhead pathways across roads are also essential to reduce road-kill and negative human-macaque interactions (Jeganathan *et al.* 2018).

Implementing these recommendations involving the local stakeholders, particularly plantation managers and the State Forest and Highways Departments, is urgently needed to resolve conflicts at their initial stage, and vital to promote coexistence and retain and increase the tolerance of people towards these endangered primates.

Acknowledgments

We thank the plantation managers and companies, particularly Arunkumar Menon, Vivek Ayanna, and Ranjit Kattapuram, of Parry Agro Industries Ltd, Tata Coffee Ltd, and Tea Estates India Ltd, respectively, for helpful interactions and permission to work in their estates. We are grateful to the Tamil Nadu Forest Department, particularly range officers and field staff, for discussions and support. For funding, we thank the Nacey Maggioncalda Foundation for the Goldberg Conservation Grant that made this work possible. We

are grateful to our field assistants, particularly A. Dharmaraj and K. Kannan, for sharing their experiences, and our colleague Ganesh Raghunathan for much help and many useful discussions. We thank all the interviewees who responded to our questionnaire survey besides sharing their experiences and ideas. We are also grateful to the Snow Leopard Trust and our colleagues in NCF for their help. We sincerely thank two reviewers for their comments which have improved the clarity of the paper.

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Received for publication: 20 November 2018
Revised: 12 December 2018

Appendix

Questionnaire used for attitude survey to identify perceptions towards lion-tailed macaques (LTM) in Valparai plateau.

Date: Time:

Name:

Address: _____ Family Size _____ Employment_____

Phone Number: _____

1. What do you think of LTMs?
2. How often do you see LTMs and where?

   Everyday_____ Once in a week _____Once in a fortnight_____

   Once a month_____ Few times (>5 times) a year_____

3. When was the last time LTM came near your house?

Date / Month_____. And the previous time Date / Month _____

4. What do they do when they come close to your house?
5. Are they troubling you? If so what kind of trouble?

Yes_____ No _____ / 1. Aggressive 2. Entering house (if so how?)

_____

6. What do you do when you see them around your house?
7. How long have they been around?
8. Since when (years) have LTMs visited around your house?

   One ____ Two_____ Three_____ Four_____ Five_____

   More than Five_____

9. Why do you think they are visiting your area?
10. Where else do you think that LTMs occur in the world? And do you know how many of them there are in the world?