

Chaos in Coexistence: Perceptions of Farmers towards Long-tailed Macaques (*Macaca fascicularis umbrosus*) Related to Crop Loss on Great Nicobar Island

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Abstract: Increased occupation of primate habitats by humans has forced primates into close contact with their settlements and crops. We conducted a survey with the island settlers on Great Nicobar Island to investigate the conflict between farmers and Nicobar long-tailed macaques. The conflict may have increased following the 2004 tsunami due to the co-dependency of people and macaques on coconuts and cultivated crops. Farmers considered the macaques to be the major cause of crop loss. Macaques foraged on crops more during the rainy season, and more at dawn and dusk. Indirect market-related reasons added to the economic hardship on the part of the settlers. Farmers with small landholdings perceived the loss to be greater than did the owners of larger holdings. Farmers with small landholdings and large families were more intolerant of the macaques. The farmers did not, however, suggest killing the macaques as a way to mitigate crop loss and overcome the conflict.

Keywords: Great Nicobar Island, *Macaca fascicularis umbrosus*, crop-foraging, farmers' perceptions

Introduction

Many primates associate closely with humans, and some even hold a significant place in human cultures, be it in reverence or as a nuisance (Hill and Webber 2010). The values and cultures predisposing attitudes towards primates vary, however, depending on whether the conditions and circumstances are competitive in nature and when and the extent to which livelihoods are affected by them (Hill and Webber 2010; Anand *et al.* 2018). Understanding the human dimensions of wildlife has become an important tool to understand the operating conditions for human-primate conflict (Baruch-Mordo *et al.* 2009). The perceptions of people concerning the degree of damage is one such dimension, important in establishing an effective conflict mitigation plan (Knight 2000; Riley 2007; Kansky and Knight 2014). It is important to understand the conflict from diverse points of view, and the perceptions regarding tolerance of the local people towards wildlife along with the socio-economic underpinnings of such perceptions.

Attitudes vary across cultural and ecological settings (Hill and Webber 2010; Radhakrishna 2018). There are particular challenges on islands resulting from stochastic natural events and the restricted space available for both humans and wildlife (Lewis 1990). Great Nicobar Island is the southernmost of the Andaman and Nicobar Islands. Much of it comprises the Great Nicobar Biosphere Reserve with a total area of 885 km² (Andaman and Nicobar Administration 2008). The endemic Nicobar long-tailed macaque (*Macaca fascicularis umbrosus*), the only non-human primate in the island group, is found on the islands of Katchal, Little Nicobar, and Great Nicobar (Umamathy *et al.* 2003). Great Nicobar is also home to c. 8,000 people—settlers from mainland India and two tribes, the Nicobarese and Shompen (Registrar General of India 2011). Farmers on the island grow coconut (*Cocos nucifera*), fruits and vegetables (Bag 2016). After the initial settlement in 1969 (Pabla 2018), the settlers cleared acres of forest for agriculture, changing the land-use pattern on the island. The major food sources for the macaques are coconut and *Pandanus* (Velankar *et al.* 2016),

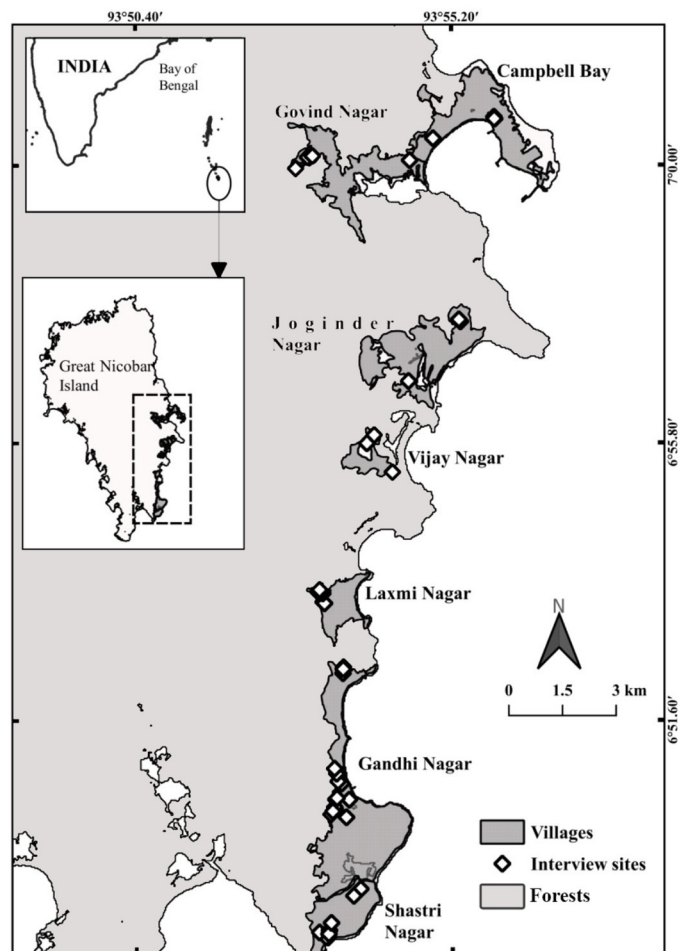


Figure 1. The sites of interviews on Great Nicobar Island.

which brings the macaques and farmers into close proximity. The 2004 tsunami washed away vast areas of coastal vegetation on Great Nicobar, submerging coconut and *Pandanus* food patches (Sankaran 2005; Sivakumar 2010; Velankar *et al.* 2016). The loss of their natural habitats and food resources, especially *Pandanus*, resulted in a decline in the macaque population (Sivakumar 2010). This perhaps pushed the macaques towards human habitations and agricultural fields where they had better access to food. This led to a certain recovery in the population but also an increase in human-macaque interactions (Sivakumar 2010; Velankar *et al.* 2016). The Nicobar long-tailed macaques, due to their restricted range and overall decline in numbers, are ranked as “Vulnerable” on the IUCN Red List (Ong and Richardson 2008) and have been accorded maximum protection under the Schedule-I category (Indian Wildlife Protection Act of 1972).

The settlers cleared the forest on Great Nicobar Island to grow crops, mainly coconut, for their sustenance, with fields being close to the forest edge (Pabla 2018) where foraging on coconuts by macaques was expected to be frequent and to result in conflict. To develop mitigation measures, it was necessary to understand the perception of the farmers towards the macaques and the conflict. With this in mind, we conducted this study to understand the nature of interactions and

perceptions of the settlers with respect to long-tailed macaques on Great Nicobar Island.

Methods

Study area

The study was conducted on Great Nicobar Island (Fig. 1). Campbell Bay is the administrative and commercial headquarters. The island is ethnically highly diverse with a population in 2011 of 8,367, comprising settlers from mainland India and two native tribes: the Nicobarese and Shompen (Registrar General of India 2011).

Interviews

We conducted semi-structured interviews with open-ended questions to understand the perception of farmers about the macaques and their effect on agriculture in the seven settler villages of Great Nicobar Island (Appendix Table 1; Fig. 1). Scattered settlements are considered to be part of one of the seven closeby villages (Table 1). We did not interview the native tribes because of legal restrictions.

We selected 45 of 188 practicing farmers on the island (Registrar General of India 2011) for the survey (Table 2). Respondents were drawn from all the villages and hence had a spread over the entire inhabited area on the island. Respondent numbers varied from the number of farmers as many had left farming recently due to incurring losses. We use the term “crop-raiding” specifically for when wild animals feed on agricultural produce that is not in their regular (wild) diet and on a farm which is outside of their usual habitat (Sillero-Zubiri and Switzer 2001). The above definition may not be strictly true in the present case as these macaques feed naturally on coconut (Umaphy *et al.* 2003) and the farms are close to the forests. Interviews were conducted with the informed consent of the respondents.

Data collection

The survey was conducted from August 2017 to November 2017. We identified farming households and located their farms. A person primarily engaged in farming in each household was selected as respondent. The villages were chosen based on the number of cultivators as per the 2011 census (Registrar General of India 2011) (Appendix, Table 1). The number of respondents did not correspond, however, with the census data due to inter- and intra-island relocations by farmers since the census. Questions were asked to gather information on demographics, and crop-related and conflict-related aspects (Appendix, Table 2).

The tolerance level of farmers was ascertained after asking the farmers about how they perceived the macaques: whether they tolerate the “macaques using the farms” (high tolerance) or whether they want immediate restriction measures for stopping the macaques (low tolerance) foraging in their crops. Also, we enumerated the various mitigation methods employed by the farmers against crop foraging by the macaques. The frequency of complaints to the authorities

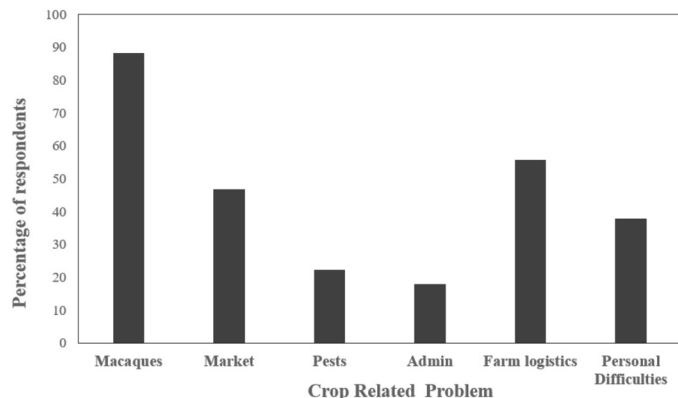


Figure 2. Proportion of farmers considering different reasons for crop loss.

concerning crop-raiding could not be ascertained because they were verbal and not officially recorded.

Analysis

The association between the loss perception by the farmers and the socio-economic variables (land holding, family size, and income) were tested using Fisher’s Exact Test (due to low class-frequencies for a contingency table), and the extent of loss perception was estimated using the Odds-Ratio Model. For the Odds-Ratio Model, we assessed the association between the categories of land-ownership, family size, and income with the perception of high loss. Similarly, the associations between the tolerance level of the farmers and the perceived loss and socio-economic variables (landholding, family size, and income) were tested using Fisher’s Exact Test and the level of tolerance was estimated using the Odds-Ratio Model. A Chi-squared Test was used to determine whether the age of the farmers influenced their perception of loss. All the tests were carried out using SPSS v20 (IBM Corp., USA).

Results

Details of the respondents

We interviewed 42 men and three women farmers from seven villages. Not all the respondents replied to all the questions. Of the 30 farmers who provided the details of family size, 17 (57.0%) had a family class size of more than three and 13 (43.0%) of less than three. Of the 30 respondents

who reported income, 17 (57%) and 13 (43.0%) were in the High- and Low-Income categories, respectively (Table 3). Of the 45 interviewees, 22 (48.9%) depended solely on farming for subsistence, the other 23 had alternative/additional livelihood options.

Agriculture

Of the 34 respondents who answered the question on land loss due to the 2004 tsunami, 14 respondents (31.0%) reported the tsunami-related loss of land with an average loss of 1.0 ± SD 1.8 ha per person. Coconut was the major crop grown by 82% of the farmers (n = 37), followed by Areca nut (*Areca catechu*) (n = 3), and vegetables and fruits (n = 3), which were each grown by 6% of the farmers. Annual per capita investment for 24 interviewees (53%) amounted to an average of INR 40,957 ± SD 109,098 (range = INR 0–600,000). The majority of the respondents (75.5%, n = 34) reported an economic loss in agriculture, and three respondents described agriculture as a profitable income source. The remaining eight respondents were uncertain about the outcome of their agricultural endeavors.

Conflict

The majority of the farmers reported that macaques were the major cause of loss on the farms. Other factors of loss reported included the availability of tractors and insufficiency of fertilizer and high-quality seeds (Fig. 2). Most of the respondents mentioned attacks by the macaques on their person or their dogs (Table 4). Most respondents said there was no seasonality, but those who perceived seasonality reported crop-foraging as more frequent during the rainy season than in the dry season. Six farmers reported that macaques would appear in the early morning and evening to forage because the farms of some of them are far from their homes, and the farmers were as such dependent on a fixed bus schedule. Thirty farmers reported that they spent the majority of the day guarding the crops, otherwise facing a total loss. The number of hours for guarding was thus approximated to be eight hours per day.

There was no significant relation between the percent of agriculture-related income and loss (r = 0.15, N = 29, p = 0.43). The major crop-related loss was classified into two categories: a) direct loss caused by animals, especially the

Table 1. Details of the villages in the Great Nicobar Island.

Village name	Date of establishment	Population	Main occupation
Campbell Bay	1969	5736	Business, government job
Govind Nagar	1974	676	Farming, government job
Joginder Nagar	1974	693	Government Job
Laxmi Nagar	1974-1980	230	Farming
Vijay Nagar	1974-1980	100	Farming
Gandhi Nagar	1974-1980	69	Farming
Shastri Nagar	1974-1980	15	Farming

Table 2. Number of cultivators and the number of respondents per village at the Great Nicobar Island.

Village	No. of cultivators	No. of respondents
Campbell Bay	38	3
Laxmi Nagar	7	8
Govind Nagar	40	7
Joginder Nagar	24	4
Vijay Nagar	5	2
Shastri Nagar	4	6
Gandhi Nagar	0	10
Total	118	45

macaques, and b) indirect loss, caused by miscellaneous market-related problems such as inconsistent pricing, lack of consumers, unavailability of labor, and lack of means to transport the crops. Lack of food and the destruction of the macaques' habitat ($n = 17$) and the lack of labor to guard the crops ($n = 10$) were considered to be the major causes of macaque-related crop loss. Market-related issues ($n = 12$) and failure to grow alternative crops ($n = 11$) were the major indirect causes of loss of income from agriculture. The sharp increase in the intensity of crop foraging by macaques and related loss in the post-tsunami period was reported by 58% of the respondents.

In six villages, macaques were considered to be the major threat to the crops, especially coconut. At Shastri Nagar, however, the crops were perceived to be damaged equally by macaques and other animals, viz. rodents, fruit bats, long-tailed parakeets (*Psittacula longicauda*) and domestic and wild pigs (*Sus scrofa*) (Table 5). Forty respondents in the seven villages mentioned macaques as the major threat to the crops (Table 5). Crop loss was perceived highest in Joginder Nagar (75% of the farmers) followed by Gandhi Nagar (60% of the farmers). Although 100% of the loss was attributed to macaques in Joginder Nagar, 83% of crop loss was due to macaques in Gandhi Nagar (Table 5). The Fisher's Exact Test did not show any significant association between the three variables tested with the perception of loss but Odds-Ratio revealed that the farmers with small landholdings, large family size, and low income perceived the loss to be higher (Table 6). Age had no influence on the perception of crop loss ($\chi^2 = 1.217$, $p = 0.270$).

Tolerance

Fisher's Exact Test did not show any significant association between the four socio-economic variables and the level

**Figure 3.** The Nicobar long-tailed macaque, *Macaca fascicularis umbrosus*. Photograph by Honnavalli N. Kumara.

of tolerance of macaque damage. The Odds-ratio Model, however, revealed that the farmers with small landholdings, low income, with large families, and facing high loss were less tolerant (Table 7).

Mitigation measures

The mitigation method most used was guarding the farm aided by dogs (31%), followed by guarding the farm without any aid (15.5%), and employing guarding services using both laborers and dogs (13%). About 22% of the farmers did not use any of these methods. One farmer used aluminum sheets to restrict rodents from climbing the coconut trees, a trick which also worked for macaques. Two respondents used airguns/catapults to scare away the macaques. Farmers also mentioned that, although having laborers is beneficial to guard against macaques, the high wages of labor make it inconducive.

The majority of the farmers did not have any ideas for the long-term mitigation of the conflict (62%), but 20% of the respondents suggested relocating the macaques, 18% of farmers were in favor of planting fruit trees in the forests for

Table 3. Categories of respondents in the Great Nicobar Island: (a) based on family class size (0, small family and 1, large family), (b) based on income category (0, low income and 1, high income)

Family size class ^a	Family members	Respondents N (%)	Income category ^b	Annual income (INR)	Respondents N (%)
Small	< 3	17 (57.0)	0	< 500000	13 (43.0)
Large	> 3	13 (43.0)	1	>500000	17 (57.0)

Table 4. Long-tailed macaque conflict perception among the respondents at Great Nicobar Island.

Conflict events	No. of respondents
Attack on humans	
Yes	11
No	1
Attack on guard dogs	
Yes	15
No	1
Seasonality	
Yes (Rainy N = 8 ; Dry N = 2)	10
No	13

the macaques, and 2% suggested introducing langurs to drive the macaques away. About 7% of the people believed that nothing could be done to mitigate the conflict. Noteworthy, none of the respondents suggested fatal means to mitigate the conflict. Farmers unanimously believed that the macaques were numerous, and did not require conservation measures.

The administration has started programs such as providing labor to guard crops at a few sites, providing aluminum sheets to wrap around the trees to minimize climbing by rodents and macaques, giving advice to sell their produce directly in the market, and providing awareness about the demand of virgin coconut oil outside the islands.

Discussion

Our findings from this preliminary study indicate a largely negative perception of macaques among the farmers, primarily influenced by socioeconomic conditions and agriculture-dependent livelihoods. Farmers with less land, low incomes, and larger families perceived the damage by the macaques to be much higher and showed less tolerance towards the macaques than those with larger farms and higher incomes. Guarding the farm with dogs was perceived to be the most effective measure. The major solution suggested by the farmers was the relocation of problem macaques to another island uninhabited by humans. Although most of the farmers did not have a final solution to the problem, none of them suggested any fatal measures against the macaques.

To understand the perceptions of loss among farmers, one has to understand their levels of "vulnerability," which relate to the degree of dependence of farmers on their crops and the amount of land available (Liverman 1990; Carter 1997; Naughton-Treves and Treves 2005). If farmers have sufficient area for farming, their tolerance towards the loss is higher (Goldman 1996). If farmers are financially unable to employ suitable preventive measures and farm only for subsistence, they are highly vulnerable (Scott 1976; Porter 1979). The most damage was reported by the farmers in Joginder Nagar, which was established after the 2004 tsunami, and most people resettled far from their earlier homes and agricultural fields. Before the tsunami, these farmers lived near their

farms near Lakshmi Nagar. Following the tsunami, however, they were resettled 5 km from the coast and their farms. As such, they are now dependent on buses to get to their farms and the macaques raid their crops before they can get there. As expected, the perception of higher loss was found in these farmers. Since the loss has not been quantified, perceptions might be a result of underlying socioeconomic conditions, which are important to understand when addressing the conflict because the respondents could be overestimating their actual loss (Riley 2007; Kansky and Knight 2014). Another probable reason for such a negative perception is the severe loss faced by the people due to the tsunami; a tsunami that caused loss of life, home, agricultural land, and livestock and had a severe impact on the financial and logistical stability of the farmers. Macaques, which prefer coastal vegetation and feed on *Pandanus* and coconut, also faced severe loss of their habitat and especially their feeding patches (Velankar *et al.* 2016). They were forced to fall back to the farmers' coconut plantations and other crops. This increased the conflict between the macaques and the farmers that includes attacks by the macaques on farmers and guard dogs. Macaques usually forage in the farms at dusk and dawn when it is difficult for the farmers to guard them due to low visibility and lack of proper transport. Conflict and crop foraging increases significantly in the rainy season. This is in agreement with other studies that have suggested that the crop-foraging coincides with the temporal availability of food which depends on rainfall (Bell 1984; Osborn 1998).

Most farmers, especially the small farmers, have to spend up to eight hours guarding a field, resulting in a lowering of their tolerance towards the macaques. There are also significant indirect causes to the loss, such as lack of a stable market, inconsistent pricing, unavailability of labor, and lack of transportation. In addition to a small consumer base, the lack of alternative income opportunities with unstable coconut prices adds to the increased negative perception towards the macaques.

Despite all this, a degree of tolerance overall was evident in that none of the farmers suggested fatal measures against the macaques. Hill and Webber (2010) found that in Uganda and Japan, perceptions towards primates in conflict situations are based on inherent cultures and acquired experiences. A particular animal will be tolerated by people until it poses a serious threat to their livelihood. These perceptions are not dependent only on ecological factors but also on social, political and economic conditions (McGuinness 2016), as we have found for the farmers on the Great Nicobar Island. It is important, hence, to mitigate the conflict considering each case study separately and after understanding the perceptions of the local stakeholders (Treves 2009),

Our preliminary study provides an understanding of the perception of farmers towards the vulnerable macaques, and it is of particular importance as both farmers and macaques share space and depend on the same resources for sustenance, on an environmentally susceptible and socially dynamic island. The colonization of Great Nicobar is recent, with

Table 5. Perceived animal-induced crop damage and perceived involvement of animals responsible at the Great Nicobar Island.

Villages	Respondents (N)	Perceived Crop Loss (%)	Macaque (%)	Other animals (%)
Gandhi Nagar	10	60.0	83.3	16.7
Govind Nagar	7	57.1	89.0	11.0
Joginder Nagar	4	75.0	100.0	0
Vijay Nagar	2	NA	NA	NA
Laxmi Nagar	8	40.0	80.0	20.0
Shastri Nagar	6	40.0	50.0	50.0
Campbell Bay	3	53.3	75.0	25.0

Table 6. Odds-Ratio scores for variables influencing perception of high loss among the farmers at Great Nicobar Island.

Variable	Odds-Ratio	CI	Fisher's Exact Test p
Small land	1.27	0.27–5.87	0.76
Large land	0.79	0.17–3.62	0.76
Low income	2.60	0.56–12.02	0.22
High income	0.38	0.083–1.77	0.22
Small family	0.63	0.14–2.91	0.56
Large family	1.58	0.14–2.91	0.56

Table 7. Odds-Ratio scores for variables influencing tolerance among the farmers of Great Nicobar Island.

Variable	Odds-Ratio	CI	Fisher's Exact Test p
Small land	0.40	0.87 - 1.82	0.24
Large land	2.50	0.54 - 11.41	0.24
Low loss	3.00	0.64- 14.02	0.16
High loss	0.32	0.08 - 1.78	0.22
Low income	0.71	0.16 - 3.11	0.65
High income	1.40	0.32 - 6.10	0.65
Small family	1.80	0.41- 7.81	0.43
Large family	0.55	0.12 - 2.41	0.43

increasing numbers of farms being established near forests, and this is perhaps one of the few areas where macaques are distributed more widely than the people but also under the highest protection. This makes it a unique case where mitigation needs an approach that considers the fact that both humans and macaques have limited resources for their sustenance. The macaques seem to have acclimatized themselves to the presence of farmland near the forest edge, and have adopted the ecological strategy of foraging on human-grown crops, in this case especially coconuts. We recommend that the administration adopt and promote various mitigation measures based on the measures already employed by the farmers. The administration has already run a pilot project, that provided labor to protect farms against macaques. With the rise in conflict between the settlers, who have faced the challenges inherent in inhabiting the island, and the macaques that have faced both land-use change and natural disasters, we strongly recommend that the administration establish better and more thoughtful management plans, associated with improved conditions for marketing farm produce and promoting a diversification of cash crops and sources of income.

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Appendix

Table 1. Details of the villages, number of cultivators and respondents on Great Nicobar Island.

Village name	Year of establishment	Population	Main occupation	No. of cultivators ¹	No. of respondents ²
Campbell Bay	1969	5736	Business, government job	38	3
Govind Nagar	1974	676	Farming, government job	7	8
Joginder Nagar	1974	693	Government Job	40	7
Laxmi Nagar	1974-1980	230	Farming	24	4
Vijay Nagar	1974-1980	100	Farming	5	2
Gandhi Nagar	1974-1980	69	Farming	4	6
Shastri Nagar	1974-1980	15	Farming	0	10
Total				118	45

¹Based on the information from 2011 census of India. ²Based on location of interviews,

Table 2. Details of questions asked to the farmers.

Details of questionnaire survey	Details (units)	Code
Demography		
Name		
Ethnicity		
Dependent Family Size	N	
Age :		
(a) Young	<35 (years)	Y
(b) Middle-aged	35-55 (years)	M
(c) Old	>55 (years)	O
Livelihood		
Dependency on farming :	Primary/ secondary	a/b
Landholding	(ha)	
Tsunami- related loss	(ha)	
Crop-related		
Crop grown		
income from farming	(INR)	
Perception of loss	(%)	
Conflict-Related		
Reasons for crop-loss		
Proportion of los due to macaques	(%)	
Extent of loss:		
(a) No/Low	0–40 %	0
(b) High	>40%	1
Attacks:	farmers/ guard dogs	a/b
Seasonality of crop foraging	month	
Favoured time of the day for crop foraging	HH:MM	
Emotional response		
	Low tolerance	0
	High tolerance	1
Total time spent on guarding	Hrs	