Environment & Ecology 36 (3) : 823—827, July—September 2018
Website: environmentandecology.com ISSN 0970-0420

Assessment of Human-Macaque Conflict and Possible Mitigation Strategies in and Around Asola-Bhatti Wildlife Sanctuary, Delhi NCR

Ishita Ganguly, Netrapal Singh Chauhan, Pradipika Verma

Received 9 April 2018; Accepted 8 May 2018; Published on 30 May 2018

Abstract Human-macaque conflict in urban environment is one of most challenging issues for conservation biologists today. No information existed prior to this study to quantify attacks, injuries, bites and substantial property damages by urban rhesus macaquesin urban landscape of Delhi NCR. The number of cases of human-monkey conflict was recorded from May 2016 to April 2017 by questionnaire survey method and direct encounter in and around Asola-Bhatti Wildlife Sanctuary. On average 14.74% cases of attack, 12.01% cases of injury, 11.15% cases of bites, 15.56% cases of snatching foods, 11.23% cases of threatening, 11.49% cases of entering into the houses, 11.36% cases of property damage and 8.27% of littering were found from select sites. The result of one-way ANOVA ($\alpha = 0.05$) shows the number of conflict cases varies significantly among localities of suburban areas ($df = 6$, $F = 5.02$, $p < 0.001$) and it shows significant difference ($p < 0.05$) among different sites of incidence (N=13). Age-class distribution of victims exhibits that the individuals are affected chronologically from age class 16-30 years (33.68%), 0-15 years (24.49%), 31-45 years (19.86%), 46-60 years (14.04%) and lastly 61-75 years (7.91%). Mitigation strategies for human-monkey conflict and action plan have been suggested. Incidents of conflict showed significant seasonal differences among the study sites ($p<0.001$) and we calculated 34.04% conflict cases in summer (March-June), 16.57% in monsoon (July-September), 26.28% in post monsoon (September-November) and 23.16% in winter (December-February) months. This study was conducted for the first time on urban rhesus macaques in Asola-Bhatti Wildlife Sanctuary and it provides the detailed quantitative measure of human-macaque conflict incidences in urban to suburban environment and recommends possible mitigation strategies.

Keywords Rhesus macaque, Translocation, Conflict, Urban landscape, Delhi NCR.

Ishita Ganguly*, Netrapal Singh Chauhan
Amity Institute of Forestry and Wildlife, Amity Institutes of Forestry and Wildlife, Amity University Campus, Sector-125, Noida 201303, Gautam Buddha Nagar, UP, India

Pradipika Verma
Amity Institute of GIS and Remote Sensing, Amity University Campus, Sector-125, Noida 201303, Gautam Buddha Nagar, UP, India

Corresponding author Ishita Ganguly,
Address: Room no. 203, Block-D, Amity Institute of Forestry and Wildlife, Amity Institutes of Forestry and Wildlife, Amity University Campus, Sector-125, Noida 201303, Gautam Buddha Nagar, UP, India
e-mail : ishitaganguly23@gmail.com

Introduction

Rhesus macaques *(Macaca mulatta)* is known to share close association with human societies in urban environment and prone to decline in wild population due to rapid urbanization, loss of natural habitat

and fragmentation, competition for food and shelter, hunting and illegal trading. Human-macaque conflict was also associated with the term monkey menace by media and management team in India (Chauhan and Pirta 2010). Attacks on humans and damaging properties due to aggressive behavior of rhesus monkeys towards humans, snatching activity, entering into the houses, disrupting the electric wires and littering activities have been studied earlier from Northern India and even fatal interaction has been reported from Delhi city during feeding activity (Southwick and Siddiqi 2011). But there was no detailed study on nature and extent of conflict in urban environment. Besides, cities represent a unique ecosystem, by both natural resources (biotic) and human-made (abiotic) urbanized structures. Primate ecology in urban habitats in contrast to forests is completely different scenario and growing urbanization can have direct influence animal movement, feeding habit, activity patterns, reproduction and behavioral interaction. As the phenomenon of urbanization have been increased globally, there is enormous need to understand the nature of human-wildlife conflict and the underlying reasons to effectively develop action plan for management of the concerned species and promote conservation (Sinha and Vijayakrishnan 2017). Associated risk of negative interactions between human and wildlife is a major challenge for survival and persistence of wild animals (Dickman 2010).

The need of translocation of rhesus macaques and its consequences have been suggested by previous studies due to its massive proliferation in the urban areas of India but the cost of this phenomenon have not been measured yet in case of rhesus macaque. Our study is entirely focused on the nature and extent of human-macaque interaction in the interface zones (forest and urban landscape mosaics) after translocation. As macaques are associated with human socially, culturally and share human resources for survival, nature of their interactions affects human life and urban ecology. Rhesus macaques were captured from urban areas and translocated into Asola-Bhatti Wildlife Sanctuary, a human dominated landscapein southern range of Delhi forest division. Rhesus macaques dispersed from the sanctuary to the nearby localities and created nuisance and severe attacks on humans after adopting the new environment. No study has been conducted till date to assess the activities of these translocated monkeys,

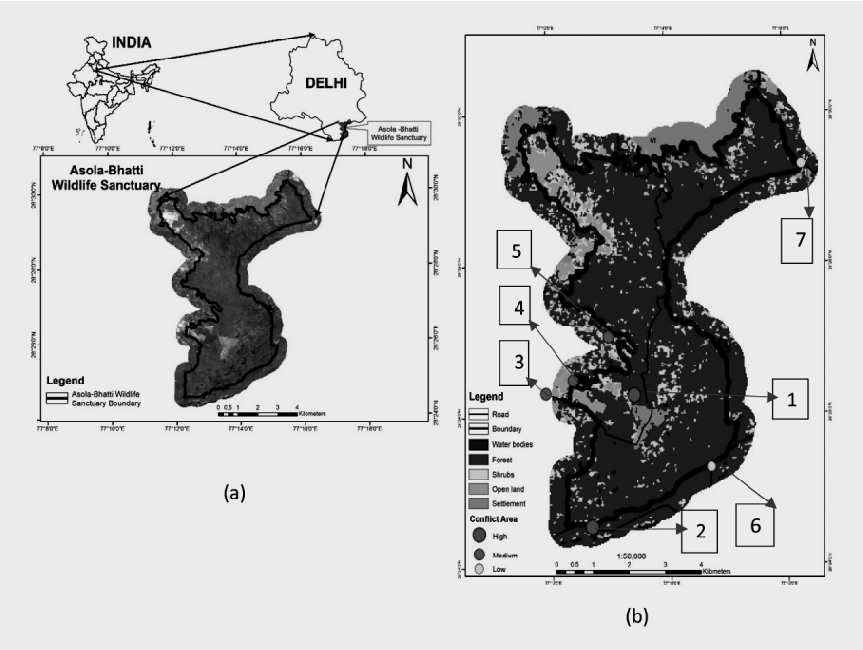

Fig. 1. (a) Location map of Asola-Bhatti Wildlife Sanctuary, (b) human-macaque conflict hotspots.

to measure the severity of threats spread by these species in the nearby localities and to quantify the number of conflict incidences occurred in this area after translocation of macaques in Asola-Bhatti Wildlife Sanctuary. The significance of the study lies in practical application and primate management in urban environment to reduce the risk of negative interaction, in developing mitigation plan, to aware local people and promoting conservation education program in affected areas. The efficacy of translocation of problematic species in a human-dominated landscape seems to be questionable based on the results of our study.

We selected 7 different localities situated in an around the Asola-Bhatti Wildlife Sanctuary at the urban edges (N 28^0 24´ 52´´–28^0 29´ 45´´ and E 77^0 11´ 32´´ – $77^0$16´ 13´´) to study the nature and extent of human-monkey conflict after extensive field survey (Fig. 1a). Site 1-Sanjoy colony; Site 2- Pali road and Indian army Eco-task force camp; Site 3-Asola farms and housing complexes; Site 4- Temple area; Site 5-Guruji-Ashram, Chattarpur ; Site-6 Faridabad-Gurgaon road; Site 7- Surajkund area (Fig. 1b). Data were collected from March 2016 to June 2017 on daily basis and we have used direct observation method and questionnaire survey method togather the information on human-monkey conflict in the suburban areas of Delhi NCR. The mean temperature in these sites fluctuates in summer months between (43-47^{0}C) and in winter months it drops down to (6^0-10^0C) with mean annual rainfall 617 mm, dry xerophytic vegetation mostly with the abundance of *Prosopis juliflora*. Among the faunal species, more than 200 birds, reptiles and mammals.

(We would like to thank Mr A. K. Shukla, Chief Wildlife Warden of Delhi Forest and Wildlife Department to issue permit for working in the field area, Mr S. K. Muan Giete, Deputy Conservator of Forest, South Division, Delhi for providing support and smooth conduct of field research. We are thankful to World Wide Fund for Nature-small grant program, India (WWF) for providing funding support in accomplishment of field work and research facility).

Materials and Methods

(a) Using stratified random sampling technique, the study was designed, and household surveys were conducted each week from March 2016 to June 2017 and total 1548 people were interviewed from 7 localities. Household individuals were interviewed randomly during the study period. Information on nature of attack, injury, bites, snatching of foods, entering into houses, damaging household articles, littering, types of monkey-menace cases, causal factors of conflicts were collected using well designed questionnaire. (b) Using direct contact method rhesus macaques were encountered and we observed the following activities related to conflict and recorded the number of episodes in and around Asola-Bhatti Wildlife Sanctuary. Total number of conflict cases were recorded by using both the methods (a and b) each month and basic statistics were computed using Microsoft excel 2007 and Minitab version 17.0 for total 12 months study. Firstly, we compared conflict incidences between the sites of occurrences, overall nature and extent of conflict in all the study sites, comparisons were made between the different sites where incidents occurred and tested statistical significance (p value <0.05 at 95% confidence limit). Age-groups of victims were classified in distinct categories and tested if there was any significance of age with the frequency of attacks and t-test was run. We compared the differences in mean number of conflict cases with seasonality and its statistical significance.

Results and Discussion

Conflict incidences between the sites

During survey period a total of 1802 number (n) of conflict episodes were recorded and 28.87% cases from site 1, 14.65% from site 2, 12.46% from site 3, 12.15% from site 4, 11.83% from site 5, 11.28% from site 6 and 8.73% from site 7 were found. The number of cases on each study site varied based on availability of food resources, size of monkey troops, feeding habits of human-being, garbage disposal system, sanitation practices income group and people perception toward monkeys. The result of one-way ANOVA (α=0.05) showed there was significant difference in number of conflict cases in between localities (df=6, F=5.02, p<0.05) under study. The maximum number of conflict incidents occurred at Sanjay colony-Site 1

which was located within the sanctuary boundary and minimum occurrences were found in Surajkund area- Site 7, the farthest distant place considered in our study and interestingly we could assume the pattern and trend of conflict incidences. The frequency of conflict incidences was inversely proportional with the distance. There were several other factors associated with this as availability of food and shelter, number of stationary shops, vegetable markets, temples, pattern of waste management in sub-urban to urban areas and food provisioning.

Nature and extent of conflict

We divided rhesus macaque to human conflict cases into following categories: Attack, injury, bite, snatching food item (s), threatening, entering into the houses, break-down of household articles and littering to record the number of incidents in each site. Overall, we recorded 14.74% cases of attack, 12.01% cases of injury, 11.15% cases of bite, 15.56% cases of snatching food (s), 11.23% cases of threatening people, 11.49% cases of entering into the houses, 11.36% cases of property damage and 8.27% of littering episodes are found from all the study sites. Several case studies on monkey menace have been reported from all over the country; Number of studies have been conducted in North-India viz. Delhi, Mussorie, Agra, Mathura, Vrindaban, Tughlaqabad, Aligarh and monkeys are translocated to reduce the degree of conflict (Ekwal and Ahmad 2013) but those studies were deficient to quantify the detailed problem. Property damage and economic losses by macaques have also been reported earlier (Enari and Suzuki 2010).

Conflict sites

Incidences of conflict were recorded from the sites under study which is comprised of suburban areas with stationary shops, eateries, open vegetable markets, semi-urban villages, poor sanitation, open garbage disposal system within localities, roadsides, temples with minimum agricultural fields, plantation, farms, and protected areas. We recorded the number of occurrence of conflict incidents at following sites: 8.44% from shops, 14.46% from temple, 16.57% from roadside, 3.12% from police check post, 7.33% from houses, 14.42% from garbage disposal site, 8.94% from vegetable market, 3.86% from agricultural field, 2.55% from cattle shades, 3.62% from forest plantation, 3.91% from protected areas, 2.34% farms, 3.07% from canal side and 7.6% from toilets of nearby localities. There was significant difference of conflict within the sites of occurrence ($p<0.05$, CI=95%) due to variation in resource availability. Macaques habituated to close interaction with human at temples and tourist destinations frequently showed certain behavioral patterns associated with snatching, begging, battering and become aggressive sometimes during provocation (Md-Zain et al. 2011). Rhesus macaques provisioned at recreation sites were seen to create nuisance in nearby residential areas (Sha et al. 2009, Shek 2011) and in rural areas macaques have threatened people (Hamada et al. 2007). In our study, the maximum number of conflict events were evident in roadsides and temple premises, open garbage disposal sites and vegetable markets and poor sanitation areas were found to be the most targeted zones of human-macaque conflict in Delhi NCR.

Age group classification of victims

We recorded age-class distribution of victims in and around Asola-Bhatti Wildlife Sanctuary. The maximum number of individual of 16-30 years (33.68%) were affected followed by 0-15years (24.49%), 31-45 years (19.86%), 46-60 years (14.04%)and 61-75 years (7.91%). Although the mean values were not equal in case of frequency of attack between the age groups but no significant difference ($p<0.05$) was found. Nature of attack was independent of ages. In certain cities in India, people share a strong religious bond over monkeys as a symbol of God and indulge into worshiping and feeding of these monkeys at roadside, temples, cities (Pragatheesh 2011). Young and adults were found to be more victimized than old aged people because they are found to provoke the macaques more frequently than others. Moreover, conflicts are known as the most challenging traditional relationship between human and macaques (Southwick and Siddiqi 2011).

Seasonality

We collected data throughout the year covering all the seasons from all the 7 different sites and analyzed the seasonal changes of conflict incidents in and around Asola-Bhatti Wildlife Sanctuary. We recorded the different conflict types from each and every site of occurrence from January to December. We calculated 34.04% conflict cases in summer (March-June), 16.57% in monsoon (July-September), 26.28% in post monsoon (October-November) and 23.16% in winter (December-February) months. One-way ANOVA showed that there was significant difference ($p<0.001$) among the study sites on the occurrence of conflict incidents in different months. Attack (12.46±SE 3.33), injury (10.21±SE 1.61), bites (9.72 ± SE 1.89), snatching (11.62 ±SE 1.47), threatening (8.60 ± SE 0.92), entering houses (9.77±SE 2.12), breaking and damaging properties (8.23±SE 1.09), telephone line disruption (1.15 ± SE 0.66) and littering (7.34 ± SE 0.82) was calculated throughout the year. In summer months (March-June) as the number of monkeys increased in summer (birth months) and minimum conflict incidents were studied in monsoon (July-September) as monkeys were less visible during rain. We have also marked the high, medium and low conflict zones in and around Asola-Bhatti Wildlife Sanctuary which will help in developing mitigation strategies and implementing the control methods in future.

Primates are considered as unique species not only for their wide geographical range, diversity, behavioral adaptations, social systems and ecological significance, but also for the kind of threats they face for inhabiting with human societies in urban landscapes (Estrada et al. 2017). Understanding the causes, nature and extent of damage in suburban settings, problems and their possible control measures should be taken. Prohibition of feeding and developing humane approach of population control programs of surplus rhesus monkey population, practicing proper garbage disposal system in the localities, improving sanitation in suburban areas, plantation of fruiting trees in the forest area with due protection to seedlings and translocation of monkeys in areas more than 100 meters far from human habitations. Promoting conservation education program in the affected areas will help in mitigating the issue.

References

Chauhan A, Pirta RS (2010) Agonistic interactions between humans and two species of monkeys (rhesus monkey *Macaca mulatta* and hanuman langur *Semnopithecus entellus*) in Shimla, Himachal Pradesh. J Psychol 1 : 9—14.

Dickman AJ (2010) Complexities of conflict : The importance of considering social factors for effectively resolving human–wildlife conflict. Anim Conserv 13 : 458—466.

Ekwal I, Ahmad A (2013) Population status of rhesus monkey *(Macaca mulatta)* and their menace : A threat for future conservation. Int J Env Sc 3 : 4.

Enari H, Suzuki T (2010) Risk of agricultural and property damage associated with the recovery of Japanese monkey populations. Landsc Urban Plann 97 : 83—91.

Estrada PA, Rylands AB, Roos C, Fernandez-Duque E, Di Fiore A, Nekaris KAI, Nijman V, Heymann EW, Lambert JE, Rovero F, Barelli C, Setchell JM, Gillespie TR, Mittermeier RA, Arregoitia LV, Guinea M, Gouveia S, Dobrovolski R, Shanee S, Boyle SA, Fuentes A, MacKinnon KC, Amato KR, Meyer ALS, Wich S, Sussman RW, Pan R, Kone I, Li B (2017) Impending extinction crisis of the world's primates : Why primates matter. Sci Adv 3 (1) : e1600946.

Hamada Y, Malaivijitnond S, Kingsada P, Bounnam P (2007) The distribution and present status of primates in the northern region of Lao PDR. Nat Hist J Chulalongkorn Univ 7 : 161—191.

Md-Zain BM, Tarmizi MR, Mohd-Zaki M (2011) Campus monkeys of University Kebangsaan Malaysia : Nuisance problems and students' perceptions. In : Gumert MD, Fuentes A, Jones-Engel L (eds). Monkeys on the edge: Ecology and management of long-tailed macaques and their interface with humans. Cambridge Univ Press, Cambridge, pp 101—117.

Pragatheesh A (2011) Effect of human feeding on the road mortality of rhesus macaques on National highway-7 routed along Pench Tiger Reserve, Madhya Pradesh, India. JoTT 3 : 1656—1662.

Sha JCM, Gumert MD, Lee BPY-H, Jones-Engel L, Chan S, Fuentes A (2009) Macaque-human interactions and the societal perceptions of macaques in Singapore. Am J Primatol 71 : 825—839.

Shek CT (2011) Management of nuisance macaques in Hong Kong. In : Gumert MD, Fuentes A, Jones-Engel L (eds). Monkeys on the edge : Ecology and management of long-tailed macaques and their interface with humans. Cambridge Univ Press, Cambridge, pp 297—301.

Sinha A, Vijayakrishnan S (2017) Primates in Urban Settings. The International Encyclopedia of Primatology.

Southwick CH, Siddiqi MF (2011) India's rhesus populations: Protectionism versus conservation management. In : Gumert MD, Fuentes A, Jones-Engel L (eds). Monkeys on the edge: Ecology and management of long-tailed macaques and their interface with humans. Cambridge Univ Press, Cambridge, pp 275—292.