



Population Status, Menaces and Management of Rhesus macaque (*Macaca mulatta*) and Tarai gray langur (*Semnopithecus hector*) in the Forest of Dharan and its Vicinities

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Abstract

The present study was conducted in 28 spots of 10 sampling sites including forest and urban areas of northern part of Dharan, Sunsari District (26.7944° N, 87.2817° E, 349 m msl) and its vicinities in the Province No. 1 of Nepal. The scan sampling method was applied to count the monkey population and their menace was surveyed through the questionnaires and direct field observations. In present study, 69.31% (n=558) Rhesus monkeys species and 30.68% (n=247) Tarai gray langurs were counted within 192.6 km² of the study site. In 14 troops of Rhesus monkeys and 9 troops of Tarai gray langurs, the gender dominance of female Rhesus monkey and female Tarai grey langur were found to be 40.32% and 58.74% respectively. Whereas, the average male-female ratio was found to be 1:8.3 and 1:5.1 for Rhesus monkey and Tarai gray Langur respectively. The largest single troop recorded was of Rhesus monkey (n=125). A total of 25.2 quintals crops was damaged by both monkeys from the study area this year. Maize (42%) was found to be major crop damaged by Rhesus monkeys. Management of non-human primates through further research is urgently required to minimize their menace and to protect people from the risk of transmission of possible zoonotic diseases. The result of this study can be implied practically for the management of monkey's menaces not only to the Dharan but also to other monkey affected areas of the country.

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1. Introduction

Nepal supports three species of monkeys namely Rhesus macaque (*Macaca mulatta* Zimmermann 1780), Assamese macaque (*Macaca assamensis* McClelland, 1840) and Hanuman langur (*Semnopithecus entellus* Dufresne, 1797) (Chalise, 2006). However, the existence of *M. mulatta* and *S. entellus* reported from the forests of Dharan and its vicinities (Khatry, 2006). Formerly, all langurs were called Hanuman langur (*Semnopithecus entellus*). Two species of langurs: Tarai gray langur (*Semnopithecus hector* Pocock, 1928) and Nepal gray langur (*Semnopithecus schistaceus* Hodgson, 1840) have been reported from Nepal so far. Among all, Rhesus macaque (*M. mulatta*) is the widely distributed species in Nepal, India, Afghanistan, Pakistan, Bhutan, Myanmar, Bangladesh, China, Thailand, Cambodia,

Vietnam and Laos (Tiwari & Mukherjee, 1992). They are highly adaptable to human proximity and often occur in villages and towns (Southwick et al., 1983). The Rhesus macaque (*Macaca mulatta*) and Hanuman langur (*Semnopithecus entellus*) share food and space with humans in the rural and urban areas and are often reported in conflict with the humans (Jolly, 1985; Singh, 2000 and Pirta, 2002) due to scarcity of natural resources and food sources in the forests.

Among the seven species, with 14 subspecies, of macaques known in south Asia (Molur et al., 2003), Rhesus monkeys are considered mostly as crops damaging species coupled with physical hurt and harassment in some extent. In Arkhale and Nayagaun village of Gulmi district of Nepal, shouting and chasing using stone and catapult were the common local deterrent method against monkeys (Aryal & Chalise,

2013). However, commensal populations of *Macaca mulatta* are much familiar while its wild populations are declining rapidly (Chhetry et al., 2007). The study revealed that the rhesus monkeys in the temple area interacted more agonistically with humans than the rhesus monkeys in the down town area in comparison to the Hanuman langurs in both the study areas in Shimla (Chouhan & Pirta, 2010). Crop raiding was found to be one of the major causes of monkey- human conflict either caused through physical hurt or harassment, grabbing and taking of food materials including harassing people (Khatry, 2006). A risk of zoonotic diseases from these animals to human is equally challengeable.

The present study revealed the total population of non-human primates of Dharan, troop size, age-sex composition, their menace coupled with destructions caused by *M. mulatta* and *S. hector*. The study on population status of monkeys and their menaces have not studied in Dharan before. Therefore, the present study aimed to find the monkey population and to suggest some feasible strategies for the management of monkey menaces along with risk of transmission of possible zoonotic diseases.

2. Materials and Methods

2.1 Study area

The study was conducted in Dharan (Fig. 1), which lies in the northern part of the Sunsari District in the Province No. 1 of Nepal. The study area situated on the foothills of Mahabharat range in the north with its southern tip touching the edge of the Terai region. It occupies an area of 192.6 km² and is located between latitude 26.7944° N and longitude 87.2817° E at an altitude of 349 m (masl). Direct observation of monkeys was done in the ten sampling sites of the study area during November 2018 to September 2019.

2.2 Data collection

2.2.1 Monkey census

Common spots for the prevalence of primates were identified through regular field visits on foot. Direct observations were made for the repeated counting of both Rhesus macaque and Tarai gray langur by the aid of binoculars and cameras based on need. Ocular observations were made from June to November in the morning (06:00 -11:00 A.M) and evening (03:00-06:00 P.M). The data on locality, time of sightings, duration of observation, activity and age-sex composition of the

group were carefully recorded following Scan sampling method (Martin & Bateson, 2007) Approximate age and sex were categorized by ocular observation with the help of Nikon and Bushnell binoculars. Geographic coordinates were taken with the help of Garmin etrex10 handheld navigator and photographs of species were taken by using Canon 520 HS and Nikon digital cameras. Individuals distinguished by their body colour, proportion and body size as described (Roonwal & Mohnot, 1977).

2.2.2 Questionnaire survey

A pre-tested and semi-structured questionnaire was used to collect the information from local villagers about crops damage, frequency and duration of monkey raids, monkey trouble, preventing methods used by the locals, possible remedial measures of conflict, flora and fauna of the area, etc. A total of 110 respondents of Dharan living around temples, market area and forests were randomly selected for this study.

2.3 Data analysis

Both descriptive statistics (percentages, frequencies) used to analyze the data with the help of Microsoft Excel software.

3. Results and Discussion

3.1 Population status

We recognized 25 common spots for Rhesus monkeys and 9 common spots for Tarai gray langurs. Out of 20 wards of the city, the study focused on most affected spots of ward numbers 1, 2, 3, 4, 5, 7, 9, 13, and 14. Ocular observations were done in all the spots of sampling sites (Table 1 and 2).

Two species of monkeys viz. rhesus monkeys (n=558) and Tarai gray langurs (n= 247) were recorded in present study (Fig. 2). During scarcity of food in the dry season of winter and summer, both types of monkeys frequently observed to be visited human settlement areas.

3.2 Age-sex composition

Either in a large or the small troop, the number of female Rhesus monkey (40.32%) and Tarai gray langur (58.74%) were found dominant over the males, which reflects the gender dominance in a troop (Fig. 3). The present study showed the male-female ratio of adult Tarai gray langur 1:5.1, which was lower than that of the Rhesus macaque (1:8.3) in Dharan (Fig. 4).

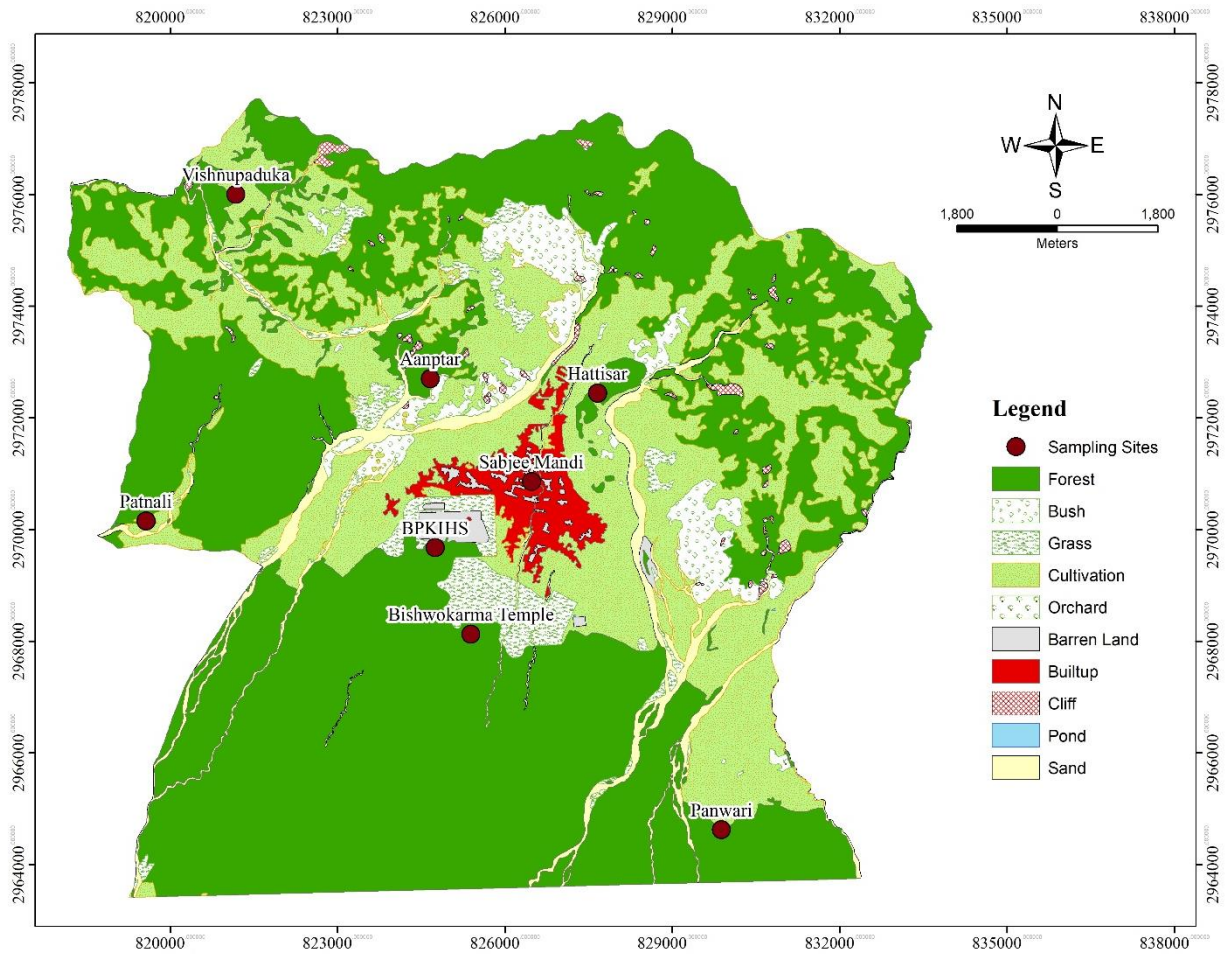


Fig. 1: Map of Dharan showing major sampling sites

Table 1: Troop composition of Rhesus macaque (*Macaca mulatta*)

S. No.	Spot/Troop	Rhesus Macaque (<i>Macaca mulatta</i>)					Total
		Adult Male	Adult Female	Juvenile	Infant	Young Male	
1	Tama Kham	2	10	8	8	3	31
2	Aanptar	1	12	1	7	4	25
3	Karkichhap	3	32	15	25	15	90
4	Vishnupaduka	1	10	1	6	2	20
5	Patnali	4	23	16	15	2	60
6	B. P. Hospital	2	13	7	5	2	29
7	Vishwakarma temple	1	2	-	-	1	4
8	Panwari	3	24	4	17	2	50
9	Panwari Kalbote	1	18	7	8	6	40
10	Radhe Shyam Temple	-	3	1	2	-	6
11	Geeta Mandir Area	1	6	1	2	3	13
12	Sabji Mandi, Dharan-2	3	8	6	8	3	28
13	Manoj Pharma Garden	2	9	14	4	8	37
14	Hattisar Campus	4	55	18	40	8	125

Table 2: Troop composition of Tarai gray langur (*Simmopithecus hector*)

S. No.	Spot/Troop	<i>Semnopithecus hector</i>					Total
		Adult Male	Adult Female	Juvenile	Infant	Young Male	
1	Tama Kham	2	6	4	2	3	17
2	Patnali	3	15	6	7	3	34
3	Bishwakarma Temple	1	6	4	5	2	18
4	Panwari bridge	4	7	5	4	3	23
5	Panwari	1	7	4	4	2	18
6	Panwari kalbote	-	6	3	2	4	15
7	Khatri Dhara	-	-	3	-	5	8
8	Pindeswori area	5	29	16	17	6	73
9	Hattisar Campus	2	17	6	10	6	41

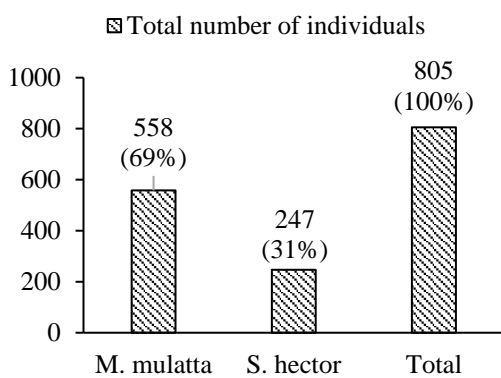


Fig. 2: Species wise composition of Rhesus monkey and Tarai gray langur

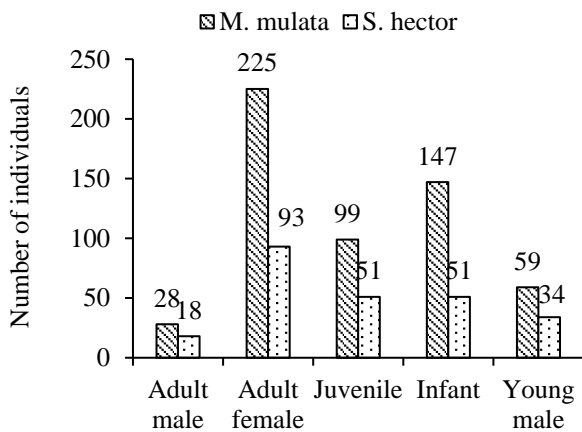


Fig. 3: Age-sex composition of Rhesus monkey and Tarai gray langur

3.3 Troop size

During the study, 14 troops of Rhesus monkeys and 9 troops of Tarai gray langurs observed in and around Dharan Sub-Metropolitan City. The mean troop size of Rhesus macaque and Tarai gray langur from all the spots were found to be 22.70 and 27.44 respectively. The maximum and minimum number of individuals of Rhesus macaque in a single troop found 125 and 4 from

the Hattisar campus area and Vishwakarma temple respectively. Whereas, the maximum and minimum number of individuals of Tarai gray langur in a single troop found 73 and 8 from Pindeswori area and Khatri dhara respectively. Some of the troops of both monkeys tend to invade territories of other’s troops. Rhesus monkeys in the city mostly observed changing their spots day by day. One of the largest troops of Rhesus monkey with 125 individuals of different age groups found roamed by changing spots at the interval of 4-5 days. Likewise, the nomadic single troops of Tarai gray langurs with 73 individuals of different ages were also observed in their regular trail.

During observations, three to four adult males were seen guiding the large troop in their regular trail. Small troops were seen mostly guided by a single adult male. Young males were seen wandering out of the group. Atypical nuclear troop of the Rhesus monkey comprised of an adult male, adult female with infants and juveniles excluding young males.

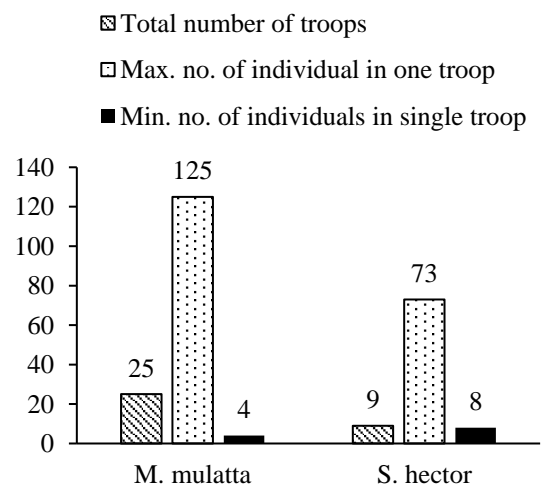


Fig. 4: Maximum-minimum individuals of monkeys (troop wise)

However, all members of the adult male, adult female, infants, juvenile, including young males of Tarai gray langur were seen in each troop, one adult male was guiding the group and another adult male escorting the group during their roam. The rest of the males were seen to be patrolling the troop as a sentry. In every troop, a number of adult females and their infants were observed.

3.4 Monkey's menace

3.4.1 Fear to human

Rhesus monkeys of the market area found to be more aggressive to humans. The large troop often created a scary situation in a community. Stealing foods from the kitchen, food vendors and doing menace in public property. Fourteen monkey bite cases found in Dharan and two in Patnali spot in two month's duration (Bishwakarma, KP, Pers. comm, 2019). Mostly, adult males found snatching foods from children, women and old people. Last year, more than one hundred Rhesus monkeys of Dharan captured and released in a forest near Patnali village (Rai PK. Pers. comm, 2019). People of the village never felt such a fear caused by before. Wild Rhesus monkeys are mostly shy and always stay far from the people. Occasionally, they come to the village, farm areas and raid the crops. On the other hand, Tarai gray langurs mostly inhabit the dense forest having fruit trees. All are very shy and showed less aggressive behavior than Rhesus monkeys. Only some of the nomadic troops were seen near the human residential area while searching food in a season. So fear caused by Tarai gray langurs was not found in any of the observed spots in present study. None of other kinds of fears caused by these monkeys were found during the study.

3.4.2 Economic loss

During the study, the kind of loss that directly or indirectly brought about by Rhesus monkeys and Tarai gray langur's raids were documented. Both monkeys were found damaging crops to a considerable extent. Rhesus monkeys spoiled more crops than they eat; juveniles and infants, in particular, brought about damage during play in the crop field. The estimate of damage assessed based on the information gathered from the owners (households). Public property like TV cables, internet amplifiers box, telephone wires, street lamps, public water tapes, were seen damaged by the rhesus monkeys. The male Rhesus was seen to make the electricity short-circuiting by jerking the electric pole by sitting on the top. Unfortunately, two rhesus

monkeys found dead in ward no.1 from electric short during the pole jerking. From the observation, it was concluded that male rhesus always used to warn the outsiders by roaring or by jerking the poles of any kind. They guide their troops by sitting at the top of all the corners where they visit. If any danger felt, the sentry males warns their troop members by signaling voice. In addition, direct impact of Tarai gray langurs in the human settlement area was not found as compared to the rhesus. Further, indirect loss by feeding upon the flowering and fruiting trees, vegetables, which reduces fruit production was observed considerably.

3.4.3 Crop preference and crop raiding

All major crops maize, potato, wheat, rice, black gram, beans, millet was found to be raided by Rhesus monkeys and Tarai gray langurs in the area. In this study, the damage caused by Rhesus monkeys were found higher than that caused by the Tarai gray langurs (Fig. 5). Maize (42%) was found to be major crop damage done by Rhesus monkeys followed by potato (14%), gram/bean (13%), rice (10%), millet (8%), wheat (8%) fruits and others (5%). Others include mainly leaves, twigs, flowers, fruits, bamboo shoots, tubers, vegetables. Damage done by Tarai gray langur is almost 50% less than that done by Rhesus macaque. Both species of monkeys preferred maize. This may be due to maize (corn) is soft, can easily be snatched, sweet in taste, more delicious, rich in carbohydrate and easily digestible. Some of the foods, turmeric, bitter guard, chili, which have bitter and hot taste, not preferred by both monkeys. A total of 25.2 quintals of crop damaged by both monkeys in 2019 in Panwari, Patnali and Vijaypur area of Dharan which were in close proximities to the forests (personal communication). The damage included 10.8 quintals of maize, 3.5 quintal potato, 3.2 quintal gram/bean/lentil, 2.5 quintal rice, 2 quintal millet, 2 quintal wheat and 1.2 quintal fruits and others (Bista M, pers. comm, 2019).

3.4.4 Raiding time of the monkeys

Both the monkeys found actively to raid the crops in the morning time between 07:00 to 11:00 A.M. However, the frequency of raiding the crops in the afternoon between 2:00- 5:00 P.M, found more in case of Rhesus monkey than Tarai gray langur. The rhesus monkeys found to raid the crops even in the evening time (5:00- 7:00 P.M).

3.4.5 Behavioral activity

The activity of the Rhesus monkeys seen from the dawn and slowly after 1100hrs, they found taking rest elsewhere. During feeding time, they collect their foods in their gular pouch to store. In Tarai gray langurs, activity found early after the sunrise. They were always seen far from the human settlement area. Rhesus monkeys stole food from vendors, houses and snatch from the people very tactfully. Aggressive behavior was seen only when the people chased them. Such behaviors were not found in the Tarai gray langur.

3.4.6 People perception of monkeys

Around 65 % of people of the town and affected areas found an outright dislike of monkeys and their presence near to them. The people who wanted a presence of these monkeys only in natural habitat were 15-20%, whereas only 5-6% of people from the religious background supported not to disturb their presence. It was also found that 5-10% of people had no objection or dislike due to the presence of monkeys around them.

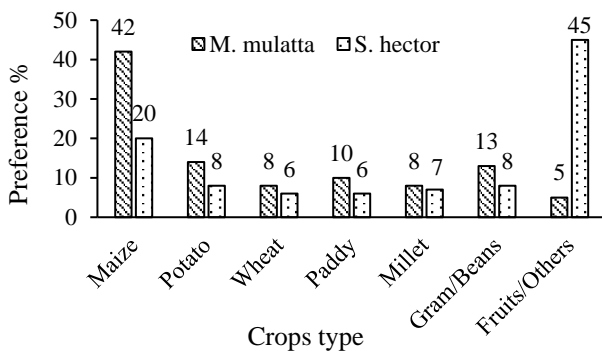


Fig. 5: Crop raiding preferences by two monkey species.

3.4.7 Defense against monkey

The people of Tarai gray langur affected areas found to be protecting themselves by throwing stones (20%), using a catapult (3%), shouting (70%), encouraging their dogs to chase monkeys (5%), and establishing the scarecrow (3%). Some religious Hindu people (2-3%) found to be tolerating their menace.

3.4.8 Mitigating measures

About 80% of people of the monkey prone area suggested a mitigating measure for rhesus monkey trouble by translocating them in a wildlife reserve, national park or their natural habitat, the forest. While, 20% people suggested their population control through sterilization.

The actual populations of these non-human primates had not been thoroughly observed in Nepal (Chalise, 2008). For the first time, Chalise (2006)

reported the presence of three monkey species *Macaca mulatta* (Rhesus monkey), *Macaca assamensis* (Assamese monkey) and Hanuman langur (*Semnopithecus entellus*) in Nepal. Formerly Tarai gray langur (*S. hector*) was considered as subspecies of Hanuman langur (*S. entellus*). Now, *S. hector* declared as distinct species. Bashyal (2005) reported the 120 individuals of rhesus monkeys from Shivapuri area. Chalise (2008) reported 1966 individuals of rhesus monkeys, 816 hanuman langurs and 734 Assamese monkeys from Langtang National Park, Beg khola (Myagdi), Kopchi pani (Myagdi) and Palpa.

The present study shows that the percentage of female sex in a group is always higher than the others. This is because of the philopatric nature of female macaques (Hassan, 2010). Males always leave their group when they get mature. The percentage of adult male-female ratio of Rhesus macaque from the result shows 1:8.3 which is very much higher as 1:1.7 mentioned by (Southwick et al., 1964); (Aggimarangsee, 1992); (Chalise, 2000) and (Regmi, 2008); 1:1.03 (Chalise et al., 2011).

Teas et al. (1980) reported the troop size of rhesus monkey from 20-200 including all the members. Only the matured males leave the group and create their troop. From the result, it shows that non-human primates live in a troop with proper leadership of adult males. Not all the males remain on the same troop. Fighting's are usually seen when outsider males approach near to the troop. During this study, we found 14 troops of Rhesus monkeys and 9 troops of Tarai gray langurs in and around Dharan Sub-Metropolitan City with the smallest troop with 4 individuals and largest troop with 125 individuals. This data indicated the abundance of monkeys in Dharan. The rhesus monkeys observed regularly throughout the study period in the study site. Their menace to the public and public property was seen regularly. The Tarai gray langurs, in comparison, not found in all the spots regularly during the study period. Due to their nomadic nature hanuman langur especially seen only in a particular season. Their visit to city areas found mostly in crops grown season in autumn and summer.

Behavioral studies on these two non-human primates in Shimla (India) indicated that the Rhesus monkeys in the temple area were more agonistic toward humans as compared to monkeys in the bazaar area and the Hanuman langurs (Chauhan & Pirta, 2010). Same agonistic behavior was observed during

present study. Ghimire et al. (2018) reported an economic loss of 39 households due to Assamese macaques in Makalu- Barun National Park (Nepal) was equivalent to around USD 23,477.90 per annum with the average of USD 602 per household. Based on questionnaire, we estimated the economic loss of about USD 5000 per annum from our study area. The results comparatively revealed less economic loss of the public property and their crops by these monkeys in Dharan. Especially rhesus monkeys that are very close to human beings do not care about the human response. The awful aggression of rhesus seen when someone tries to chase them.

Maize is the main food source of both the monkeys (Hill, 1997). Khatry (2006) has also mentioned maize is the first food to raid. Chalise (2000) reported that cereal, fruits and tubers are equally valuable foods of the monkeys. The survey done by Ghimire et al. (2018) indicated that macaques raided rice (69%) and maize (59%) the most followed by cardamom (44%), millet (28%) and others (15.4%). Ghimire and Chalise (2019) reported that maize (*Zea mays*) was the highest raided (47.14%) crop by Assamese monkeys (*Macaca assamensis*) in Kaligandaki river basin at Ramdi of Palpa and Syangja districts of western Nepal. These results supports the result of the present study on Rhesus macaque (42 %).

Rhesus monkeys interact agonistically with human especially in urban and temple areas than the Hanuman langurs, (Chauhan & Pirta, 2010). People want to force these non-human primates out of their habitat. However, this is not the sole solution to balance the conflict. Only certain 5-6% of people who are from religious backgrounds support their presence anywhere else. Because of their notorious behavior to human 65% of people, dislike their presence.

Piston (2005) says physical and noise method if implement in the field reduces the chance of crop raiding more (Chhangani & Mohnot, 2004); (Priston, 2005); (Regmi, 2008) have mentioned the use of stones, catapult, animal as a dog, scarecrow, noise for defense. The use of catapult for the monkeys in my study shows a great significant role in their control in the Hattisar campus premises. The main important cause of increase in monkey population in the town area is to feed them by anthropogenic foods. Those monkeys who are habitual to anthropogenic food have a large-sized and obese bodies in comparison to those who have retained a natural diet have lean body

composition (Dittus, 2014).

4. Conclusions

Population data on both rhesus monkey and Tarai gray langur showed their abundance in the study area. Monkey menace and their management is a challengeable task to keep the people unaffected. The number of non-human primates is increasing day by day with notorious menace. The study of these non-human primates has shown a significant intrusion in human habitat and creating a threat to small children, women and the older. Public properties have been a playground for these animals. The regular presence of rhesus monkeys in urban areas was due to the easy availability of anthropogenic food elsewhere.

The risk of zoonotic diseases from these animals to human is equally challengeable. People of the prone area are living behind the cage. The problem is not limited to the town area. Farmers also suffered from their menace. They have destroyed their agriculture products. Time and money of the farmers have been gone to sand. Local people are still trying to solve the monkey problem by their translocation in a forest but expected outcomes not been achieved yet.

Therefore, the following steps suggested for the concerned authority for the management of monkey's menaces and threats:

1. Most affected areas should be declared as 'red zone' and various efforts made to control the increasing monkey's population and their menace at any cost.
2. Translocation and rehabilitation of nonhuman primates in their natural habitat should be done with high emphasis.
3. Human activities such as feeding anthropogenic foods to these nonhuman primates should be discouraged.
4. Awareness against chasing to these nonhuman primates should be implemented in a community.
5. Catapult can kill the monkey if it hits their head. Instead, the use of loud sound, flame sticks, dogs, scarecrow help to run them away.
6. Family planning by sterilization of male monkeys (castration) may help to control the reproduction rate.

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Conflicts of Interest

The authors declare no any conflicts of interest regarding this publication.

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