Exploration and Conservation of Newly Reported Endangered Assam Macaque Population in Far-Western Nepal

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1. Background

Macaques (genus *Macaca*) are ecologically extremely adaptive primates which are distributed more widely than any other non-human primate genus (Thierry et al. 2004). They are diurnal, omnivorous primates which bear cheek pouches for storing food (Strier 2017). They have well-developed thumbs and some species bear ischial callosities which can change their colour during their mating periods (Groves 2005). Macaques are believed to have diverged 5.1 Mya, and at present extant macaques are represented by single species of African lineage, the *M. sylvanus*, and the Asian lineage consisting of well-defined species groups (*fascicularis*, *sinica*, *mulatta*, *nemestrina*, and Sulawesi) inhabiting South and South-east Asia and Sundaland (Ziegler et al. 2007).

The Assam macaque (*Macaca assamensis* McClelland 1840) is one of the members of polytypic Sinica-group which is characterized by the sagittate shaped glans penis and has the fragmented distribution in South and South-east Asia. It includes *M. assamensis*, *M. thibetana*, *M. sinica, M. radiata* (Fooden 1979); and recently described two new species- *M. munzala* (Sinha et al. 2005) and *M. leucogenys* (Li et al. 2015). The *M. assamensis* has two known subspecies- *M. a. assamensis* (eastern Assam macaque) and *M. a. pelops* (western Assam macaque), whose distribution ranges are demarcated by the Brahmaputra River (Roos et al. 2014). The Assam macaque in Nepal differs in pelage and facial color, relative tail length and elevational distribution range to their nearest conspecific populations (*M. a. pelops*) from adjacent countries such as India and Bhutan. Thus, the Nepalese population of Assam macaque has been doubted for distinct subspecies status and referred to "*M. assamensis* Nepal Population" (Molur et al. 2003, Chalise 2005,2013, Boonratana et al. 2020). Recent phylogenetic analysis suggested for the distinct species status of the macaque population in Nepal (Khanal et al. 2021).

The Assam macaque is categorized as 'Near Threatened' by the IUCN (Boonratana et al. 2020) and its Nepalese population, one of the least studied primates, is nationally listed as 'Endangered' due to its restricted distribution, population threats, and small numbers in fragmented patches of remaining habitat. Thus, the species is protected by the National Park and Wildlife Protection Act-1973 of Nepal (Chalise 2013, Khanal et al. 2019, Boonratana et al. 2020). It has been reported from the mid-hills within Nepal as the sub-tropical habitat specialist, but the details on its socioecology is yet to be documented. Among the few studies on it, Chalise (2013) 1099 individuals belonging to 51 troops from forest fragments which ranged between 380 m above sea level (asl) and 2350 m asl in Nepal (Chalise 2013). Khanal et al. (2019) counted 829 individuals from 43 troops with an elevational range of 130 m asl to 2650 m asl.

Assam macaques are medium-sized, arboreal, diurnal and omnivorous cercopithecine primates that live in multimale-multifemale social groups (Chalise 1999, Molur et al. 2003). It resembles much with rhesus macaque (*M. mulatta*) but differs in having uniform brownish-grey to yellowish-grey pelage, lack of a pinkish face and absence of red loins/buttock. It has darker fur in exposed area while whitish-blonde haired to ashy-white in abdominal and inner parts (Fooden 1979). The pelage coloration of infants and juveniles are more blond than adult individuals. Males have dark purple snout particularly around the nose and whitish yellow on the face, whereas, females have crimson red to pinkish red around the eyes and cheeks. The palm, sole and nails are dirty brown/black in color (Chalise 2003). In higher elevation, the animals are with darker fur on back and whitish in abdominal parts resembling Tibetan monkey (Chalise 2008). The male Assam macaque has dark beard on the cheeks which are found directed backwards to the ears while the hair on the crown is divided from the middle. The ischial callosities in male are conspicuous from a distance and distinct in darker individuals. The Assam monkey is a large sized monkey weighing almost above 12 kilograms with about 60 cm head-body length and 35 cm long tail (Chalise 2003).

It is omnivorous and feeds on vegetables, cereals, twigs, and invertebrates (Chalise et al. 2005), however, they are predominantly frugivorous; but will eat leaves and flowers. The sleeping sites of Assam macaques are typically rocky cliffs along the steep banks of streams and rivers (Chalise 2003). The gestation period is of average 164.2 (158- 170) days and the age of female for the first reproduction if of 5 years (Furtbauer et al. 2010). Estrus female has subcaudal sexual swellings that looks like a blackish-brown protruded moist organ (Chalise et al. 2005),

with primiparous females exhibiting larger swellings than multiparous females (Furtbauer et al. 2010).

The Assam macaque is declared 'endangered' and legally protected by the National law, but the species has been reported to be fierce crop raider at different parts of the country (Chalise 1999, Chalise et al. 2013, Adhikari et al. 2018). Primate species inhabiting outside the protected areas are more stressed (Rangel-Negrin et al. 2014) and they decline rapidly in unprotected forests (Rovero et al. 2015). The studies so far in Nepal (Chalise 1999, Chalise et al. 2005, Wada 2005, Chalise 2008,2013) have confined at surveying the fragmented populations of Assam macaque at different patches, lacking the systematic study that cover the entire range of the species. For the conservation and management of an endangered species, the information on its population status, distribution range, general behavior etc. are crucial (Plumptre & Cox 2006). Therefore, a detailed assessment of population and distribution of least studied Assam macaque is essential in Nepal, especially in the areas where no systematic study has been carried out earlier.

2. Fieldworks

Surveys were conducted in February–March 2020 across the three major rivers of far-western Nepal belonging to the Karnali and Mahakali River System (KMRS): Karnali, West-Seti and Chamelia rivers. Spatial distributions of study species in the four physiographic zones across the river systems were surveyed by modified line transect method (Buckland et al. 2010). Wherever the troops were observed, the detail population censuses were conducted for the troops. The geographical location of the troop was noted using GPS and vegetation samplings were done using 20m × 20m quadrates. Distances of troop occurrence from Population census: Total count, age-sex classification, the nearest river, human settlement, crop fields and other relevant measurements were noted. The troop size and population composition were observed in detail from the observation distance varying from about 10 to 100 m aided with the binocular whenever necessary. The individuals were divided into four age groups, namely- adults (male and female), sub-adults, juveniles and infants following the method of Chalise (2003). The counting was repeated until the concurrent readings were obtained for total count and age groups.

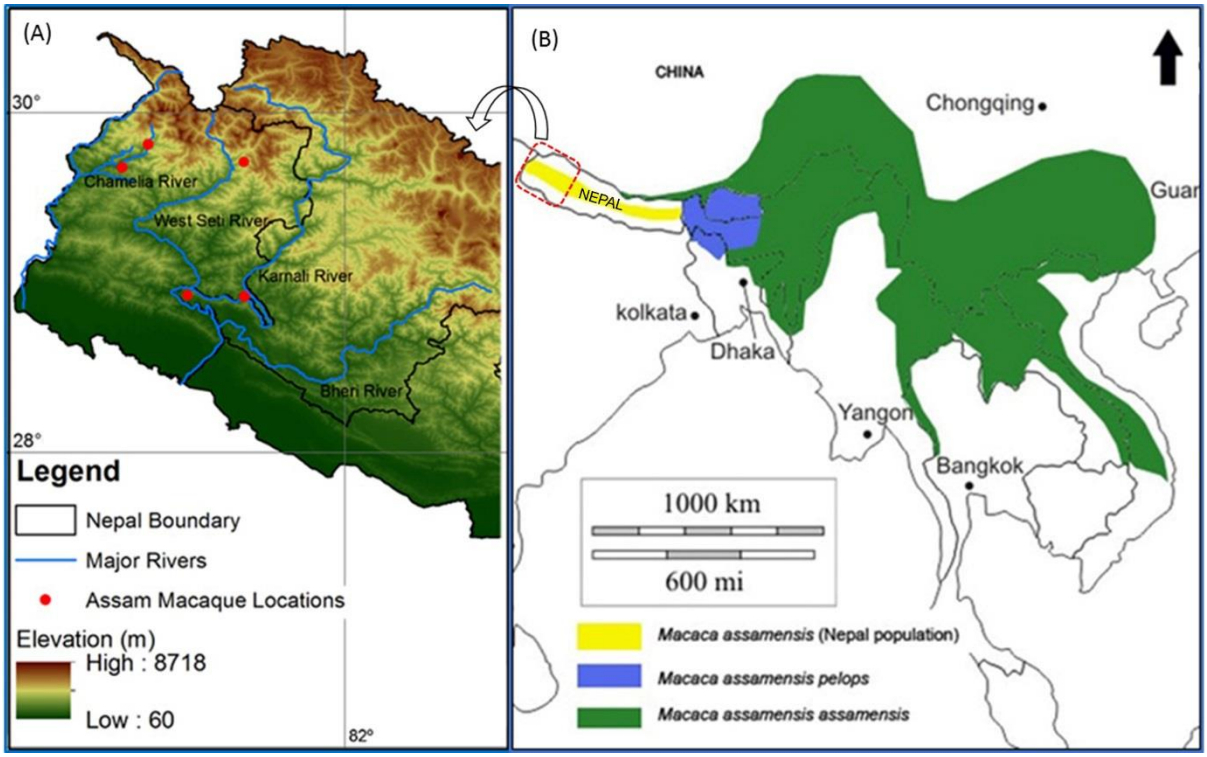

Figure 1. Map of the study area. A, Map of western Nepal showing the rivers surveyed and Assam macaque troops recorded during this study; B, distribution range of two known subspecies and Nepal population of Assam macaque (modified from Boonratana et al. 2020).

In order to characterize the habitat of the Assam macaques, tree surveys were conducted using 10×10 m^2 quadrates. Additionally, 56 local people were interviewed aiming to assess the knowledge they hold about the species and level of human-monkey conflicts.

3. Major Findings

A total of five troops of the Assam macaques were observed from the river catchments under study (Table 1). A total of 77 individuals of Assam macaques from those troops accounted the average troop size of 15.4 individuals. The male to female sex ratio for the observed population was 1:1.8 and the young to adult ratio was 1:1.2. Infants to adult female ratio was 0.56:1. The elevational distribution of the observed troops ranged between 684 m asl at Karnali River bank in Balde, Achham and 2260 m asl at Ghusa area of the Darchula district. Among the five troops, only one troop in Darchula was recorded from the protected area, the Api Nampa Conservation Area.

Table 1. Troops of Assam macaque recorded from the Karnali and Sudurpaschim provinces of Nepal with their distribution and population details.

S.N.	Area	Latitude	Longitude	Elevation	Troop Size	Habitat
1	Balde, Achham	28.9156	81.4107	684	39	Riverine forest
2	Pokhare, Surkhet	28.9305	81.10261		7	Riverine forest
3	Kotpetra, Baitadi	29.6749	80.6938	1207	8	Riverine forest
4	Ghusa, Darchula	29.8109	80.8454	2260	14	Pine, Fir
5	Chhabish, Bajhang	29.5276	81.0654	1153	9	Pine forest

Earlier studies considered the Kaligandaki River in the central Nepal as the westernmost distribution limit to the global population of the Assam macaque species (Groves 2001, Wada 2005, Boonratana et al. 2020). This study complemented the findings of the Khanal et al. (2019) and recorded two additional troops beyond their reports. The average troop size of the Assam macaque in far-western Nepal (15.4) is much lower than the national average 21.55 (Chalise 2013) and 19.29 (Khanal et al. 2019). Elevational distribution of Assam macaques in western Nepal appears different than that of the eastern Nepal. The lowermost recorded distribution of the species in eastern Nepal is 130 m asl (Khanal et al. 2018) whereas the same was found to be above 684 m asl in the western Nepal.

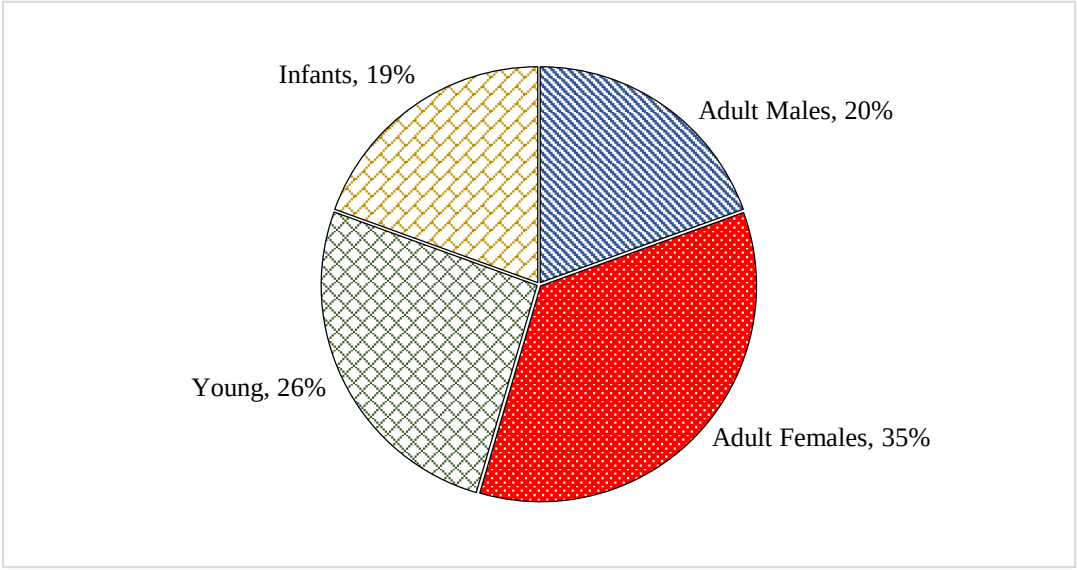

Figure 2. Pie chart showing age sex composition of the Assam macaque in the western Nepal

Only 18.2% of the population in far-western Nepal is within the protected area system of Nepal whereas about half of the overall national population of the species is estimated to have within the protected areas (Khanal et al. 2019). Among the recorded troops from the far-western Nepal, 3 (60%) were observed from the riverine broad-leaved forest represented by tree species such as *Adina cordifolia*, *Bombax ceiba*, *Ficus racemosa*, *Mallotus philippensis*, *Schima wallichi*, *Syzygium cumini*, *Toona ciliate*, etc. and associated climber plants. The troops were recorded close to the water resources such as rivers, rivulets or streams. These results were

consistent to the distribution of the species in the eastern and central Nepal (Chalise 2013, Khanal et al. 2019)), Bhutan (Kawamoto et al. 2006, Choudhury 2008) and north-eastern India (Choudhury 2018).

Among 56 people interviewed, 36 were males and 20 were females. More than 2/3rd (67.86%) of them could distinguish the Assam macaque from the rhesus macaque and named them as 'Kala banar' or 'Pahare banar'; whereas, almost 1/3rd were unaware about existence of the two different species of macaques in the area. 78.57% (n=44) of the interviewed locals considered monkeys as the major crop raider in their agricultural fields and storage. Although Assam macaque is listed as an endangered species and is protected nationally, the species was described as a crop-raider in some parts of Nepal (Chalise 2010, Paudel 2017, Adhikari et al. 2018). However, at most of places of Nepal, rhesus macaque has been experienced as a terrible problem causing a huge loss of crops (Chalise 2009). Due to shy nature and smaller troop sizes, Assam macaque causes lesser crop depredation than the rhesus macaque.

4. Conservation Implication

The westernmost population of the Assam macaque in far-western Nepal is less explored, small in size and sporadically distributed in fragmented forests. Those troops remained unnoticed till the recent past and majority of them are outside the protected area system. At many places of Nepal, including the far-western region, human-macaques conflict is high. Subsistence farmers loose huge amount of crop production due to the raids by monkeys. On another side of the coin, the monkeys get injured and even lose their life due to multitudes of preventive measures employed including retaliatory killings at its extreme. Macaques are considered as one of the pest species and many local governments have employed measures to control them by chasing, capturing, translocating and even culling. Our results revealed that a large proportion of the local people in far-western Nepal are not able to distinguish the Assam macaque from the main nuisance species, the rhesus macaque. They are also unaware of the protection status of the Assam macaque by the national law. Therefore, despite being protected by the National Parks and Wildlife Protection Act 1973 of Nepal, Assam macaques are also known to be injured or killed. The population of the species from the far-western Nepal remained unnoticed to national and international scientific communities and management authorities as they are least explored in the Nepal Himalaya. Therefore, the Assam macaque population from the far-western Nepal requires a high conservation priority.

5. Future Plans

Amid COVID-19 pandemic, fieldworks could not be completed in the planned timeframe. I will complete the remaining works of the project once the travel restriction suspended or risk of the COVID-19 lowers. Remaining rivers and tributaries will be surveyed for searching the Assam macaque troops. As proposed, awareness campaigns will be carried among locals in the Assam macaque presence areas.

6. Acknowledgements

I would like to thank The Rufford Foundation, UK for the research grant to support this study. Thanks are due to our field assistants Dhirendra Bahadur Chand, Laxman Timalsina, Melina Karki and local people for support in the field and sharing information.

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