

Estimating Group Density of Assamese macaques (*Macaca assamensis*) using Multiple Covariate Distance Sampling (MCDS) in Lower Kanchenjunga Area (LKA), Eastern Nepal.



A Project Report to the Primate Society of Great Britain



**OXFORD
BROOKES
UNIVERSITY**

GANGA RAM REGMI (Principal Investigator)

&

KAMAL KANDEL (Co-investigator)

Global Primate Network-Nepal, GPO Box 26288, Kathmandu, Nepal

www.primatelife.org

EXECUTIVE SUMMARY

Ninety line transects were walked, totaling 179.29 km, in which 35 observations of Assamese macaques (*Macaca assamensis*) were made in Lower Kanchenjunga Area (LKA) in Eastern Nepal. These data were analyzed using freely available DISTANCE software. The result suggests that the macaque group encounter rate was 0.19521 groups/km in the study area. The estimated Assamese macaque group density (DS) was 1.2253 (± 0.21569) groups/km² with the expected group size (ES) 26.714 (± 2.373). Similarly, the estimated population density (D) and the total number of macaques (N) in the area were 32.733 (± 6.454) and 1015.0 (± 200.13) respectively. This first systematic and scientific population estimation of Assamese macaques has provided base line information about the population status of the species in the region. In addition, the findings of this research are useful to understand, mitigate and manage the crop-raiding problem and useful to address the human-monkey conflict in the area.

INTRODUCTION

Two species of macaques have been reported from Nepal: the rhesus macaque (*Macaca mulatta*) and the Assamese macaque (*M. assamensis*), the latter is the least known non-human primate of Nepal. After the CAMP (Conservation Assessment and Management Plan) Workshop 2002 held in India, the Assamese macaque of Nepal was postulated as (*M. assamensis* 'Nepal Population') due to its morphological characters that differ from the currently recognized subspecies i.e. Eastern Assamese macaque (*M. a. assamensis*) and Western Assamese macaque (*M. a. pelops*) (Chalise, 2003; Molur *et al.*, 2003). The 'Nepal Population' differs in the head-body and tail lengths, body weight and colour (darker fur with purple snout). Molur *et al.* (2003) considered this macaque as a new subspecies endemic to Nepal.

The isolated distribution of the Assamese macaque in Nepal seems insufficient for maintaining a viable population (Wada, 2005). A species' viability must be measured by evaluating population dynamics and environmental effects (Fa and Lind, 1996). The only studies estimating the population size of Nepalese Assamese macaques were unsystematic surveys concentrated in protected areas (Chalise, 2003; Regmi and Kandel, 2008). Although Assamese macaques have

been reported outside the protected areas (Chalise, 2003; Wada, 2005) including LKA (Pers. Obs.), no ecological studies or population assessments have been carried. Most attention has been on feeding behavior and human-Assamese monkey conflict (Chalise, 2001, Regmi and Kandel, 2008; Regmi, 2008; Regmi, 2009).

Efficient and reliable methods are crucial to estimate the abundance of wild animals (Silveira *et al.*, 2003); different techniques are available depending on behaviour of animals, geographic conditions and available costs. Line transect sampling is commonly used to estimate primate group and population density (Buckland *et al.*, 2001; Buckland *et al.*, 2004). A systematically estimated density of Assamese macaque is crucial to prepare effective management plans for this taxonomically uncertain “Endangered” macaque in this unprotected area. In addition, we delivered this distance sampling technique to the university graduates and forest rangers so that future survey will be carried out effectively to monitor the group and population density of primates and other wildlife in Nepal.

METHODS

Study area

The proposed study area (Fig. 1) i.e. LKA, is also an important part of Eastern Himalayas, one of the top 25 Global Biodiversity Hotspots (Myers *et al.*, 2000) and included in WWF’s Global 200 eco-regions. It is also the trans-boundary biological corridor between Kanchenjunga Conservation Area (KCA) in Nepal, and Singhalila National Park (SNP), India (Olson and Dinerstein, 2002).

Survey design and analysis

We designed the line transect survey (Fig. 1) using Hawth’s Tool available in www.spatial ecology.com and analyze line transect data with DISTANCE 6.0 (Thomas *et al.*, 2009). Field survey completed using line transect methods (we previously planned to do point transect but due to the shy nature of wild Assamese macaque, they were immediately flushed

out when we reached to the point for survey and we had only 10 detections from point transects. So we avoided these data in our analysis. Therefore we applied line transect survey data for our analysis for reliable estimation of density). Data were analyzed using DISTANCE software and the results were presented in the project report.

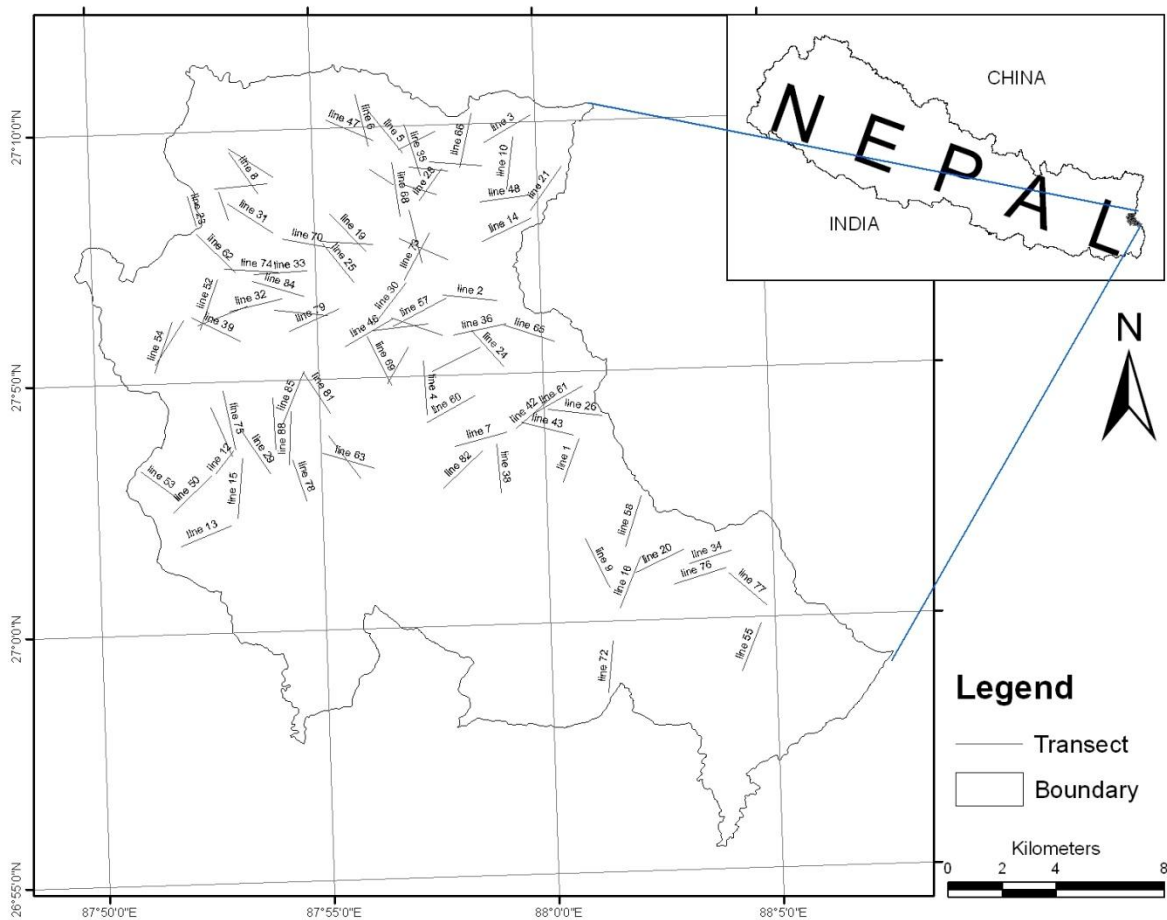


Figure 1: Map of Nepal showing the study area (LKA) and the transect locations

RESULTS

Assamese macaque group encounter rate (ER)

Overall, 90 line transects were overlaid in the study area totaling of 179.29 km in which 35 observations have been made. This means

The total number of samples (k) = 90

Number of observed groups of animals (n) = 35

Total length of transect lines (L) = 179.29 km

Therefore, encounter rate (ER) = n/L

$$= 35/179.29$$

$$= 0.19521 \text{ groups/km}$$

Table 1. Assamese macaque encounter rate estimation summary

Parameters	Estimate	%CV	df	95% Confidence Interval	
n	35.000				
k	90.000				
L	179.29				
n/L	0.19521	17.14	89.00	0.13921	0.27374
Left	0.0000				
Width	114.72				

This estimation suggests us that we encountered 0.19521 Assamese macaque groups per kilometer in the study area.

The group size of Assamese macaque

The expected group size of Assamese macaque in the study area was 26.714 (± 2.373).

Population of Assamese macaque

Table 2. Density estimates summary

Parameter	Point Estimate	Standard Error	Percent Coef. Of Variation	95% Percent Confidence Interval	
DS	1.2253	0.21569	17.60	0.86634	1.7330
E(S)	26.714	2.3730	8.88	22.310	31.988
D	32.733	6.4540	19.72	22.243	48.170
N	1015.0	200.13	19.72	690.00	1493.0

Where, DS = estimate of group density of macaque

E (S) = estimate of expected value of group size of macaque

D = estimate of density of animals i.e. Assamese macaques

N = estimate of number of animals in study area

The above table shows that the estimated Assamese macaque group density (DS) is 1.2253 (± 0.21569) groups/km² with the expected group size (ES) 26.714 (± 2.373). Similarly, the estimated population density (D) and the total number of macaques (N) in the area are 32.733 (± 6.454) and 1015.0 (± 200.13) respectively.

Detection Probability

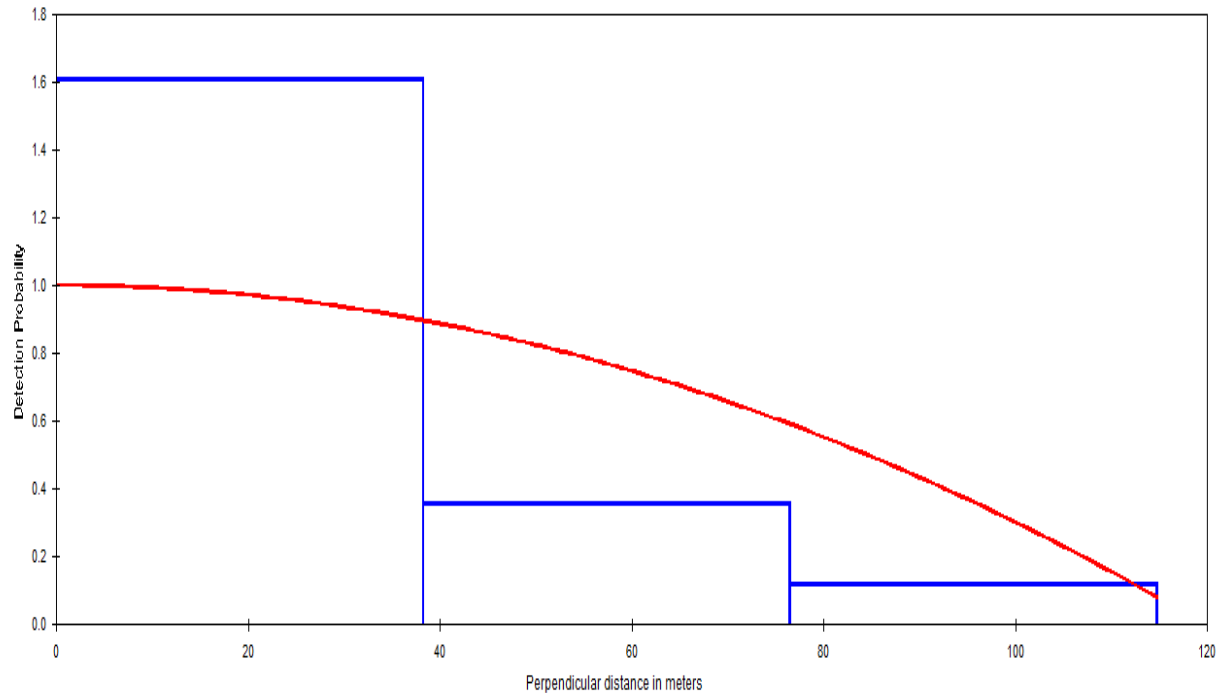


Figure 2: The detection curve showing the probability of detecting macaques on lines. Though the detection curve is not fitted well, it indicated that there is the decreasing trend of detecting animals with increasing perpendicular distance from the lines.

Potential distribution niche of Assamese macaque in Nepal

We have prepared potential distribution niche of Assamese macaque in Nepal using the 'presence only' species occurrence data, species distribution modeling tool and freely available bioclimatic layers (www.worldclim.org). For this we used species presence only locations derived from this project work, previous field works and from freely available public data from Global Biodiversity Information Facility (GBIF). The manuscript is under preparation for submitting to peer-reviewed journal (Regmi et al in prep.). The preliminary Assamese macaque occurrence probability map in Nepal is as follow:

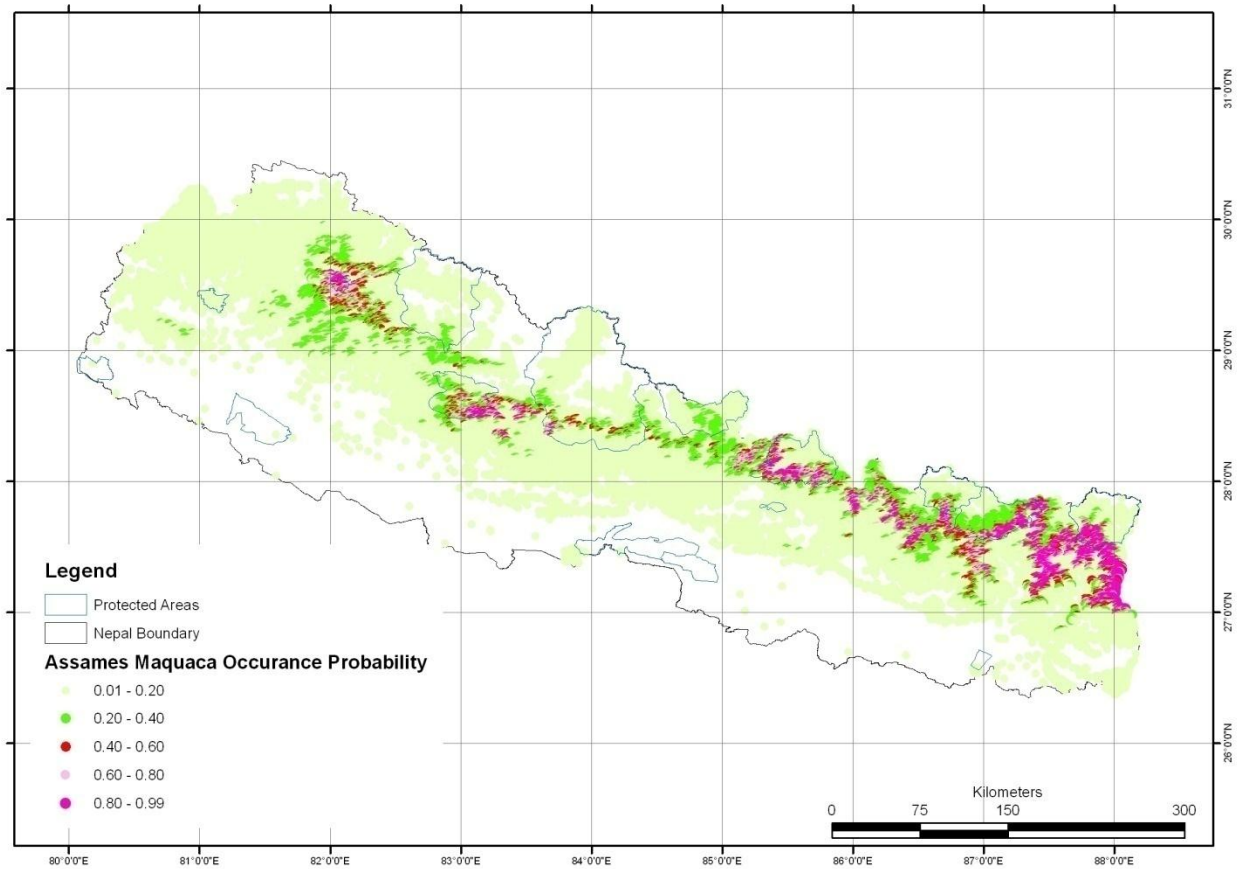


Figure 3: Assamese macaque occurrence probability in Nepal. Higher probability value indicates the most suitable ecological niche of macaque in Nepal. Here, the map shows that eastern part of Nepal holds the more suitable habitat of macaque than in western part of the country. This predictive map leaves a good question about sister taxa of this macaque and extinct meta-populations, and missed animals and their niches (Regmi et al. in prep.).

Potential distribution of Assamese macaque in south and south-east Asia

We have developed the first quantitative potential niche distribution models for the Assamese macaque for the 12 nations of South and South-east Asia: Afghanistan, Pakistan, Nepal, India, China, Bangladesh, Bhutan, Myanmar, Vietnam, Thailand, Lao PDR and Cambodia. We applied RandomForests (RF), Classification and Regression Trees (CART), TreeNet (TN), Maxent and Multivariate Adaptive Regression Splines (MARS) machine learning algorithms. Then we averaged all of these model outputs as an ensemble model prediction. We used species

occurrence records from our own PSGB funded field works as well as extracted species occurrence records from published sources and we also used the elevation and 19 environmental layers related to precipitation and temperature from WorldClim (www.worldclim.org) to develop these models. The predicted distribution of Assamese macaque was strongly associated with BIO 18 (Precipitation of Warmest Quarter), BIO 7 (Temperature Annual Range) and BIO 4 (Temperature Seasonality). The predicted map showed that there is a continuous and potential niche of Assamese macaque from east to the Kaligandaki river in Nepal up to the Brahmaputra river in northeast India. Other predicted areas seem to have either fragmented or confined in small pockets. Here we have provided the first robust rules and resource selection functions for such predictions. Our predictions also show that there are no ecologically suitable areas for this species in Pakistan, Afghanistan and Cambodia. Our most significant contribution probably is the identification of the areas with a high probability of the presence of Assamese macaque, which is information that can be applied to identify new population of this species and to planning future surveys in previously un-surveyed areas in the region. The model outputs obtained here is also helpful for understanding biogeography and historical ecological niche evolution of the species (Regmi et al. in prep.).

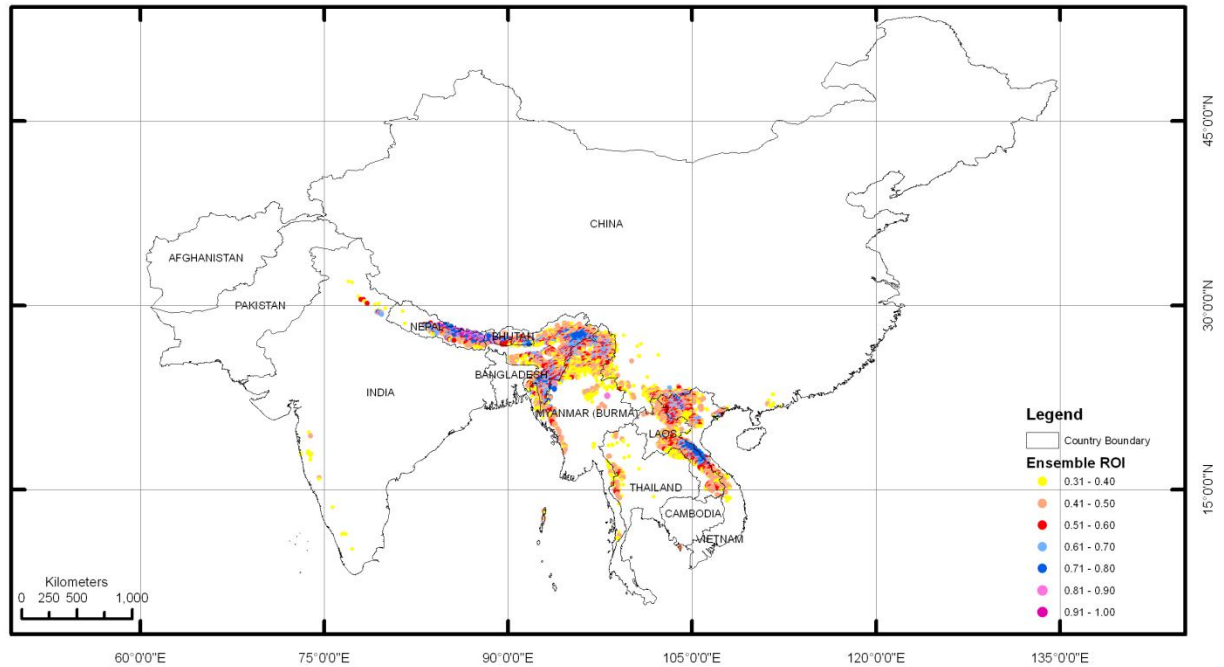


Figure 4. Potential distribution of Assamese macaque in south and south-east Asia derived from using ensemble model prediction (Regmi et al. in prep.). The legend in the map denotes the Relative Index of Occurrence (ROI) for the suitable ecological niche of Assamese macaque in the study area. Higher the ROI values, better will be the Assamese macaque habitat.

First record of ALBINO Assamese macaque in Nepal

During our survey we had deployed some camera traps in the study area. Our one camera had trapped a troop of Assamese macaque in Chintapu Community Forest of Ilam district, which had a unique and ALBINO adult macaque. This is the first record of ALBINO macaque in Nepal. We are planning to follow this troop to study its detail ecology and behavior.



Figure 5: A camera trapped photo of small troop of Assamese macaque where we can see the ALBINO macaque (Photo ©Global Primate Network-Nepal).

One day national level distance sampling training workshop

We organized one day national level Distance Sampling Workshop in Kathmandu, Nepal and it had been completed successfully on Saturday, 25th August, 2012 at Hotel Palagya, Kathmandu. The training benefited 23 young researchers from Central Department of Zoology and Central Department of Environmental Science, Tribhuvan University and faculties from affiliated colleges, conservation agencies and Department of National Parks and Wildlife Conservation of Government of Nepal. We proudly say that this training workshop is first of its kind in Nepal. We would like to acknowledge all the partner agencies and Dr. FALK HUETTMANN, Associate Prof. –EWHALE lab- University of Alaska Fairbanks (UAF) USA, for his outstanding contribution as resource person and lecturer in the training workshop.



Fig 6: Dr Falk Huettmann is giving lecture about DISTANCE SAMPLING and software to the participants.

Global Primate Network-Nepal, CARON-Nepal and -EWHALE lab-, University of Alaska-Fairbanks (UAF), USA had organized this training workshop. We had given proper acknowledgements to our funding partners - Ocean Park Conservation Foundation Hong Kong (OPCFHK); American Society of Primatologists, USA; Primate Society of Great Britain, UK; The Rufford Small Grants Foundation, UK; The Columbus Zoo and Aquarium, USA; and Idea Wild, USA.



Figure 7: Participants are listening the lecture of Dr Falk Huettmann



Figure 8: A group photograph with all the participants and instructor Dr. Falk Huettmann.

CONCLUSION

The project has been successfully completed in time. This is the first scientific and systematic population assessment of Assamese macaque in Nepal and outside protected areas. The information generated from this project is very useful and can be used in species conservation and management plan. For example, using the Assamese macaque presence only locations derived from this project, we have already prepared the Assamese macaque potential habitat mapping in Nepal which is crucial information and deliverables for wildlife managers. Moreover, the 'Distance Sampling Training Workshop' provided the opportunity to the postgraduate students of Nepalese university, wildlife officers and young researchers for learning about the advanced wildlife population and abundance survey and data analysis technique. We hope that participants will apply this method for scientific estimation of population and abundance of wildlife including primates in their habitat country Nepal.

PUBLICATIONS AND DELIVERABLES GENERATED FROM THE PSGB FUNDED PROJECT

1. Publication of Assamese macaque 'presence only' data

We have published the presence only location data of Assamese Macaque in the form of ISO standard METADATA in United States Geological Survey (USGS) website with the proper acknowledgement to Primate Society of Great Britain and other donors.

Regmi, G. R., K. Kandel, D. K. Karmacharya, S. T. Lama & Y. Ghimirey. 2012. Compiled 'Presence Only' data for Assamese Macaque (*Macaca assamensis*) in Nepal Himalaya. (http://mercury.ornl.gov/clearinghouse/send/xsltText2?full_datasource=uaf&fileURL=d:%5Cmercury_instances%5Cusgs%5Cuaf%5Charvested%5Cmercury.bio.ualf.edu~falk_huettmann_nbii_Assamese_MacaqueNepalMetadataFH3.xml)

2. Publications of Assamese macaque line transect data

We have published the line transect survey data of Assamese macaque in public domain with the proper acknowledgement to Primate Society of Great Britain and other donors. These data are online and free to use for anyone.

Regmi, G. R., K. Kandel, D. K. Karmacharya & S. T. Lama. 2012. Distance sampling line transect data for Assamese Macaque (*Macaca assamensis*) in Eastern Nepal, Himalaya 2011 til 2012.

<https://dspace.alaska.edu/bitstream/uaf/1012/26/Assamese%20MacaqueLineTransctMetadataFH4.xml.html>

3. Publication of Indian Muntjak 'presence only' data

During our Assamese macaque survey in LKA, we also did the opportunistic survey of Indian muntjak (*Muntiacus muntjak*) and publish this data also in the following link with the proper acknowledgement to the PSGB and other donors of the project. We also use this data for species distribution modeling purpose in future or anyone can use this data for such purpose as they are freely available globally on public domain.

Regmi, G. R., K. Kandel, D. K. Karmacharya & S. T. Lama. 2012. Compiled 'Presence Only' data for Barking Deer (*Muntiacus muntjak*) in Lower Kanchenjunga Area, Nepal.

http://mercury.ornl.gov/clearinghouse/send/xsltText2?full_datasource=uaf&fileURL=d:%5Cmercury_instances%5Cusgs%5Cuaf%5Charvested%5Cmercury.bio.uaf.edu~falk_huettmann_nbii_IndianMuntjak_MetadataFH2.xml

4. **Regmi, G. R.,** F. Huettmann, V. Nijman, M. K. Suwal, K. A. I. Nekaris, K. Kandel & N. Sharma. (*in prep. for Global Ecology and Biogeography journal*). Potential Distribution of Assamese macaque (*Macaca assamensis*) in South and South-East Asia: A first Open-Access Ensemble Model Prediction.
5. **Regmi, G. R.,** F. Huettmann, M. K. Suwal, K. A. I. Nekaris & K. Kandel. (*in prep.*). Density Surface GIS modelling of Assamese Macaque (*Macaca assamensis*) in Lower Kanchenjunga Area, East Nepal.
6. **Regmi, G. R.,** Nekaris, K. A. I., Kandel, K. & Nijman, V. (2013). Crop-raiding macaques: predictions, patterns and perceptions from Langtang National Park, Nepal. *Endangered Species Research* (Accepted).

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