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COMMUNICATION

DISTRIBUTION AND HABITAT PREFERENCES OF THE CHINESE PANGOLIN *MANIS PENTADACTYLA* (MAMMALIA: MANIDAE) IN THE MID-HILLS OF NEPAL

Suman Acharya, Hari Prasad Sharma, Rajeev Bhattarai, Beeju Poudyal, Sonia Sharma & Suraj Upadhaya

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COMMUNICATION

Distribution and habitat preferences of the Chinese Pangolin *Manis pentadactyla* (Mammalia: Manidae) in the mid-hills of Nepal

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Abstract: The Chinese Pangolin is a 'Critically Endangered' species, which is estimated to have declined by over 90% in the last 21 years due to increased anthropogenic activities on the species and its habitat. Only a few pieces of research on the Chinese Pangolin have been done throughout Nepal; there is little information among the mammal species of Nepal, especially on distribution and habitat preference. This study was set to assess the distribution and habitat preferences of the Chinese Pangolin in Panauti municipality, central Nepal. We identified the most preferred habitat of the Chinese Pangolin using different covariates. Its preferred habitat was found ranging 1,450–1,600 m of elevation within a moderate slope of 5–25° steepness, forested areas in west-facing slopes. The maximum number of burrows of the species were found to be distributed in open canopy (0–50 % coverage). The increase anthropogenic activities in the agricultural land and deforestation in forested land has negatively impacted the occurrence of the Chinese Pangolin. We recommend that the community-based conservation initiatives like community forestry programs should be robustly implemented in the study area for better conservation of species and habitat in the coming years.

Keywords: Critically Endangered species, distribution, habitat, pangolin, wildlife.

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Author contributions: SA—research design, data collection, data analysis and interpretation, drafting manuscript, critical review, revisions at different stages. HPS—methodology design, write up, data analysis, revisions at different stages. RB—drafting manuscript, and revisions at different stages. BP—draft manuscript preparation, reviewing, editing. SS—conceptualization, drafting manuscript, reviewing, editing. SU— conceptualization, writing: draft preparation, data analysis, reviewing, editing.

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INTRODUCTION

Anthropogenic activities like illegal hunting and trading, deforestation, wildfire, increased agricultural landscape, and habitat fragmentation are the major threats to the biodiversity conservation in the contemporary world (Nepstad et al. 1999; Wolfe et al. 2005; Jha & Bawa 2006; Gibson et al. 2011; Laurance et al. 2014; Abood et al. 2015). The major impact of these activities can be found on flora and fauna. To minimize the anthropogenic effects, several areas are demarcated under the protected areas system for biodiversity conservation around the world (Bruner et al. 2001; Naughton-Treves et al. 2005). However, a majority of anthropogenic threats are highly confined outside the protected areas that accounts for approximately 86% of the earth's total land (Deguignet et al. 2014) and are highly vulnerable in terms of species distribution and habitat management (Sharma & Acharya 2017). The established protected areas in most of the countries including Nepal do not cover all threatened species under the protected area system (Jnawali et al. 2011; Polak et al. 2016). As other wildlife species, the pangolin's more suitable habitat is predicted outside the protected area of Nepal (Sharma et al. 2020a; DNPWC & DoF 2018), and the species is also facing survival threats due to similar anthropogenic activities that have reduced the distribution of the pangolin (Challender et al. 2014; Acharya 2015; Kaspal et al. 2016; Katuwal et al. 2017; Acharya et al. 2018; Sharma et al. 2020a,b).

Nepal hosts two species of pangolin out of eight species distributed across the world: The Chinese Pangolin *Manis pentadactyla* and the Indian Pangolin *M. crassicaudata* (Baral & Shah 2008; Jnawali et al. 2011; Challender et al. 2019). Indian Pangolins are distributed below 500 m and Chinese Pangolins are distributed in lower regions as well as mountain areas with a maximum elevation of 2,400 m (Baral & Shah 2008; Jnawali et al. 2011; Kaspal et al. 2016; Sharma et al. 2020a). Globally, the Chinese Pangolin is found in Bangladesh, Bhutan, China, Hong Kong, India, Japan, Lao, Myanmar, Nepal, Taiwan, Thailand, and Vietnam (Challender et al. 2019). In Nepal, the Chinese Pangolin is distributed from east to west at the extreme limits of the Gandaki Province (Baral & Shah 2008; Jnawali et al. 2011; Acharya 2016; Katuwal et al. 2017; Acharya et al. 2018; Suwal et al. 2020; Sharma et al. 2020a,b,c). Within these geographic regions, the Chinese Pangolin inhabits forests, agricultural lands, degraded landscape, and nearby human settlements (Katuwal et al. 2017; Sharma et al. 2020a,b) and its occurrence is influenced by forest canopy, soil, distance to water sources, distance to human settlements, road or foot path, and slope (Wu et al. 2003; Acharya 2016; Katuwal et al. 2017; Sharma et al. 2020a,b). Generally, its distribution in these habitats will be supported by food availability such as termites and ants (Challender et al. 2019).

However, the species is protected in different nations including Nepal with strong national laws and acts (Challender & Waterman 2017; Challender et al. 2019), the population status of the species is declining day by day mainly due to poaching for meat and scales in China and Vietnam (Pantel & Chin 2009; Challender & Heywood 2012; Heinrich et al. 2016; Ghimire et al. 2020; Sharma et al. 2020d) and these threats are assumed in almost all countries including Nepal (DNPWC & DoF 2018; Challender et al. 2019). Therefore, the IUCN Red List categorized the species under 'Critically Endangered' (Challender et al. 2019), under protected mammal species in Nepal, and Appendix I on CITES. In spite of these status, the detail site specific information on the Chinese Pangolin and its habitat especially on distribution and habitat preference is little known, therefore, we aimed to provide the site specific information on the habitat preferences of the Chinese Pangolin for developing a management plan.

MATERIALS AND METHODS

Study Area

We performed this study in the Balthali of Panauti Municipality (former Balthali Village Development Committee) in Kavrepalanchowk district of Nepal. The study area is located outside the protected area system and will be more crucial for designing the site-specific management plan for long term conservation of the Chinese Pangolin. The study area comprises 9.5km^2 (27.54^{0}N, 85.54^{0}E), and ranges at 1,300–1,900 m of elevation. The area is occupied by agricultural land, grassland, and forest. This area is quite famous for multiple agricultural products like rice, wheat, potato, barley, maize, pea, and mustard. These two sentences are combined as: The area is inhabited by many fauna and flora such as Leopard Panthera pardus, Indian Palm Squirrel *Funambulus penantii*, Golden Jackal *Canis aureus*, Porcupine *Hystrix* spp. Mongoose *Herpestes auropuncatatus*, and Yellow-throated Marten *Martes flavigula*. Balthali supports mixed types of forest species including Pine *Pinus roxburghii*, Nepalese Alder *Alnus nepalensis*, Wild Himalayan Pear *Pyrus pashia*, Wild Himalayan Cherry *Prunus cerasoides*, and Needlewood *Schima wallichii*.

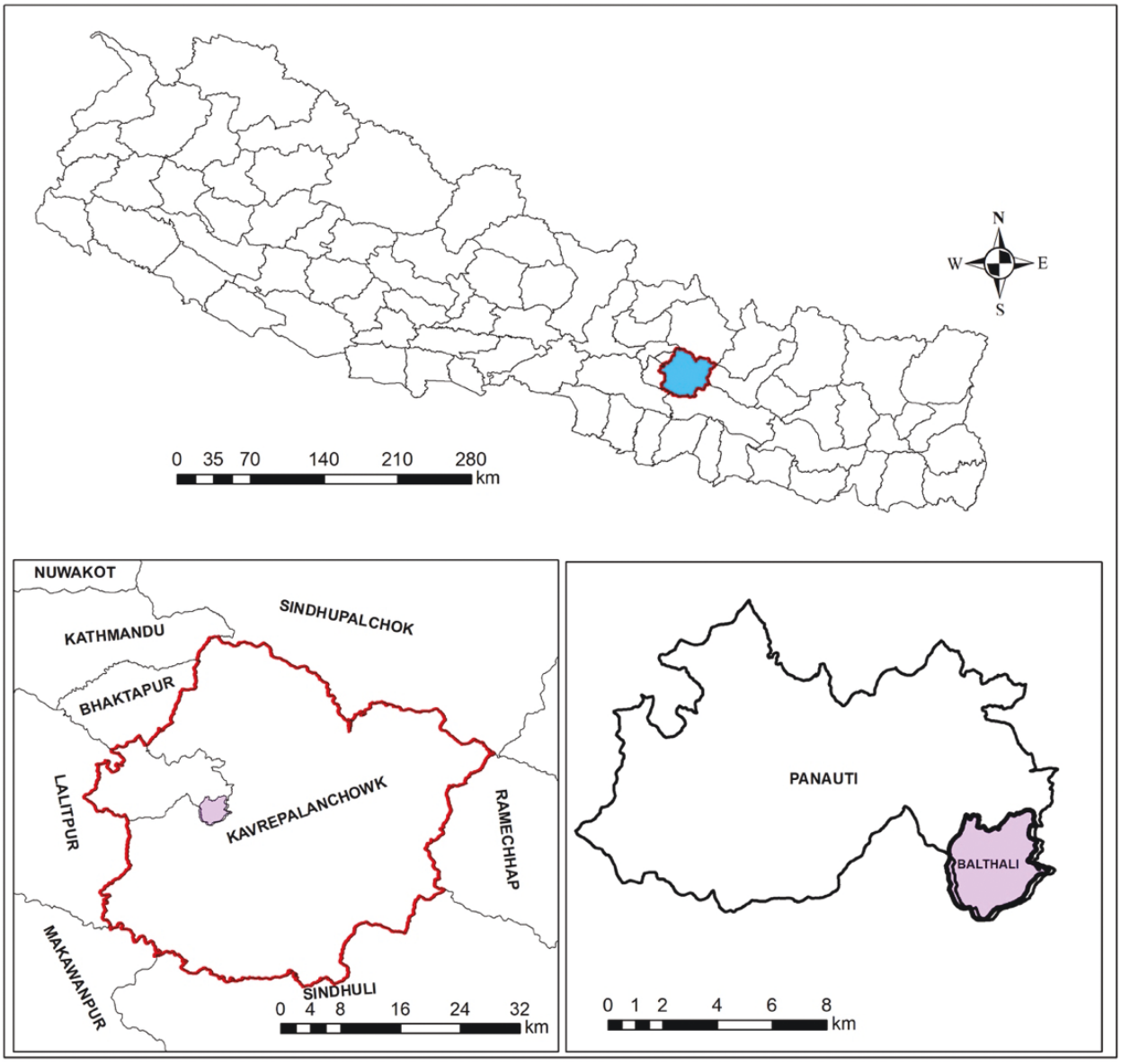

Figure 1. Location of the study area (Balthali of Panauti municipality) in Kavrepalanchowk district, mid-hills of Nepal.

Methods

We collected data between December 2017 to March 2018. A reconnaissance survey was carried out in the first week of December 2017 in the study area to identify the potential sites of the pangolin. It was performed in consultation with local people and district forest officials before we initiated our fieldwork. After confirmation of the Chinese Pangolin's presence in the study area, a random sampling technique was followed to collect data. We followed the method applied by Katuwal et al. (2017); however, we modified it based on our study area in which we divided the study area into 160 grids and each grid was 250 × 250 m. We established 10 × 10 m of plot at the center of each alternate grid to collect the information on pangolin presence records.

We recorded slope, aspect, elevation, canopy, and habitat information in each plot, which are influencing factors for the Chinese Pangolin occurrence (Katuwal et al. 2017; DNPWC & DoF 2018; Sharma et al. 2020b). However, the present study was not able to include all influencing factors such as food, nearest distance to road and other anthropogenic factors because of financial and time constraints. We noticed the slope and aspect of each plot using a clinometer, and elevation and spatial locations by global positioning system (GPS) Etrex 10 (Garmin Ltd., Olathe, Kansas). We recorded the canopy

cover by using a crucial mobile application (Gap Light Analysis Mobile Application) (Tichy 2016; Sharma et al. 2020b) and categorized into open (0–50%) and close (50–100%) canopy. We identified the habitat types into forest, shrubs, grassland, and agricultural land. However, we did not notice the occurrence of Chinese Pangolins in shrubs and grassland during our study period, therefore we excluded these variables for data analysis. We noticed the presence/absence of Chinese Pangolin based on its signs such as burrows, scratches, and feces. We categorized burrows as old and new burrows based on scratches and pugmarks (Katuwal et al. 2017) and presence of any types of burrows recognized as presence.

Data Analysis

We calculated the descriptive statistics (Mean +SD) of the continuous variables. We used logistic regression to estimate the effects of slope, aspect, canopy cover, elevation, habitat types on the presence of Chinese Pangolin. We ran all combinations of variables without interactions. As our sample size was small, we adjusted Akaike information criterion (AIC) for small samples as suggested by Burnham & Anderson (2002). We used this AIC to rank the models. The relative strength of evidence for each model were estimated using the Akaike model weights. To estimate 95% confidence intervals for each independent variable we conducted model averaging of all the models.

RESULTS

Distribution of Chinese Pangolin

We found altogether 258 burrows of Chinese Pangolin in the study area. These coordinates were plotted in the Arc GIS map to depict the distribution in the Balthali of Panauti municipality (Figure 2).

Habitat preference

The presence of the Chinese Pangolin was found in 47 plots (59%) out of 80 plots. The observed plots were found at 1,300–1,895 m of elevation (mean 1,562.13 ±14.61 m SD). Mean elevation of plots with and without pangolin was 1,564.93 ± 17.94 m and 1,556.35 ± 25.15 m, respectively. Elevation class of 1,450–1,600

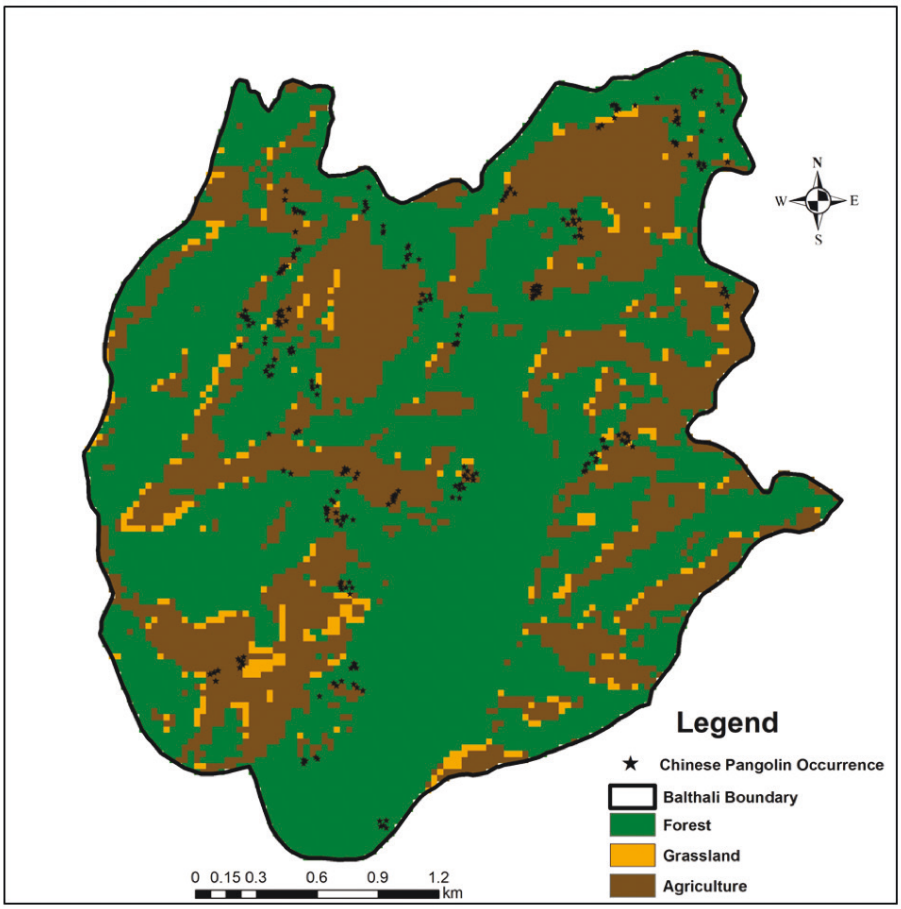

Figure 2. Potential preferred habitat of Chinese Pangolin *Manis pentadactyla* within existing land cover for the year 2010. Landcover source: ICIMOD

m hosts the highest evidence of Chinese Pangolin presence. The studied plots were found from 5–<30° slope. The Chinese Pangolin's occurrences were found between 5–25° slopes. Mean slope of plots with and without pangolin was 17.11 ± 1.15° and 22.23 ± 1.57°, respectively. Comparatively more Chinese Pangolin presence (44%) was found in west aspect and followed by the east aspect (30%), south (19%) and the least was found in north aspect (7%), respectively. We found that 78% of Chinese Pangolin presence was detected in open canopy whereas only 22% of presence was found in close canopy. Similarly, 60% of Chinese Pangolin presence was detected in forest land followed by 40% in agricultural land.

Using the Akaike information criterion adjusted for small samples (AIC), our model revealed that the best-supported models included canopy, habitat and slopes followed by the model containing canopy, habitat, slope, and aspect (Table 1). Chinese Pangolin preferred habitat with 0–50% of tree canopy, i.e., open canopy. Increased tree canopy had negative effects on the occurrence of Chinese Pangolin (Table 2). They preferred to live at lower slope (10–20°), and the number of their occurrences decreases with increasing slope (Table 2). Their occurrences was greatly influenced by habitat including forest and majority of the presence was detected in forested areas than agricultural areas. West facing slopes supported the occurrence of Chinese Pangolin (Table 2; Figure 3). Their occurrence was decreased with increasing elevation (Table 2).

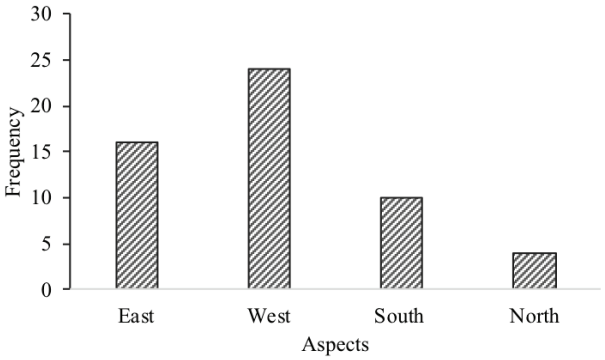

Figure 3. Aspect wise distribution of the Chinese Pangolin.

DISCUSSION

In our study both forest and agricultural lands support the occurrence of Chinese Pangolin may be due to the availability of higher food such as ants and termites. These are the major habitats in Nepal (Gurung 1996; Bhandari & Chalise 2014; Katuwal et al. 2017; Suwal et al. 2020; Sharma et al. 2020a,b) for the species. Among these habitats, the forest supports the higher proportion of occurrence, which might be due to food availability in the forest and less disturbances, which was also indicated by Sharma et al. (2020a) in mid-mountain regions of Nepal. The forest provides ample space and food for pangolins because ants and termites are found abundantly in this habitat (Okwakol 2000; Ellwood 2002; Lee et al. 2017), that could support the robust presence of its population in forest (Swart et al. 1999). The pangolin prefers the west slope probably for getting sunlight before foraging.

We also documented 40% of the pangolins preferred agricultural land as a suitable habitat. The occurrence of the Chinese Pangolin is higher in those settlement areas that are near to forest and surrounded by shrubs and diverse forest vegetation (Carter & Glimour 1989; Acharya 2006; Sharma et al. 2020a,b). As the presence of farmers in agricultural land for their daily chores disturb the movement of the pangolins, therefore the species preferred forest adjoining the agricultural land (Katuwal et al. 2017; Sharma et al. 2020b). Moreover, during our survey we directly observed the presence of shrubs, small trees, ants, termites, and tree leaves in the agricultural land that promote habitat preference of the pangolins (Richer et al. 1997). However, increase in insecticides use, habitat destruction due to construction works in agricultural land, and deforestation has affected the presence and distribution of the pangolins (Acharya et al. 2018).

Our study revealed that the elevation range of 1,300–1,895 m hosts the occurrence of Chinese Pangolins, and most preferred range was 1,450–1,600 m of elevation located in the mid-mountain regions of Nepal. This range also fall under the predicted suitable habitat for the Chinese Pangolins (Sharma et al. 2020a; Suwal et al. 2020) and field based (Thapa et al. 2014; Dorji et al. 2017; Wu et al. 2020) except 200–1,000 m of elevation in Taiwan (Sun et al. 2019). Their preferences might be due to increased forest in the mountain regions of Nepal.

We report the Chinese Pangolins prefer open canopy forest (0–50% coverage) such that the increase in canopy coverage has negative effect on its occurrence. The occurrence of large number of fallen logs and cut stumps in open canopy forest might support the occurrence of ants and termites. However, Katuwal et al. (2017) claimed the presence of Chinese Pangolin in dense canopy cover, which might support in the habitat protection from erosion.

Table 1. Logistic regression models describing the occurrence of the Chinese Pangolin in Balthali of Panauti municipality, Kavrepalanchowk for 2017 year, ranked according to the Akaike information criterion adjusted for small sample size (AICc). Model parameters include aspect (°), canopy (%), elevation (m), slope (°), habitat (agricultural/forest), (presence/absence). K is the number of parameters, ΔAICc is the difference between the AICc value of the best-supported model and successive models, LogLik is used for a model fitted by maximum likelihood and *Wi* is the Akaike model weight.

Models	K	LogLik	AICc	ΔAICc	*Wi*
Canopy + Habitat + Slope	4	-34.358	76.7	0	0.448
Aspect + Canopy + Habitat + Slope	5	-34.01	78	1.3	0.234
Canopy + Elevation + Habitat + Slope	5	-34.232	78.5	1.75	0.187
Aspect + Canopy + Elevation + Habitat + Slope	6	-33.956	79.9	3.2	0.091
Canopy + Slope	3	-39.144	84.3	7.57	0.01
Aspect + Canopy + Slope	4	-38.537	85.1	8.36	0.007
Canopy + Habitat	3	-39.758	85.5	8.8	0.006
Aspect + Canopy + Habitat	4	-38.913	85.8	9.11	0.005
Canopy + Elevation + Slope	4	-39.016	86	9.31	0.004
Aspect + Canopy + Elevation + Slope	5	-38.295	86.6	9.87	0.003
Canopy + Elevation + Habitat	4	-39.752	87.5	10.79	0.002
Aspect + Canopy + Elevation + Habitat	5	-38.91	87.8	11.1	0.002
Habitat + Slope	3	-42.243	90.5	13.77	0
Canopy	2	-43.566	91.1	14.41	0
Elevation + Habitat + Slope	4	-41.672	91.3	14.63	0
Aspect + Canopy	3	-42.689	91.4	14.66	0
Aspect + Habitat + Slope	4	-42.105	92.2	15.49	0
Aspect + Canopy + Elevation	4	-42.199	92.4	15.68	0
Canopy + Elevation	3	-43.205	92.4	15.69	0
Aspect + Elevation + Habitat + Slope	5	-41.591	93.2	16.47	0
Habitat	2	-46.038	96.1	19.36	0
Aspect + Habitat	3	-45.474	96.9	20.23	0
Elevation + Habitat	3	-45.803	97.6	20.89	0
Aspect + Elevation + Habitat	4	-45.31	98.6	21.9	0
Slope	2	-47.361	98.7	22.01	0
Aspect + Slope	3	-46.983	100	23.25	0
Elevation + Slope	3	-47.353	100.7	23.99	0
Aspect + Elevation + Slope	4	-46.981	102	25.25	0
Null	1	-50.446	102.9	26.18	0
Aspect	2	-49.82	103.6	26.92	0
Elevation	2	-50.409	104.8	28.1	0
Aspect + Elevation	3	-49.754	105.5	28.79	0

This study found that the burrows of Chinese Pangolin were distributed between 5–25° slopes, so that they can move easily in the area to avoid the terrain slope. In most of the areas of Nepal a maximum number of burrows was recorded at 15–22° slopes (Sharma et al. 2020b). Sharma et al. (2020a,b) argued that the presence of large number of burrows in lower slope could be due to the presence of plethora of fallen logs and prey species (ants and termites). However, Wu et al. (2003), Dorji et al. (2017), and Suwal et al. (2020) noticed the preferred slopes for Chinese Pangolin was <50°. The presence of the pangolin in varied slope recorded in different locations might be due to physiographic condition of the locality.

In conclusion, Balthali of Panauti municipality is one of the suitable places in Nepal that supports the

Table 2. Model averaged parameter estimates and 95 % confidence limits (CL) for Chinese Pangolin occurrence. Variables detail was described in Table 1. Significant variables are in bold.

	Estimate	SE	Lower 95% CL	Upper 95% CL	Z	p
(Intercept)	6.623250	2.708539	1.24022	12.00627	2.412	**0.015886**
Canopy	-0.063462	0.017954	-0.09922	-0.0277020	3.478	**0.000505**
Habitat	-2.473016	0.964771	-4.39456	-0.5514705	2.522	**0.011654**
Slope	-0.112887	0.038628	-0.18983	-0.0359469	2.876	**0.004032**
Aspect	0.252597	0.303325	-0.35166	0.8568507	0.819	0.412599
Elevation	-0.001260	0.002520	-0.00628	0.0037597	0.492	0.622816

pangolins occurrences. The Chinese Pangolin's suitable habitat is influenced by habitat and habitat related covariates, therefore, we recommend the development and implementation of extensive conservation strategies such as community-based conservation initiatives like community forestry programs for species conservation to prevent the loss of this critically endangered species from the earth.

REFERENCES

Acharya, K.P. (2006). Linking trees on farms with biodiversity conservation in subsistence farming systems in Nepal. *Biodiversity and Conservation* 15: 631–646. https://doi.org/10.1007/s10531-005-2091-7

Acharya, S. (2015). Pains of the pangolin. The Kathmandu Post https://kathmandupost.com/opinion/2015/02/22/pains-of-the-pangolin/ accessed 02 May 2020

Acharya, S. (2016). Assessment of conservation threats and habitat management of Chinese Pangolin (*Manis pentadactyla*) in Balthali VDC of Kavreplanchowk Nepal. B.Sc. Dissertation. Institute of Forestry, Tribhuvan University, Pokhara, Nepal.

Acharya, S., S. Rayamajhi, S. Sharma, S. Upadhaya, S. Joshi & S. Lamichhane (2018). Anthropogenic Threats to Survival of the Critically Endangered Chinese Pangolins (*Manis pentadactyla*) and their Habitat in Kavrepalanchowk Nepal. Journal of Biodiversity & Endangered Species 6(218): 2.

Abood, S.A., J.S.H. Lee, Z. Burivalova, J. Garcia-Ulloa & L.P. Koh (2015). Relative contributions of the logging, fiber, oil palm, and mining industries to forest loss in Indonesia. *Conservation Letters* 8(1): 58–67.

Baral, H.S. & K.B. Shah (2008). *Wild Mammals of Nepal*. Himalayan Nature, Kathmandu, 55pp.

Bhandari, N. & M.K. Chalise (2014). Habitat and distribution of Chinese Pangolin (*Manis pentadactyla* Linnaeus, 1758) in Nagarjun Forest of Shivapuri-Nagarjun National Park, Nepal. *Nepalese Journal of Zoology* 2: 18–25.

Bruner, A.G., R.E. Gullison, R.E. Rice & G.A. da Fonseca (2001). Effectiveness of parks in protecting tropical biodiversity. *Science* 291(5501): 125–128.

Burnham, K.P. & D.R. Anderson (2002). *Model Selection and Multimodal Inference: A Practical Information - Theoretic Approach. 2nd Edition*. Springer-Verlag, New York, xxvi+488pp. https://doi.org/10.1007/b97636

Carter, A.S. & D.A. Gilmour (1989). Increase in tree cover in private farmland in central Nepal. Mt. Res. Dev. 9, 381–391. Accessed May 02, 2020. https://doi.org/10.2307/3673586

Challender, D.W.S. & L. Hywood (2012). African pangolins under increased pressure from poaching and intercontinental trade. *Traffic Bulletin* 28(1): 53–55.

Challender, D. & C. Waterman (2017). Implementation of CITES Decision2 17.239 B) and 17.240 on Pangolins *(Manis* spp.*)*. Prepared by IUCN for the CITES Secretariat. SC69 Doc 57.

Challender, D., S. Wu, P. Kaspal, A. Khatiwada, A. Ghose, N. Ching-Min Sun, R.K. Mohapatra & T.L. Suwal (2019). *Manis pentadactyla* (errata version published in 2020). The IUCN Red List of Threatened Species 2019: e.T12764A168392151. Downloaded on 20 May 2020. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12764A168392151.en

Deguignet, M., D. Juffe-Bignoli, J. Harrison, B. MacSharry, N.D. Burgess & N. Kingston (2014). United Nations list of protected areas.

Dorji, D. (2017). Distribution, habitat use, threats and conservation of the Critically Endangered Chinese Pangolin *(Manis pentadactyla)* in Samtse District, Bhutan. Unpublished. Rufford Small Grants, UK. https://www.rufford.org/projects/dago_dorji

DNPWC & DoF (2018). Pangolin Conservation Action Plan for Nepal (2018–2022). Kathmandu, Nepal: Department of National Parks and Wildlife Conservation and Department of Forests.

Ellwood, M.D., D.T. Jones & W.A. Foster (2002). Canopy ferns in lowland dipterocarp forest support a prolific abundance of ants, termites, and other invertebrates. *Biotropica* 34: 575–583.

Ghimire, P., N. Raut, P. Khanal, S. Acharya & S. Upadhaya (2020). Species in peril: assessing the status of the trade in pangolins in Nepal. *Journal of Threatened Taxa* 12(8): 15776-15783. https://doi.org/10.11609/jott.5698.12.8.15776-15783

Gibson, L. T.M. Lee, L.P. Koh, B.W. Brook, T.A. Gardner, J. Barlow, C.A. Peres, C.J.A. Bradshaw, W.F. Laurance, T.E. Lovejoy & N.S Sodhi (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature* 478(7369): 378–381.

Government of Nepal (2016). Ministry of finance. Nepal: Economic Survey. Kathmandu.

Gurung, J.B. (1996). A pangolin survey in Royal Nagarjung Forest in Kathmandu, Nepal. *Tiger Paper* 23: 29–32.

Heinrich, S., T.A. Wittmann, T.A. Prowse, J.V. Ross, S. Delean, C.R. Shepherd & P. Cassey (2016). Where did all the pangolins go? International CITES trade in pangolin species. *Global Ecology and Conservation* 8: 241–253. https://doi.org/10.1016/j.gecco.2016.09.007

ICIMOD (2013). Land cover of Nepal 2010 [Data set]. ICIMOD. https://doi.org/10.26066/rds.9224

Jha, S. & K.S. Bawa (2006). Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology* 20: 906–912.

Jnawali, S.R., H.S. Baral, S. Lee, K.P. Acharya, G.P. Upadhyay, M. Pandey, R. Shrestha, D. Joshi, B.R. Laminchhane, J. Griffiths, A.P. Khatiwada, N. Subedi & R. Amin (compilers) (2011). The Status of Nepal Mammals. The National Red List Series, Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Katuwal, H.B., K.R. Neupane, D. Adhikari, M. Sharma & S. Thapa (2015). Pangolins in Eastern Nepal: Trade and Ethno-Medicinal

Importance. Journal of threatened Taxa 7(9): 7563–7567. https://doi.org/10.11609/JoTT.o4202.7563-7

Katuwal, H.B., H.P. Sharma & K. Parajuli (2017). Anthropogenic impacts on the occurrence of the critically endangered Chinese pangolin *(Manis pentadactyla)* in Nepal. Journal of Mammalogy 98(6): 1667–1673. https://doi.org/10.1093/jmammal/gyx114

Kaspal, P., K.B. Shah & H.S. Baral (2016). SAALAK (i.e. Pangolin). Himalayan Nature, Kathmandu, Nepal.

Laurance, W.F., J. Sayer & K.G. Cassman (2014). Agricultural expansion and its impacts on tropical nature. *Trends in Ecology & Evolution* 29(2): 107–116.

Lee, R.H., K. Cheung, J.R. Fellowes & B. Guenard (2017). Insights into the Chinese Pangolin's *(Manis pentadactyla)* diet in a peri-urban habitat: a case study from Hong Kong. *Tropical Conservation Science* 10: 1–7.

Naughton-Treves, L., M.B. Holland & K. Brandon (2005). The role of protected areas in conserving biodiversity and sustaining local livelihoods. *Annual Review of Environment and Resources* 30: 219–252.

Nepstad, A. Verssimo, A. Alencar, C. Nobre, E. Lima, P. Lefebvre, P. Schlesinger, C. Potter, P. Moutinho, E. Mendoza, M. Cochrane & V. Brooks (1999). Large-scale impoverishment of Amazonian forests by logging and fire. *Nature* 398(6727): 505–508.

Okwakol, M.J.N. & M.B. Sekamatte (2007). Review article soil macrofauna research in ecosystems in Uganda. *African Journal of Ecology* 45: 2–8.

Pantel, S., & S.Y. Chin (2009). Proceedings of the workshop on trade and conservation of Pangolins native to South and Southeast Asia, 30 June – 2 July 2008. Singapore Zoo. TRAFFIC Southeast Asia.

Polak, T., J.E., Watson, J.R., Bennett, H.P., Possingham, R.A. Fuller & J. Carwardine (2016). Balancing ecosystem and threatened species representation in protected areas and implications for nations achieving global conservation goals. *Conservation Letters* 9(6): 438–445.

Richer, R.A., I.M. Coulson & M. Heath (1997). Foraging behaviour and ecology of the Cape Pangolin *(Manis temminckii)* in north-western Zimbabwe. *African Journal of Ecology* 35: 361–369.

Sharma, H.P., B. Rimal, M. Zhang & S. Sharma (2020a). Potential distribution of the critically endangered Chinese Pangolin *(Manis pentadactyla)* in different land covers of Nepal: Implications for conservation. *Sustainability* 12(1282): 1–13.

Sharma, S. & S. Acharya (2017). Human-Rhesus macaque conflict at Pumdivumdi/ Tallokodi, Pokhara, West Nepal. *Banko Janakari* 27(2): 46–50.

Sharma, S., H.P. Sharma, C. Chaulagain, H.B. Katuwal & J.L. Belant (2020b). Estimating occupancy of Chinese Pangolin *(Manis pentadactyla)* in a protected and non-protected area of Nepal. *Ecology and Evolution* 10(10): 4303–4313. https://doi.org/10.1002/ece3.6198

Sharma, S., H.P. Sharma, H.B. Katuwal & J.L. Belant (2020c). Knowledge of the Critically Endangered Chinese Pangolin *(Manis pentadactyla)* by local people in Sindhupalchok, Nepal. *Global Ecology and Conservation* 32: p.e01052. https://doi.org/10.1016/j.gecco.2020.e01052

Sharma, S., H.P. Sharma, H.B. Katuwal, C. Chaulagain & J.B. Belant (2020d). People's Knowledge of Illegal Chinese Pangolin Trade Routes in Central Nepal. *Sustainability* 12(12): 4900.

Sun, N.C.M., B. Arora, J.-S. Lin, W.-C. Lin, M-J. Chi, C-C. Chen & C.J-C. Pei (2019). Mortality and morbidity in wild Taiwanese pangolin *(Manis pentadactyla pentadactyla)*. *PLoS One* 14: e0198230. https://doi.org/10.1371/journal.pone.0198230

Suwal, T.L., A. Thapa, S. Gurung, P.C. Aryal, H. Basnet, K. Basnet, K.B. Shah, S. Thapa, S. Koirala, S. Dahal & H.B. Katuwal (2021). Predicting the potential distribution and habitat variables associated with pangolins in Nepal. *Global Ecology and Conservation* 23(2020): e01049. https://doi.org/10.1016/j.gecco.2020.e01049

Thapa, P., A.P. Khatiwada, S.C. Nepali & S. Poudel (2014). Distribution and conservation status of Chinese Pangolin *(Manis pentadactyla)* in Nangkholyang VDC, Taplejung, Eastern Nepal. American Journal of Zoological Research 2, 16-21. Available at: https://doi.org/10.12691/ajzr-2-1-3

Tichý, L. (2016). Field test of canopy cover estimation by hemispherical photographs taken with a smartphone. *Journal of Vegetation Science* 27: 427–435. https://doi.org/10.1111/jvs.12350

Wolfe, N.D., P. Daszak, A.M. Kilpatrick & D.S. Burke (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. *Emerging Infectious Diseases* 11: 1822–1827.

Wu, S., N.C.M. Sun, F. Zhang, Y. Yu, G. Ades, T.L. Suwal & Z. Jiang (2020). Pangolins Science, Society and Conservation; Chapter 4 – Chinese Pangolin *Manis pentadatyla* (Linnaeus, 1758), 49–70pp. https://doi.org/10.1016/B978-0-12-815507-3.00004-6

Wu, S.B., N.F. Liu, G.Z. Ma, Z.R. Xu & H. Chen (2003). Habitat selection by Chinese Pangolin *(Manis pentadactyla)* in winter in Dawuling Natural Reserve. *Mammalia* 67(4): 493–502. https://doi.org/10.1515/mamm-2003-0403

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