

Habitat Occupancy of the Critically Endangered Chinese Pangolin (*Manis pentadactyla*) under Human Disturbance in an Urban Environment: Implications for Conservation

城市环境中人类干扰下极度濒危中华穿山甲 (*Manis pentadactyla*) 的栖息地占用：对保护的影响

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Abstract: Globally, urban expansion has led to habitat fragmentation and altered resource availability thus posing significant challenges for wildlife. This study analyzed spatial distribution, habitat use patterns, and anthropogenic impacts on habitat occupancy of the Critically Endangered Chinese pangolin (*Manis pentadactyla*) in the urban landscape of Dharan Sub-metropolitan City, Nepal. It is essential to investigate how the Chinese pangolins use habitat patches of high anthropogenic activity in an urban landscape so that we can formulate effective local-level management and conservation plans. The single-season-single-occupancy framework was used to identify the Chinese pangolin distribution in the urban landscape where there was maximum human caused threats available for the species. With the help of Arc GIS 10.5, the study area was divided into multiple grids (600 m x 600 m), following standard methods for pangolin monitoring. A subset of the grids (study grids) was randomly selected using Fishnet tools in ArcGIS 10.5 that covered more than 25% of the total study area. This produced 152 study grids for the survey. However, 18 of the grids were excluded from the survey because they covered challenging terrain and had less than 50% coverage within the survey boundary. This left a total of 134 study grids targeted for survey. In each study grid, a continuous belt transect of 600 m length and 50 m width was laid. The data were collected continuously in each 100 m of distance as a spatial replicate. Within every 600 m of each transect, we collected Chinese pangolin detection/non-detection data along with field-based covariates in every 100 m segment. Only fresh burrows were recorded as "1" indicating detected grids and as "0" for non-detected grids. Moreover, based on a literature review of factors influencing Chinese pangolin distribution and ecology, we identified key variables that likely play an important role in shaping the spatial patterns of Chinese pangolins in our study area. Old burrows were excluded from the analysis. Later, detection histories were constructed by aggregating the segment-level detection/non detection data, whereas the values of field-based covariates were averaged from each grid to form site covariates. We utilized the Unmark package in R software to conduct a single-season occupancy hierarchical model following the approach outlined by Fiske & Chandler (2011). This model estimates the maximum likelihood of observing a detection history, considering both detections and non-detections at a site. Model selection and comparison were performed using the Akaike Information Criterion (AIC) value and to calculate their Akaike weights. A total of 43 fresh burrows of Chinese pangolins were identified, distributed across 19 study grids, resulting

in a naïve occupancy estimate of 0.128. The majority of burrows (67.4%, $n = 29$) were categorized as fresh-feeding burrows, while the others (32.6%, $n = 14$) were fresh-living burrows. Notably, most burrow signs were observed in *Shorea robusta* forests (69.8%, $n = 30$), followed by mixed deciduous forests (30.2%, $n = 13$). No burrows were found in riverine forests. The detection of fresh burrows was influenced by factors such as the number of ant and termite mounds and medium levels of human disturbance. The average Human Disturbance Index (HDI) for the entire number of study grids was (mean $\pm$ SD, 0.74 ± 0.0197). In contrast, the HDI within detected grids was (mean $\pm$ SD, 0.475 ± 0.04) indicating anticipated human disturbances, as reflected in the comparatively lower HDI values observed in the detected grids. We developed 22 regression models to assess habitat use occupancy, each with the number of termite mounds as a fixed covariate for detectability. Notably, termite mounds significantly and positively influenced the detection probability of fresh pangolin burrows ($\beta_{\text{Termite mounds}} = 1.48$, 95% CI = 1.07 to 1.89. The detection probability ($p \pm \text{SE}$) of fresh pangolin burrows showed an average value of 0.095 ± 0.013 across the study grids. The range of detection probability among grids varied from a minimum of 0.0079 to a maximum of 0.75. The findings emphasize the need for targeted conservation efforts, considering the fine-scale ecological and anthropogenic factors impacting Chinese pangolins in urban and peri-urban areas. The results underscore the urgency of implementing effective conservation measures to ensure the long-term survival of Critically Endangered Chinese pangolins in urban environments, not only in Dharan but also in similar lowlands areas and other potential habitats all over Nepal.

Keywords: Occupancy, Urban landscape, Chinese pangolin, Anthropogenic threats, Termites mounds