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Journal of Threatened Taxa

Open Access

10.11609/jott.2025.17.10.27551-27786
www.threatenedtaxa.org

26 October 2025 (Online & Print)
17(10): 27551–27786
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Zooreach Zoo Outreach Organisation 40 Years

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

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Cover: A Warty Hammer Orchid *Drakaea livida* gets pollinated by a male thynnine wasp through 'sexual deception' — a colour pencil reproduction of photos by ron_n_beths (flickr.com) and Rod Peakall; Water colour reproduction of Flame Lily *Gloriosa superba* -- photo by Passakoran_14; and a bag worm and its architectural genius (source unknown). Art work by Pannagasri G.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2025 | 17(10): 27563–27575
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
https://doi.org/10.11609/jott.9617.17.10.27563-27575
#9617 | Received 08 January 2025 | Final received 24 September 2025 | Finally accepted 04 October 2025

OPEN ACCESS

ARTICLE

The impact of anthropogenic activities on *Manis javanica* Desmarest, 1822 (Mammalia: Pholidota: Manidae) in Sepanggar Hill, Malaysia

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Abstract: The Sunda Pangolin, also known as *Manis javanica* Desmarest, 1822 (Pholidota: Manidae), is the only pangolin species found in Malaysia. This species is 'Critically Endangered' as per the IUCN Red List of Threatened Species and is among the most heavily trafficked mammals globally. Anthropogenic activities such as residential development and frequent human movement near forest edges have increasingly threatened the safety of the Sunda Pangolin. These activities not only lead to habitat fragmentation but also expose wildlife to elevated noise levels and human disturbances due to the proximity of settlements. Therefore, this study aims to determine the impact of anthropogenic activities that influences the distribution of Sunda Pangolins in Sepanggar Hill using camera trap survey method. Ten camera traps were set up in a systematic random design from May 2023–January 2024. The distances of nearest human settlements from the camera traps and anthropogenic noise level were also measured. The data from the camera traps and the anthropogenic noise level were collected every month. Over 2,724 trapping nights, camera traps captured five pangolin events. The Pearson correlation shows very weak correlations (-0.24 - 0.32) on the correlation of Sunda Pangolin presence and the proximity to the human settlements based on 2,741 data points. Despite high noise levels ranging 44.3 – 57.0 dB, Sunda Pangolins were detected more frequently near the first camera trap (N = 348, r = 0.147, p = 0.006**), an area with the highest anthropogenic noise, indicating a degree of noise tolerance. These findings highlight the adaptability of Sunda Pangolins to disturbed habitats as long as they do not feel threatened, but also underscore the necessity for targeted conservation efforts to mitigate more areas. Preserving quieter environments and reducing human impact is critical to ensure the survival of Sunda Pangolins in Sepanggar Hill. This research provides valuable insights for developing effective conservation strategies to protect this Critically Endangered species.

Keywords: Activity pattern, adaptability, camera trap, Critically Endangered, human impact, human presence, human proximity, noise level, Sunda Pangolin.

Editor: L.A.K. Singh, Bhubaneswar, Odisha, India. **Date of publication:** 26 October 2025 (online & print)

Citation: Shairi, N.A., J. Kodoh, N.B.A. Besar & J. Sompud (2025). The impact of anthropogenic activities on *Manis javanica* Desmarest, 1822 (Mammalia: Pholidota: Manidae) in Sepanggar Hill, Malaysia. *Journal of Threatened Taxa* 17(10): 27563–27575. https://doi.org/10.11609/jott.9617.17.10.27563-27575

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Funding: Universiti Malaysia Sabah and the Pangolin Consortium.

Competing interests: The authors declare no competing interests.

Malay abstract: See end of this article.

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Author contributions: NAS: Led field data collection and prepared the initial draft of the manuscript. JK: co-supervised and contributed to critical manuscript revision and refinement of the text. NbAB: Provided administrative coordination and strategic oversight throughout the project. JS: Conceptualized the study design and supervised academics as well as all fieldwork activities.

Acknowledgments: This study was funded by UMSGreat GUG0611-1/2023, Universiti Malaysia Sabah Research Grant SBK0424, and the Pangolin Consortium. We would like to express our gratitude to the Sabah Biodiversity Council (SaBC) for granting the necessary permits (JKM/MBS.1000-2/13JLD.265). Special thanks to the fieldwork team for their invaluable assistance during data collection. We also extend our profound thanks to the reviewers whose insights and feedback significantly enhanced this manuscript.

INTRODUCTION

Sabah, on the island of Borneo, supports high biodiversity, and is home to key wildlife species essential for ecosystem function, including the Clouded Leopard *Neofelis diardi*, Bornean Tembadau *Bos javanicus lowi*, Bornean Pygmy Elephant *Elephas maximus borneensis*, and Sunda Pangolin *Manis javanica* (Hearn et al. 2019; Sompud et al. 2022, 2023; Hiew et al. 2023). These species contribute significantly to habitat stability and ecological processes. Their persistence is increasingly threatened by habitat loss, poaching, and illegal trade, which collectively undermine regional biodiversity (Sompud et al. 2019; Giordano et al. 2023).

The Sunda Pangolin *Manis javanica* (Desmarest, 1822, Pholidota: Manidae) (Image 1), also known as the Malayan or Javan Pangolin, is a species of pangolin native to southeastern Asia. These solitary and nocturnal mammals are primarily found in various habitats, including tropical forests, subtropical forests, grasslands, and agricultural areas. Sunda Pangolins are adept climbers, often dwelling in trees, and utilizing their strong, curved claws to forage for ants, and termites (Chong et al. 2020). They play a crucial role in the ecosystems by controlling insect populations (Lim & Ng 2008; Sompud et al. 2019).

Despite their ecological importance, Sunda Pangolins are Critically Endangered due to severe threats from illegal wildlife trade and habitat destruction (Challender et al. 2019). They are among the most heavily trafficked mammals globally, driven by high demand for their scales, and meat (Challender et al. 2015; Aisher 2016; Nash et al. 2018). In Peninsular Malaysia, the Sunda Pangolin is protected under the Wildlife Protection Act No. 72 of 1972 (Sing & Pantel 2009). Meanwhile, in Sabah, the Sunda Pangolin is listed as a protected animal species, in Part I of Schedule 2 of the State's Wildlife Conservation Enactment 1997 (Pantel & Anak 2010). Internationally, it is listed in Appendix I of the Convention on International Trade in Endangered Species (CITES). Despite these legal protections, Sunda Pangolins continue to be captured, and illegally traded across southeastern Asia, including in Malaysia (Ariffin & Nan 2018). The scales are highly valued in traditional medicine, particularly in China, and Vietnam, for their alleged health benefits (Cheng et al. 2017). Additionally, pangolin meat is considered a delicacy in some cultures (Duckworth et al. 2008). The relentless poaching and habitat loss have pushed the Sunda Pangolin to the brink of extinction, necessitating urgent global conservation, and law enforcement efforts to combat the illicit trade, and protect the species.

The relationship between Sunda Pangolins and humans is fraught with challenges. Conservation of the Sunda Pangolin is hindered by differing levels of awareness and participation across community groups (Nash et al. 2020; Jomes et al. 2023). Human encroachment on their habitats through deforestation and agricultural expansion displaces pangolins, leading to increased contact with human settlements. This often results in pangolins being accidentally caught in traps set for other animals, which subsequently increases poaching rates. Although previous studies suggest that Sunda Pangolins can tolerate some level of human presence (Chong et al 2020; Withaningsih et al. 2021; Nursamsi et al. 2023), their ability to survive in areas affected by people largely depends on the type and intensity of the activities, less harmful actions like research or hiking may not disturb them, while more damaging activities like logging, and land clearing can seriously impact their chances of living in those areas. Human encroachment, especially when involving habitat modification such as felling trees or agricultural expansion, can disrupt pangolin behavior, diminish food source, and reduce habitat quality (Panjang 2015; Chao et al. 2020). Furthermore, Subba et al. (2024) stated that urban expansion results in habitat fragmentation, negatively affecting pangolin occupancy rates due to increased human disturbance.

Hence, studying the impact of human activities on the Sunda Pangolin is crucial for several reasons. Firstly, it helps in understanding how human activities influence pangolin behaviour and resource access, which can inform effective conservation strategies (Bhandari et al. 2025; Chen et al. 2025). Secondly, such research can identify critical habitats needing protection to ensure the

Image 1. Sunda Pangolin *Manis javanica*. © Sompud, J., 2025.

survival of this endangered species by pinpointing areas most affected by human activities (Camaclang et al. 2015; Peters et al. 2023). Thirdly, investigating these dynamics offer insights into human-wildlife negative interactions, guiding strategies to benefit both local communities, and wildlife (Sompud et al. 2023). Addressing the impact of human activities such as logging and forest degradation requires comprehensive, long-term approaches that go beyond ecological research. These include preserving remaining natural habitats, enforcing wildlife protection laws more effectively, and engaging local communities through education to reduce demand for pangolin products, and increase awareness of the species' Critically Endangered status.

The objectives of this study are to assess the impact of anthropogenic activities that influences the distribution of Sunda Pangolin. These anthropogenic activities were measured based on the anthropogenic proximity, anthropogenic activity patterns, and anthropogenic noise in Sepanggar Hill. As such these are the specific objectives; 1) to assess the distribution of Sunda Pangolins in Sepanggar Hill, 2) to determine how human presence influences pangolin distribution in Sepanggar Hill, 3) to determine the correlation between the proximity to human settlements and the presence of the Sunda Pangolin, 4) to determine the correlation between anthropogenic noise levels and the presence of the Sunda Pangolin, and 5) to determine the activity pattern of human and Sunda Pangolins.

This study hypothesizes that Sunda Pangolins exhibit a positive response to certain aspects of human presence, particularly in areas where direct threats such as hunting are absent or minimal. It is proposed that Sunda Pangolins may be more frequently detected near human settlements or infrastructure due to indirect benefits such as reduced presence of natural predators, increased availability of food sources like termites associated with human-modified environments, or the presence of secondary vegetation that provides suitable cover. Furthermore, in areas with consistent and non-threatening human activity, Sunda Pangolins may become habituated and show reduced avoidance behaviour, allowing them to utilize edge habitats, and anthropogenic landscapes more freely. This suggests that under specific conditions, human-modified environments may offer ecological opportunities that Sunda Pangolins can exploit, indicating a level of behavioural flexibility, and potential for coexistence with humans in low-risk environments.

MATERIALS AND METHODS

Study Area

The study area is located in Sepanggar Hill, Universiti Malaysia Sabah (UMS), commonly known as UMS forest (Figure 1). This area includes Sustainable Forest and Research Area at Universiti Malaysia Sabah (SFERA@ UMS), a 0.25 km^2 of land that has been set aside as a forest reserve by the UMS management to be utilized for forest research and education development (The Borneo Post 2022). It is located northwest of the campus with coordinates of 6.037^o N and 116.115^o E. Sepanggar Hill is a 2.2 km^2 secondary forest with its tallest peak at 190 m (Majuakim et al. 2018). The terrain varies from flat to hilly with some steep slopes. The land cover within the study area primarily consists of secondary forested habitats, although certain parts have been cleared, and are currently used as agricultural land. Notably, UMS protected and managed a small area for conservation, and research purposes (SFERA@UMS), while the other half is classified as state land, which lacks formal protection for biodiversity. This site was chosen because Sunda Pangolins were first found here in 2023, with no research done on their ecology (Sompud et al. 2023).

Methodology

The study employs a combination of camera trap surveys, decibel meters, and geographical tools to investigate the impact of anthropogenic activities on Sunda Pangolins. Camera traps are utilized to monitor and record the presence of both humans and Sunda Pangolins at each camera trap stations, providing data on their frequency of occurrence. To assess anthropogenic noise level, a decibel meter was used to measure the level of anthropogenic noise at the camera trap stations. Additionally, Google Maps was employed to calculate the distances between human settlements, and the camera trap locations, offering insights into how proximity to human activity influences pangolin behaviour.

Camera Trap Survey

The camera trap survey was conducted over eight months, from 17 May 2023–28 January 2024. The plot size was 300 x 300 m to maximize coverage by the camera traps. Each plot included a camera trap station with one camera trap. Stations were selected using a systematic random design (Stehman et al. 1992). The selection criteria for camera trap locations were based on ecological features known to attract *Manis javanica*, such as wildlife trails (Image 2), termite mounds (Image 3), and areas with dead trees (Image 4) (Simo et al.

2023). Each station was chosen to represent a range of microhabitats across the study area, ensuring varied terrain coverage. The consistency in habitat type was maintained by positioning camera traps within the secondary forest, avoiding areas with dense undergrowth that might obscure the field of view.

Upon determining the optimal position, each camera trap, equipped with an infrared sensor, was affixed to the base of a tree, positioned approximately 20–40 cm above ground level using a belt (Image 5). Placement adjustments were made based on topographical considerations, ensuring an appropriate camera angle (Ancrenaz et al. 2012). Following setup, batteries, and a memory card were inserted, and a walk test was conducted to confirm the camera's coverage of the selected areas. Camera trap data were collected

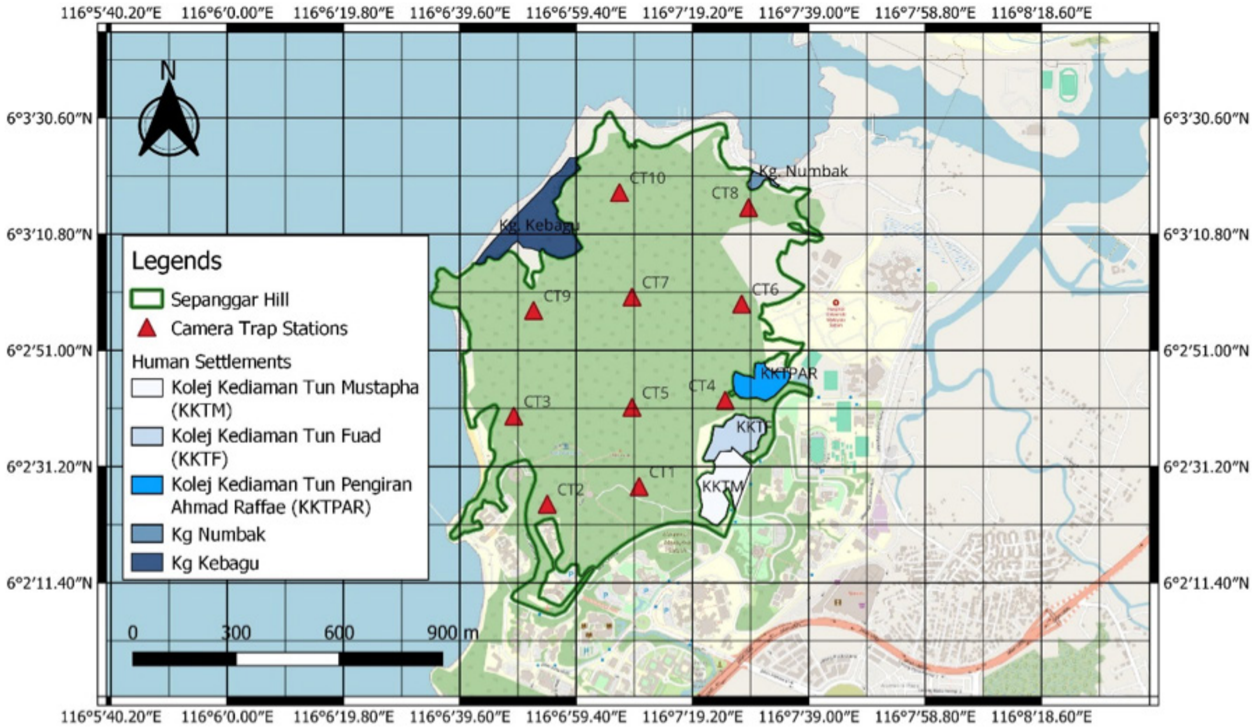

Figure 1. Map of the location of camera traps in Sepanggar Hill.

Image 2. Wildlife trail that was chosen for CT3. © UMS, 2023.

Image 3. Termite mound that was chosen for CT1. © UMS, 2023.

Image 4. Dead trees that was chosen for CT7. © UMS, 2023.

Image 5. Installing camera trap in CT1. © Shairi, N.A., 2023.

on a monthly basis, including battery replacement. The camera traps were set to capture images instead of videos because video files are much larger, which would have filled up the memory quickly, and reduced the amount of data that could be collected. The captured images were analyzed to detect the presence of Sunda Pangolins and humans. Additionally, the images obtained from the camera traps were utilized to assess the activity patterns of both humans and the pangolins by recording the number of human and pangolin events captured by the camera traps hourly.

Measuring distances between camera trap locations and the nearest human settlements

The distances from each camera trap station to the nearest human settlement were measured using Google Maps, based on straight-line (Euclidean) distance from the center point of each settlement to the exact GPS coordinates of each camera trap location (Trianni et al. 2014). For consistency, the nearest house or structure from each settlement to the study area was selected as the reference point. This approach was used to reflect the point of first human presence closest to the forest edge, which is more relevant to the Sunda Pangolin's sensitivity to human disturbance. While this method does not account for the full spatial extent of each settlement, it provides a standardized, and ecologically relevant measure of the nearest point of human activity to the study area. Five closest settlements were chosen: Kolej Kediaman Tun Mustapha (KKTM), Kolej Kediaman Tun Fuad (KKTF), Kolej Kediaman Tun Pengiran Ahmad Raffae (KKTPAR), Kg. Numbak, and Kg. Kebagu (Figure 1). The total number of UMS residents in the KKTM, KKTF, and KKTPAR are 1,600, 1,400, and 3,000 students, respectively (Universiti Malaysia Sabah, 2015). Meanwhile, the total number of humans resides in Kg. Numbak and Kg. Kebagu were estimated to be 600 and 300 people, respectively (Alim pers. comm. 24.xi.2023; Abniti pers. comm. 20.viii.2024).

Measuring anthropogenic oise levels

Anthropogenic noise levels were measured manually using a calibrated decibel meter model of SL-5868P from May 2023–April 2024 (Akpan & Obisung 2022). The decibel meter was calibrated before each field deployment to ensure accurate sound level readings. Calibration was conducted using a standard sound level calibrator set at 94 dB at 1 kHz. This process allowed for consistent baseline measurements across different collection periods.

Sound readings were taken during times of minimal wind activity to limit external interference. Furthermore, the noise level was only taken during the day because the noise levels at night are much lower than during daytime due to less noise pollution at night (Anomohanran & Osemeikhian 2006). For example, the calls for prayers can only be heard once at night, compared to the day, and there are fewer cars, and buses at night. Vegetation density was accounted for by positioning the decibel meter in open clearings near the camera trap stations to prevent absorption or reflection effects from dense foliage. Readings were conducted at approximately ear height to standardize the measurement environment and mitigate sound propagation issues related to variable terrain and vegetation (Alademomi et al. 2020). This data was meticulously recorded and entered into an Excel spreadsheet for further analysis.

Data analysis

Distribution of the Sunda Pangolin in Sepanggar Hill

For the first objective, the data collected from the camera traps were meticulously organized in an Excel spreadsheet. This spreadsheet included detailed information such as the camera trap stations, dates, times, locations, the number of Sunda Pangolin events, the number of human events, and the image titles. A descriptive analysis was conducted to map the distribution of Sunda Pangolins within Sepanggar Hill. Each plot where Sunda Pangolins were present was marked on a detailed map of the area, providing a visual representation of their distribution across the study site. The occupancy rate was also calculated by using the following equation:

$$\textit{Occupancy rate } (\psi) = \frac{\textit{Number of sites occupied}}{\textit{Total number of sites surveyed}}$$

Impact of Human Presence and Settlements on Pangolins

To achieve the second and third objective, a two-tailed Pearson correlation coefficient analysis was conducted using the Statistical Package for the Social Sciences (SPSS). The Pearson correlation is a parametric statistical test used to measure the strength and direction of the linear relationship between two variables, with values ranging from -1 (perfect negative correlation) to +1 (perfect positive correlation) (Berman 2016). In this study, the analysis was based on 2,741 data collected from 10 camera trap stations distributed across Sepanggar Hill, with each station contributing one observation. The dependent variable was the presence of Sunda Pangolins, coded as 1 for presence and 0 for absence. Independent variables included the presence of humans (1 = present, 0 = absent), as well as the distances (in km) from each camera trap station to five human settlements: KKTM, KKTF, KKTPAR, Kg. Numbak, and Kg. Kebagu. This analysis aimed to determine whether there was a significant relationship between Sunda Pangolin presence and human-related factors in the study area.

Activity pattern

For the fourth objective, the activity pattern was

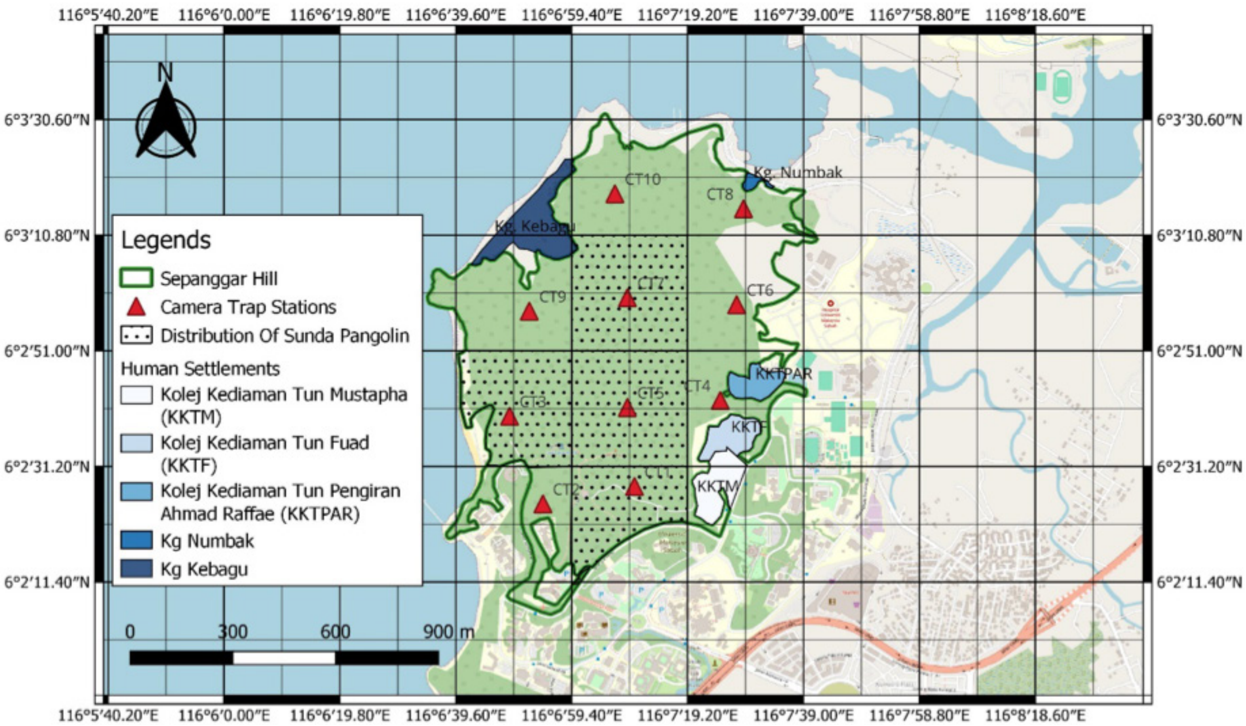

Figure 2. Distribution map of Sunda Pangolins in Sepanggar Hill.

analyzed by calculating the total events of human presence and the presence of Sunda Pangolin in each plot of camera trap during diurnal, and nocturnal times. Diurnal time is defined as the time taken between 0600–1759 h (12 hr) and the nocturnal time is the period between 1800–0559 h (12 hr) (Semiadi et al. 1993). The data was calculated and analyzed using descriptive analysis by observing, and counting the number of events of human presence, and the Sunda Pangolin presence in the camera trap pictures every 60 minutes. Hence, the data was counted as one if multiple pictures were taken within 60 minutes (Gardner & Goossens 2017). The data were then presented in an image to measure humans' and Sunda Pangolins' relative number of active times for each camera trap station.

Anthropogenic noise levels

For the fifth objective, the relationship between the presence of Sunda Pangolins and the average anthropogenic noise levels was also analyzed using Pearson correlation coefficient analysis in SPSS (Fialho et al. 2025). Noise levels were recorded monthly at each camera trap station using decibel meters, and these data were correlated with the frequency of pangolin detections at each station. The correlation analysis was performed individually for each camera trap to assess whether higher noise levels affected pangolin activity and distribution. This analysis provided insights into the impact of noise pollution on the behavior and habitat use of Sunda Pangolins within Sepanggar Hill.

RESULTS AND DISCUSSIONS

In general, 1,17,993 pictures were captured, derived from 2,724 trapping nights. Six camera traps were relocated after three months because those camera traps captured no Sunda Pangolin. During the survey, the camera traps also captured images of various other wildlife species, highlighting the biodiversity within Sepanggar Hill. These species included groups of Long-tailed Macaques *Macaca fascicularis*, Mouse Deer *Tragulidae* sp., Monitor Lizard *Varanus* sp., Birds (*Aves sp.*), Squirrels *Sciurus* sp., Water Buffaloes *Bubalus bubalis*, Masked Palm Civets *Paguma larvata*, and Ground Tortoise *Testudinidae* sp. This diverse array of animals underscores the ecological richness of the area and the importance of preserving this habitat, not only for the Critically Endangered Sunda Pangolin but also for the myriad of other species that coexist within this ecosystem.

Distribution of the Sunda Pangolin

Despite the high volume of data, Sunda Pangolins were recorded in only five events at four camera trap stations (CT1, CT3, CT5, and CT7) with an occupancy rate of 40%. The distribution of Sunda Pangolins appeared to be concentrated towards the center of Sepanggar Hill and more towards the UMS campus, as shown in Figure 2. This spatial distribution could be influenced by several factors, including habitat preferences such as human encroachment, and their preference for undisturbed environments (Liu & Weng 2014; Chong et al. 2020).

In this study, the differences in human activities within UMS campus and outside of the campus may contribute to the visitation factor of the Sunda Pangolin. UMS has designated 0.25 km^2 of land in the Sepanggar Hill forest as a forest reserve, which serves as a research area (The Borneo Post, 2022). This protected status may contribute to the presence of Sunda Pangolins in camera trap stations located closer to UMS, as they do not feel threatened even though there are existing anthropogenic activities that are confined to research and education activities only. On the other hand, the areas that are outside of the UMS campus are accessible to the residents who live near the forested areas. We observed during the course of this study that there were some areas that had become barren due to the felling of trees by the people around the area, totalling 0.099 km^2. This could be the reason why the Sunda Pangolin does not prefer to visit areas outside of the UMS campus, as this species are vulnerable to habitat loss, and poaching (Challender et al. 2012).

Although the study recorded only five independent Sunda Pangolin events within a limited study area, which may constrain the statistical power and generalizability of the findings, this limitation is expected given the species' elusive behaviour, and Critically Endangered status (Panjang et al. 2024). Reliable field data on Sunda Pangolins remain scarce, and even a small number of detections can offer valuable insights into their habitat use and potential responses to anthropogenic disturbances. These preliminary findings provide a foundation for future, larger-scale research, and underscore the importance of long-term monitoring efforts in human-impacted landscapes.

The Presence of Sunda Pangolins and Humans

Pangolins show some resilience to moderate human disturbances depending on various factors (Zanvo et al. 2023). In the current study, it was found that the presence of Sunda Pangolins was detected even in areas with recorded human presence, as evident by camera

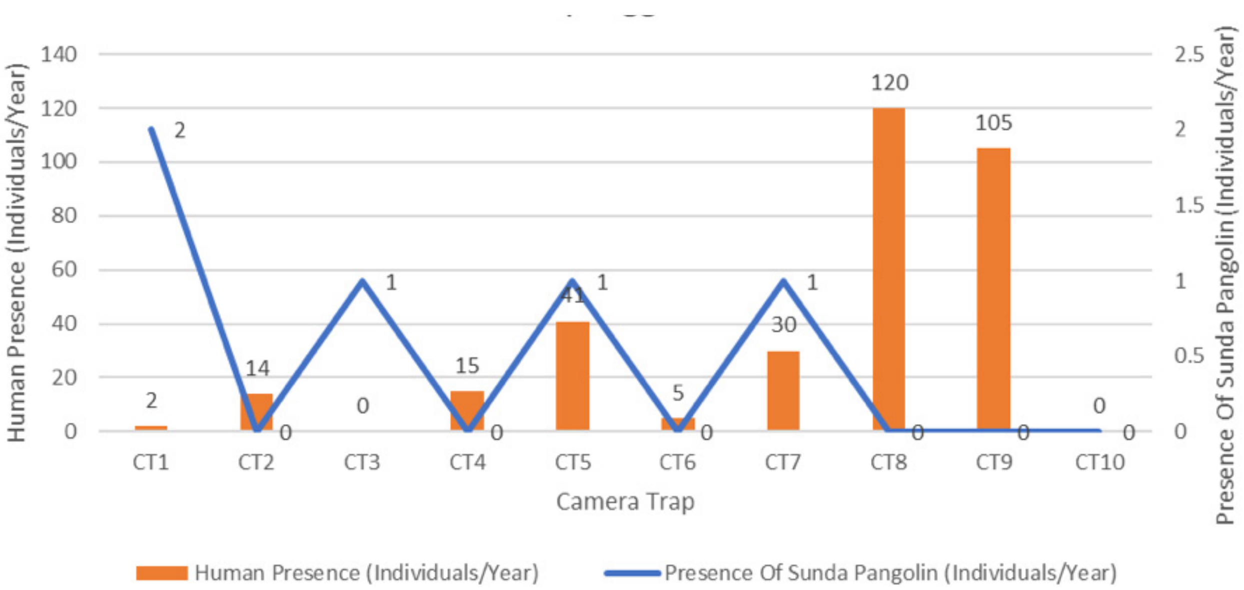

Figure 3. Graph of human presence and the Sunda Pangolins in Sepanggar Hill.

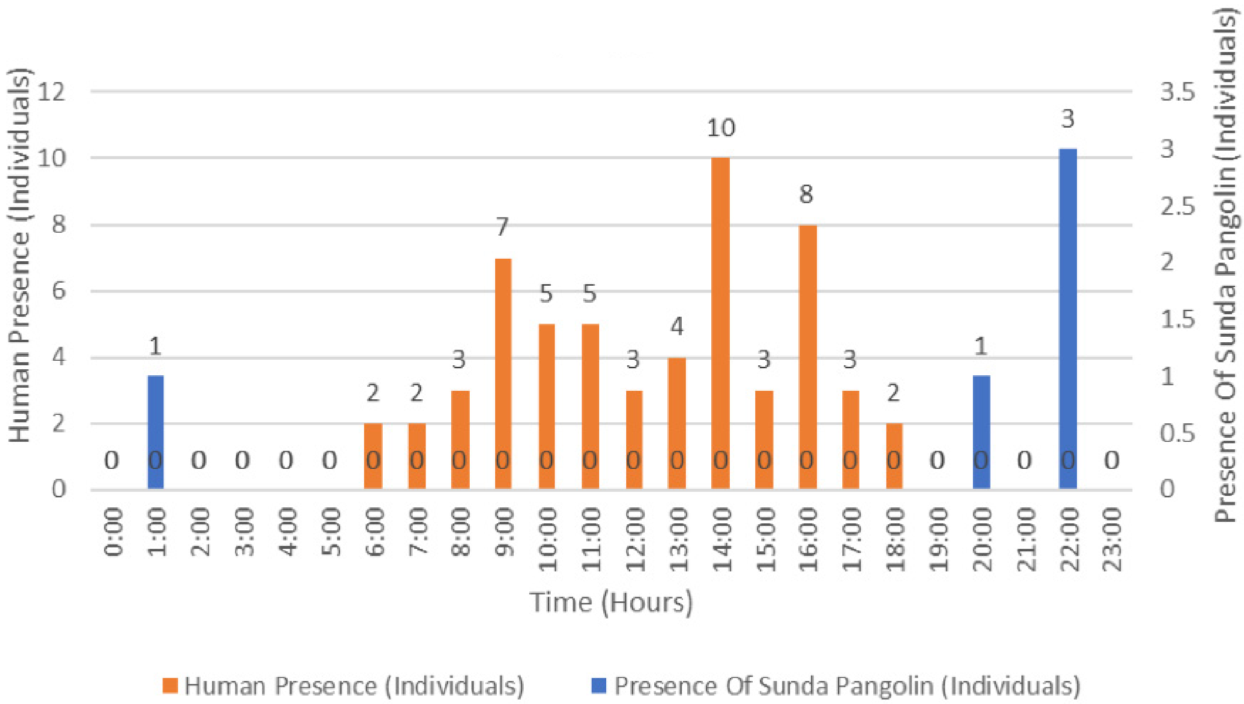

Figure 4. Graph of activity pattern of humans and the Sunda Pangolins in Sepanggar Hill.

trap data (Figure 3). The human presence ranged from 2–120 individuals during data collection, with one to three individuals recorded per event. In this study, the Pearson correlation analysis examined the relationship between Sunda Pangolin presence and distance from five human-related locations: KKTM, KKTF, KKTPAR, Kg. Numbak, and Kg. Kebagu. The correlation values were -0.24, -0.12, 0.00, 0.32, and -0.01, respectively, with a sample size of 2,741 (Table 1). These values show very weak relationships, meaning that the distance from human areas does not strongly affect whether pangolins are present or not.

Interestingly, the analysis showed a weak negative correlation near KKTM and KKTF, which are residential

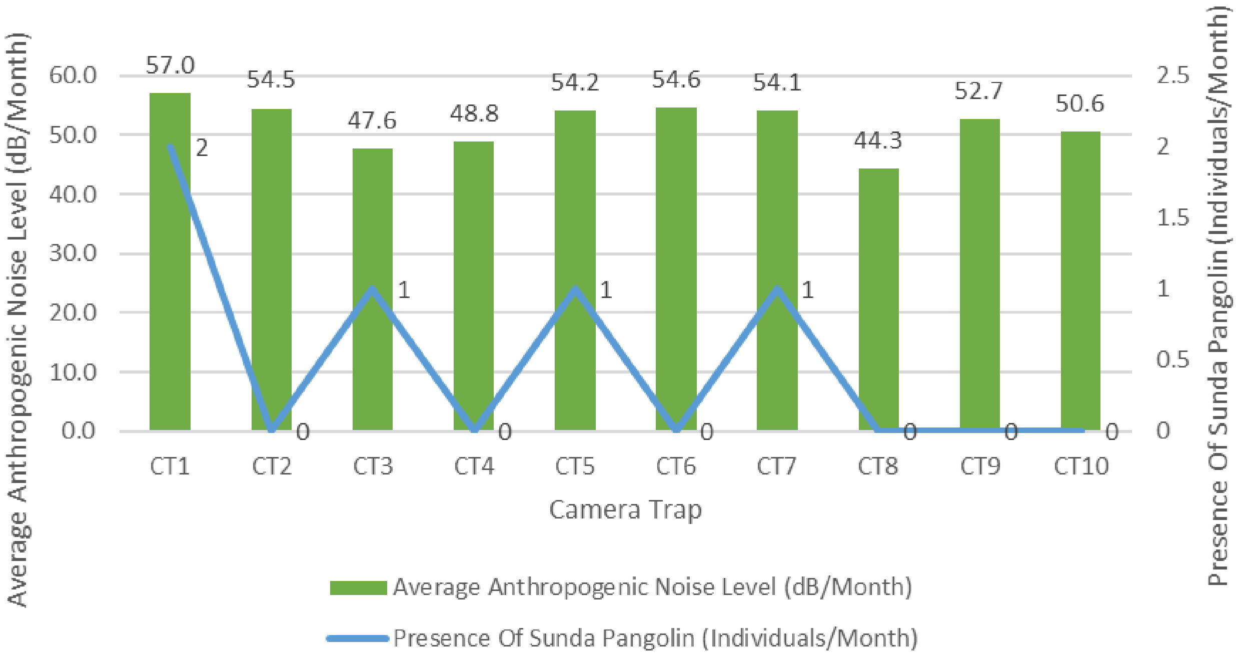

Figure 5. Graph of anthropogenic noise level and the Sunda Pangolins in Sepanggar Hill.

Table 1. Results of Pearson correlation coefficient analysis on the correlation between the presence of Sunda Pangolin and the human settlements.

	Presence of Sunda Pangolin	Proximity to KKTM	Proximity to KKTF	Proximity to KKTPAR	Proximity to Kg Numbak	Proximity to Kg Kebagu
Correlation Coefficient	1	-0.024	-0.012	0.000	0.032	-0.001
Sig. (2-tailed)		0.206	0.521	0.989	0.098	0.957
N	2741	2741	2741	2741	2741	2741

areas for UMS staff and students. People in these areas mostly do research or hiking, not harmful activities. However, because people are regularly present there, the Sunda Pangolins might avoid the area even if there is no direct threat. This may be because disturbances like human noise or lingering scent trails can affect wildlife, especially, since pangolins depend on their sense of smell to find food while foraging (DiPaola et al. 2020).

On the other hand, a weak positive correlation was found near Kg. Numbak and Kg. Kebagu, even though people in these villages do more harmful activities like cutting trees and using fire to clear land. One reason for this might be that these destructive actions usually happen during the day, while pangolins are active at night. Additionally, disturbed areas may offer improved burrows, and foraging conditions for pangolins, such as increased access to termites in decaying wood (Dorji 2017; Chao et al. 2020).

Other studies support the idea that pangolins respond differently depending on the situation. Some studies, like Karawita et al. (2017), say that pangolins tend to avoid humans as they are highly sensitive to human activities (Manshur et al. 2015; Anasari et al. 2021; Sulaksono et al. 2023). But others, like Chong et al. (2020), found that pangolins are sometimes seen in human-modified areas. In one case, a pangolin was even spotted walking inside a shop at KKTPAR without showing fear, suggesting that they may get used to humans in places where they are not hunted (Sompud et al. 2023).

Overall, the results suggest that Sunda Pangolins do not completely avoid areas with people. Instead, they might adjust based on how often people are around, what kind of activities they do, and whether the environment still meets their needs. This shows that pangolins may have some ability to live in areas where human activity is present, especially when the risks are low, and resources are still available (Chong et al. 2020; Nash et al. 2020).

Activity pattern of Sunda Pangolins and humans

Humans are primarily diurnal due to the nature of the human body which operates on the circadian rhythm and other biological factors that help modulate activity levels during daylight hours (Bonny & Firsov 2012; Andreatta & Allen 2021). In this study, the humans were observed to be diurnal, in which they are active during daytime (Figure 4). For instances, the humans were mostly seen active from 0600–1859 h, with the peak activity observed from 1400–1459 h as observed in Figure 4. On the contrary, the Sunda Pangolins were observed to be active at night from 2000–0159 h, with peak activity at range time between 2200–2259 h . This shows that the Sunda Pangolin is a nocturnal mammal species as seen in previous research (Lim & Ng 2008; Challender et al. 2012; Sompud et al. 2019). Based on Figure 4, there were no instances where Sunda Pangolins and humans were present simultaneously at the same location. This temporal separation suggests that there is no direct overlap in the activities of Sunda Pangolins and humans in the Sepanggar Hill forest, which might be a coping mechanism for the pangolins to avoid human encounters. This behavior could be crucial for their survival in disturbed habitats where human presence is significant.

Currently, there is a dearth of studies specifically examining the activity patterns of Sunda Pangolins and humans. The nocturnal behaviour observed in this study aligns with previous research conducted by Lim & Ng (2008), Challender et al. (2012), and Sompud et al. (2019), which consistently reported nocturnal activity in Sunda Pangolins. In contrast, humans are diurnal which means that they are primarily active during the day and resting at night. This nocturnal lifestyle allows them to coexist with humans, however, it also increases their susceptibility to poaching (Khatiwada et al. 2022).

Anthropogenic noise level and presence of the Sunda Pangolin

Sunda Pangolins, like many nocturnal mammals, rely heavily on their acute sense of hearing for foraging and predator avoidance (DiPaola et al. 2020). Increasing levels of anthropogenic noise can interfere with these crucial activities. The analysis shows that there is a positive correlation between noise levels and pangolin presence at Camera Trap Station 1 (N = 348, r = 0.147, p = 0.006**). The anthropogenic noises that were observed come from cars, aeroplanes, people talking, the call to prayer (adhan), and occasional ferry horns. The observations of this study revealed that the noise levels in Sepanggar Hill ranged 44.3–57.0 dB (Figure 5). Based on the Figure 5, the Sunda Pangolin was detected in areas ranging 47.6–57.0 dB. This suggested that the Sunda Pangolin can tolerate the noise levels below 57.0 dB as it is still below the threshold that can causes stress on the species. A study done by Manci (1988) found that noise levels up to 60 dB does not cause negative response to animals that have habituated to noise (Johansson et al. 2016). Therefore, it was suggested that the Sunda Pangolin have adapted the noise level in Sepanggar Hill.

This result is somewhat unexpected, given that previous research, such as Shannon et al. (2016) and Withaningsih et al. (2018), found that many wildlife species, including pangolins, tend to avoid areas which are above 40 dB (Duporge et al. 2021). High noise levels, between 52–68 dB are generally thought to interfere with foraging, communication, and predator avoidance behaviour, leading to increased stress, and decreased reproductive success in many wildlife species (Nursamsi et al. 2023; Shannon et al. 2016). In a study done by Dipaola et al. (2020), the Sunda Pangolin was suggested to react to loud noises, and may adjust their tail position, and their movement to minimize the noise they make in their natural environment. Although pangolins may not rely on sound to find prey, it is likely they use it to detect, and avoid predators. A similar study was done by Sabin et al. (2024) on the impacts of anthropogenic noise on other pangolin species in Chandragiri-Champadevi Hills, Nepal. The study focuses more on the impacts of noise on the foraging and resting burrow count for Chinese Pangolins in the study area. It was found that the presence of these species at foraging burrows is significantly higher in areas with elevated noise levels (0.285 ± 0.073 m), ranging 22.67–58.00 dB. This could be due to their preference for agricultural areas which are the potential habitats for these species (Newton et al. 2008). In contrast, the impact of noise on resting burrow selection by Chinese Pangolins was deemed insignificant. This shows that anthropogenic noise impacts only certain behaviors of the Chinese Pangolins such as foraging.

CONCLUSION

In conclusion, there were impacts of the anthropogenic activities on the Sunda Pangolin in Sepanggar Hill, such as human presence, proximity to human settlements, activity pattern, and anthropogenic noise levels. The analysis results indicate a positive correlation between the Sunda Pangolin and anthropogenic activities, specifically, proximity to human settlements, and anthropogenic noise levels. It was found that the Sunda Pangolin does not avoid humans completely as evident in this study. For instance, the Sunda Pangolins were still detected even in areas near human settlements with minimal activity pattern such as CT1. This shows that the Sunda Pangolins have adapted to human presence in Sepanggar Hill. On the other hand, it was observed that anthropogenic noise levels do not impact the Sunda Pangolins that much despite being significant at CT1. This could be due to the insufficient data over the six-month period, and the noise levels recorded are below 60 dB. Thus, it is concluded that three out of four parameters of the anthropogenic activities had impacted the Sunda Pangolin.

Given these findings, it is clear that while pangolins can coexist with low-impact human activities, the more severe impacts of habitat destruction, and noise from areas outside UMS threaten their survival. Therefore, we recommend for collaborative conservation efforts between the local governments, non-government organisations, and researchers at UMS by enforcing stricter regulations to protect Sunda Pangolins. By combining knowledge and resources, these groups can develop a clear strategy that addresses the species' needs, and their habitat by limiting deforestation, and land-clearing activities in Sepanggar Hill forest, and nearby areas. Thus, it is important to secure enough funding and resources to execute this plan. These funds can be used to put protective measures in place, support research, and ensure that the efforts to conserve pangolins can continue over time. Working as a team will help achieve long-term success in protecting this Critically Endangered species. In addition, buffer zones should be set up around Sepanggar Hill to provide a safe space between humans and wildlife by minimizing the anthropogenic noise, construction, and agricultural development, on the habitats of the Sunda Pangolins. These buffer zones would act as transitional spaces and introducing noise barriers, reducing direct human encroachment, and providing a safe boundary for pangolins to thrive. These steps could provide actionable pathways to mitigate threats to Sunda Pangolins while promoting coexistence with human activities.

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Malay: Tenggiling Sunda atau Manis javanica Desmarest, 1822 (Pholidota: Manidae) merupakan satu-satunya spesies tenggiling yang terdapat di Malaysia. Spesies ini dikategorikan sebagai “Sangat Terancam” (Critically Endangered) dalam Senarai Merah Spesies Terancam IUCN dan merupakan antara mamalia yang paling banyak diperdagangkan secara haram di dunia. Aktiviti antropogenik seperti pembangunan penempatan dan pergerakan manusia yang kerap berhampiran tepi hutan semakin mengancam keselamatan Tenggiling Sunda. Aktiviti ini bukan sahaja menyebabkan fragmentasi habitat, tetapi juga mendedahkan hidupan liar kepada tahap bunyi dan gangguan manusia yang tinggi akibat jarak yang dekat dengan kawasan penempatan. Oleh itu, kajian ini dijalankan untuk menentukan kesan aktiviti antropogenik terhadap taburan Tenggiling Sunda di Bukit Sepanggar menggunakan kaedah tinjauan kamera perangkap. Sebanyak sepuluh kamera perangkap dipasang secara sistematik dan rawak dari Mei 2023 hingga Januari 2024. Jarak antara penempatan manusia terdekat dengan lokasi kamera perangkap serta tahap bunyi antropogenik turut diukur. Data dikumpul setiap bulan bagi kedua-dua parameter tersebut. Sepanjang 2,724 malam pemasangan, kamera perangkap merekodkan lima kejadian tenggiling. Analisis korelasi Pearson menunjukkan hubungan yang sangat lemah (-0.24 hingga 0.32) antara kehadiran Tenggiling Sunda dengan jarak ke penempatan manusia berdasarkan 2,741 titik data. Walaupun tahap bunyi tinggi antara 44.3–57.0 dB, Tenggiling Sunda lebih kerap dikesan berhampiran kamera perangkap pertama (N = 348, r = 0.147, p = 0.006**), iaitu kawasan dengan tahap bunyi tertinggi, menunjukkan toleransi terhadap gangguan bunyi. Dapatan ini menonjolkan keupayaan adaptasi Tenggiling Sunda terhadap habitat terganggu selagi mereka tidak berasa terancam, serta menekankan keperluan usaha pemuliharaan bersasar untuk mengurangkan impak manusia. Pemeliharaan kawasan yang lebih tenang dan pengurangan gangguan manusia amat penting bagi memastikan kelangsungan hidup Tenggiling Sunda di Bukit Sepanggar. Kajian ini memberi panduan penting untuk merangka strategi pemuliharaan yang berkesan bagi melindungi spesies yang sangat terancam ini.

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NAAS rating (India) 5.64

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

October 2025 | Vol. 17 | No. 10 | Pages: 27551–27786
Date of Publication: 26 October 2025 (Online & Print)
DOI: 10.11609/jott.2025.17.10.27551-27786

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