Quarter Update (2nd Quarter, 2025)

This quarter update report focused only on terrestrial mammal species with at least 10 independent sightings, excluding those with fewer sightings at any of the five study sites in Western Sabah, to enhance the accuracy and reliability of the outcomes. Sightings were classfied by time of day as night (7:01 p.m. to 5:00 a.m.), twilight (dawn: 5:01 a.m. to 7:00 a.m.; dusk: 5:01 p.m. to 7:00 p.m.), or day (7:01 a.m. to 7:00 p.m.). The relative abundance index (RAI), expressed as the number of independent detections of a species per 100 trap nights, was calculated to represent a species' activity level during specific time periods. Subsequently, a species' main activity pattern, examined as the time of day when its activity level was significantly higher than at other periods, was validated using the Kruskal-Wallis test, with Dunn-Bonferroni test used for post-hoc analysis. Based on these results, each species was categorized as cathemeral (active throughout the day), crepuscular (active during twilight), nocturnal (active at night), or diurnal (active during the day). Moreover, kernel density plots were used to illustrate each species' diel activity pattern by displaying the likelihood of detection over a 24-hour period. Consequently, similarities in diel activity patterns between species were evaluated utilizing the analysis of overlapping, with the coefficient of overlapping (Δ) functioning as the metric. Coefficient values below 0.50 indicated low similarity in diel activity patterns, while higher values reflected greater overlap.

Among the 27 documented native terrestrial mammal species, only 15 species (55.6 %) met the criteria for inclusion in the analysis. These included the plantain squirrel (*Callosciurus notatus*), long-tailed porcupine (*Trichys fasciculate*), Prevost's squirrel (*C. prevostii*), long-tailed macaque (*Macaca fascicularis*), southern pig-tailed macaque (*M. nemestrina*), Whitehead's Sundaic maxomys (*Maxomys whiteheadi*), leopard cat (*Prionailurus bengalensis*), common palm civet (*Paradoxurus hermaphroditus*), Malay civet (Viverra tangalunga), mousedeer (Tragulus spp.), Sunda stink-badger (*Mydaus javanensis*), northern long-footed treeshrew (*Tupaia longipes*), southern red muntjac (*Muntiacus muntjak*), large treeshrew (*T. tana*), and moonrat (*Echinosorex gymnura*). Moreover, humans were observed 535 times throughout the study, with more than 10 sightings recorded at all five sites. In contrast, two exotic species, classified as invasive due to their ability to thrive in new environments, were each sighted only 10 times at a single site. The free-ranging dog (*Canis familiaris*) was sighted 22 times in total, but it was detected 10 times only at Kinarut Eco Forest Park. Similarly, the domestic cat (*Felis catus*) was observed only at Tenghilan Community Forest, with 10 sightings recorded throughout the study. While there was no evidence that free-ranging dogs were used by humans to hunt native terrestrial mammals at any of the five study sites, but humans and free-ranging dogs were found together on one occasion **(See Picture 1).**

Out of the 15 analysed native species, eight (53.3 %) were sighted significantly more often at night ($p < 0.05$) along and around human pathways across the five sites, suggesting nocturnal behaviour **(See Table 1)**. These species included moonrat, Malay civet, Whitehead's Sundaic maxomys, common palm civet, mousedeer, leopard cat, long-tailed porcupine, and Sunda stink-badger. In contrast, six native species (35.3 %) exhibited significantly higher activity during the daytime ($p < 0.05$), suggesting diurnal behaviour. These included the long-tailed macaque, Prevost's squirrel, northern long-

footed treeshrew, southern pig-tailed macaque, plantain squirrel, and large treeshrew. The southern red muntjac exhibited significantly higher activity during twilight (RAI = 0.0432 ± 0.0211 $100TN^{-1}$) compared to both daytime (RAI = 0.0395 ± 0.0112 $100TN^{-1}$) and night-time (RAI = 0.0049 ± 0.0049 $100TN^{-1}$; $\chi^2_2 = 10.16$, $p = 0.0062$), indicating crepuscular behaviour. Both humans and the free-ranging dog displayed diurnal activity patterns ($p < 0.05$), with peak activity happening in the morning between 8:00 a.m. and 11:00 a.m. Conversely, the domestic cat demonstrated cathemeral activity ($\chi^2_2 = 0.3826$, $p = 0.8259$), with a slight tendency over twilight activity (RAI = 0.0247 ± 0.0247 $100TN^{-1}$), followed by lower levels during night-time (RAI = 0.0099 ± 0.0055 $100TN^{-1}$) and daytime (RAI = 0.0049 ± 0.0033 $100TN^{-1}$) throughout the sampling periods.

Picture 1. Images of A) humans, B) free-ranging dogs, C) humans accompanied by free-ranging dogs, and D) domestic cats observed along and near human pathways across the five study sites in Western Sabah

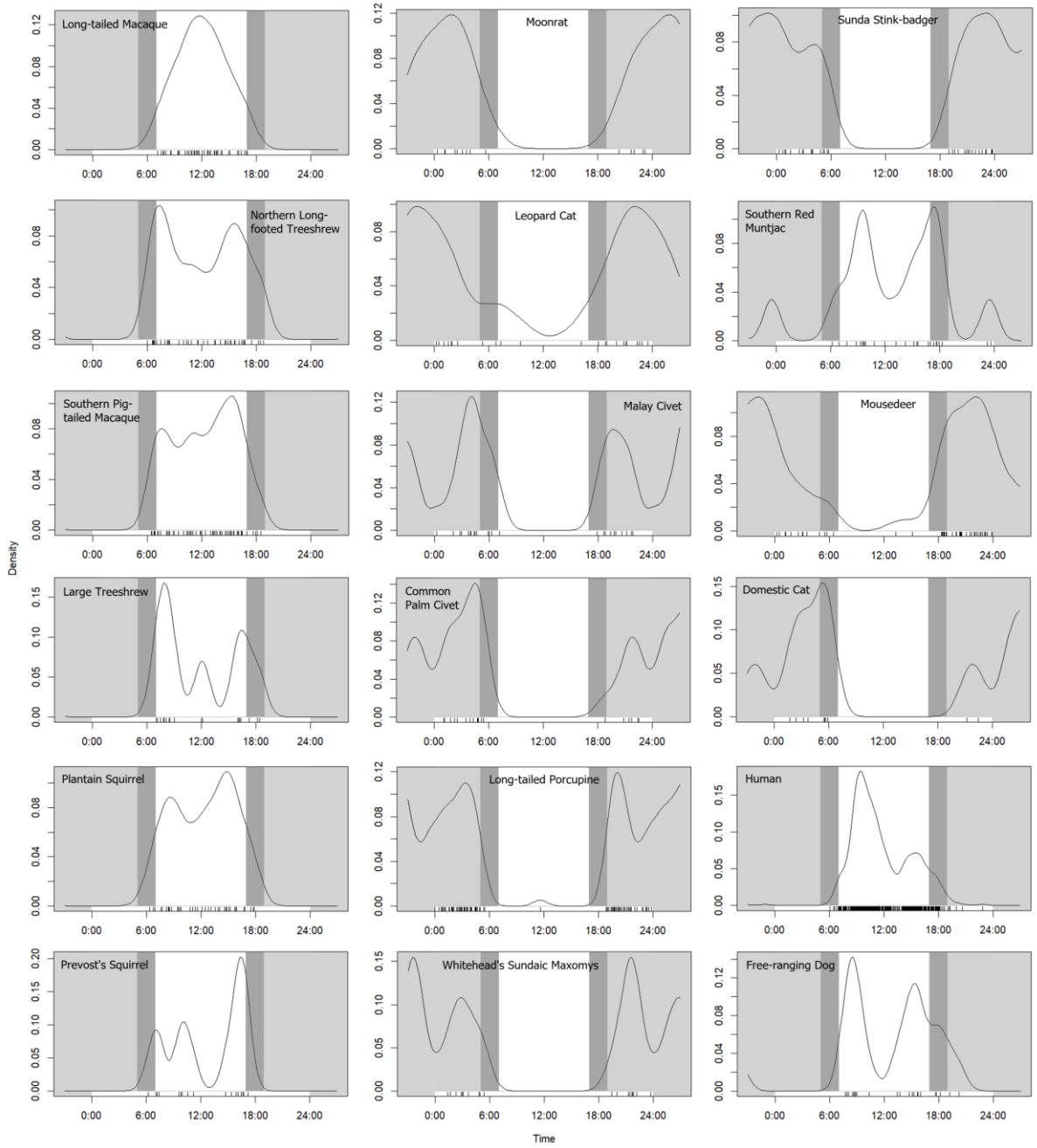
The analysis of overlapping unravelled that the eight nocturnal species shared similar diel activity patterns with each other ($\Delta > 0.50$), as did the six diurnal species ($\Delta > 0.50$). While each species had distinct peak activity hours across the five sites, several used local human pathways and nearby areas during overlapping time intervals **(See Picture 2)**, leading to a high similarity level in their diel activity patterns. The crepuscular

southern red muntjac exhibited a diel activity patterns that resembled that of the six verified diurnal species ($\Delta > 0.50$), being more active during the day than at night. In contrast, the cathemeral domestic cat exhibited the highest activity at night and the lowest during the day, with peak activity at dawn, resulting in a diel activity pattern similar to that of the seven identified nocturnal species seven ($\Delta > 0.50$). However, its diel activity pattern varied from that of the mousedeer ($\Delta_1 = 0.4609$), which was active during both night-time and twilight. Although both species were least active during the day, their activity levels during twilight and night-time differed, resulting in distinct diel activity patterns.

Table 1. Main activity patterns of 15 native terrestrial mammal species, plus humans and the invasive free-ranging dog and domestic cat, sighted along and near human pathways in Western Sabah (based on pooled data)

	Species	RAI (100TN^{-1})			Kruskal-Wallis Test		Main Activity Pattern
		Twilight	Day	Night	χ^2	p	
Invasive	Domestic cat	0.0247 ± 0.0247	0.0049 ± 0.0033	0.0099 ± 0.0055	0.3826	0.8259	CAT
	Free-ranging dog	0.0185 ± 0.0118	0.0420 ± 0.0152	0.0049 ± 0.0033	6.043	0.0487*	DIU
	Human	0.2718 ± 0.1223	1.196 ± 0.207	0.0173 ± 0.0122	18.42	0.0001***	DIU
Native	Common palm civet	0.0185 ± 0.0118	-	0.0395 ± 0.0092	12.37	0.0021**	NOC
	Large treeshrew	0.0185 ± 0.0118	0.0395 ± 0.0129	-	9.972	0.0068**	DIU
	Leopard cat	0.0247 ± 0.0101	0.0074 ± 0.0038	0.0469 ± 0.0125	7.615	0.0222*	NOC
	Long-tailed macaque	0.0062 ± 0.0062	0.1186 ± 0.0142	-	20.22	<0.0001***	DIU
	Long-tailed porcupine	0.0247 ± 0.0142	0.0025 ± 0.0025	0.2249 ± 0.0225	19.25	<0.0001***	NOC
	Malay civet	0.0371 ± 0.0071	0.0025 ± 0.0025	0.0420 ± 0.0111	10.64	0.0049**	NOC
	Moonrat	0.0062 ± 0.0062	-	0.0297 ± 0.0081	10.9	0.0043**	NOC
	Mousedeer	0.0803 ± 0.0565	0.0049 ± 0.0033	0.0914 ± 0.0177	15.07	0.0005***	NOC
	Northern long-footed treeshrew	0.0741 ± 0.0440	0.0791 ± 0.0089	-	16.83	0.0002***	DIU
	Plantain squirrel	0.0371 ± 0.0214	0.0865 ± 0.0124	-	17.14	0.0002***	DIU
	Prevost's squirrel	0.0124 ± 0.0071	0.0420 ± 0.0148	-	10.39	0.0055**	DIU
	Southern pig-tailed macaque	0.0556 ± 0.0255	0.1359 ± 0.0166	-	18.78	<0.0001***	DIU
	Southern red muntjac	0.0432 ± 0.0211	0.0395 ± 0.0112	0.0049 ± 0.0049	10.16	0.0062**	CRE
	Sunda stink-badger	0.0309 ± 0.0234	-	0.0692 ± 0.0089	16.86	0.0002***	NOC
	Whitehead's Sundaic maxomys	0.0062 ± 0.0062	-	0.0494 ± 0.0156	13.71	0.0011**	NOC

Note: RAI = Relative abundance index (Number of sighting per 100 trap nights); χ^2 = Chi-square score; p = Significance value (* = $p < 0.05$; ** = $p < 0.01$; and, *** = $p < 0.001$; 2-tailed); CAT = Cathemeral; DIU = Diurnal; NOC = Nocturnal; and, CRE = Crepuscular



Picture 2. Diel activity patterns of 15 native terrestrial mammal species, plus humans and the invasive free-ranging dog and domestic cat, sighted along and near human pathways in Western Sabah (based on pooled data)