FIELD EXPEDITION

ORANGUTAN SURVEY IN TAWAU HILL NATIONAL PARK

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Report written by Hutan

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Executive Summary

In July 2025, joint teams from Hutan and Sabah Parks carried out a comprehensive wildlife survey in Tawau Hill NP. Hutan mobilized two of its team (totalling 25 field researchers) for these surveys in order to cover the entirety of the NP in the given time (Note that MPOGCF is only charged for the orangutan team that contributed to this survey, and not other activities). However, we share all information gathered during tis survey to provide a more complete overview of the findings. At the time of writing, some analysis are not completed yet and a full report will be shared as soon as data from camera trapping and bioacoustics monitoring will become available.

Overall, we found orangutan nests at all five survey locations, demonstrating that the species is widespread across Tawau Hill NP. We also detected two orangutans during drone surveys, one in Balung and another in Andrassy.

Nests tended to be slightly more common in areas bordering the edges of the NP. However, despite our extensive search efforts, the teams did not record any signs of orangutan activity within oil palm plantations bordering the forest. This finding indicates that, unlike in Kinabatangan and other sites, orangutans in Tawau Hill NP tend to remain inside the protected forests and have not yet penetrated nearby oil palm plantations.

Overall, we observed fewer nests within the interior of Tawau Hill NP (Lucia) than at other sites. It appears that orangutans are predominantly distributed in forests that are more diverse than dipterocarp-dominated areas. This result was expected given orangutan preference for lowland areas with diverse tree composition.

However, since there is no statistical difference between sites, we estimate the overall mean kilometric index for the entire Tawau Hill NP to be 1.10 nests/km (SD=0.77 nests/km). Although we cannot derive a density estimate from linear kilometric indices obtained from recce walks, based on results from previous expeditions, we can hypothesize that the overall orangutan population could approximate 50 individuals for the entire NP.

This number will be refined at the end of the current project when all data have been analyzed. But we can already conclude that Tawau Hill NP is home to a significant orangutan population, a result worth emphasizing given the paucity of data available about orangutans in this NP.

In conclusion, Tawau Hill NP is home to a resident orangutan population. With climate change, we can expect orangutans and other wildlife species to move toward higher elevation forests. Keeping Tawau Hill NP connected with other lowland forest areas inhabited by orangutans is a conservation priority to allow orangutans living outside the NP to migrate in when forest changes begin to occur as a result of climate change.

A Keeled Pit-viper or Wagler's Pit Viper (*Tropidolaemus subannulatus*) eating a hairy-backed bulbul, during night surveys.

Background Information about the Orangutan Survey Project

Understanding the distribution and size of orangutan populations in Sabah is crucial for effective conservation strategies for the species. Over time, the Sabah Wildlife Department (SWD) and its collaborators have conducted multiple surveys in the State to establish reliable size estimates of the orangutan populations across Sabah. Continuous monitoring of population size and dynamics is essential for evaluating the sustainability of orangutan populations in Sabah and assessing the effectiveness of conservation efforts by the SWD and other stakeholders.

The Overall project funded by MPOGCF and entitled "Orang-utan surveys in Sabah" follows the following objectives (see detailed proposal):

- Surveying orangutan nests in key protected and non-protected areas in Sabah.
- Finalising what we know about the orangutan metapopulation in Kinabatangan.
- Collecting practical and detailed information using mixed bio-social methods to document orangutan conservation status in at least two other agricultural landscapes.
- This project serves as a vehicle for the capacity building of relevant stakeholders and a training platform.

This report summarises the results of the field expedition conducted under the MPOGCF project in the Tawau Hill Park between July 7th and July 16th, 2025 (eight days of fieldwork and two days of travel). In addition to the team of orangutan researchers, Hutan also sent a team specifically tasked with identifying other biodiversity taxa. Although MPOGCF does not cover these activities, we present the findings in this report to provide a more comprehensive view of the expedition results.

Background information about Tawau Hills Park and its orangutan population

Tawau Hills Park, an IUCN category II (National Park), covers an area of 27,972 ha and was established in 1979, primarily to protect the water catchment area of Tawau town. The park ranges from lowland dipterocarp to upper montane forest, with several mountains, including Mont Magdalena (the highest peak at 1,310 m), Mount Lucia (1,201 m), and Bombalai Hill (530 m). This area originates from very ancient volcanic activities, explaining the presence of hot water sources in several locations.

Although mostly covered in primary forests, several parts of the National Park were logged in the 1960s and 1970s, resulting in a diverse range of habitats, especially at the edge of the protected area.

In addition to the field HQ, we used the three field stations available on site during fieldwork: Merotai, Andrassy, and Balung.

The park is located 24 km from the town of Tawau and is primarily surrounded by non-forest habitats dominated by industrial oil palm plantations. Its northern side is bordered by Ulu Kalumpang and adjacent Forest Reserves (Mt Wullersdorf and others), representing a block of 64,954 ha managed by the Sabah Forestry Department.

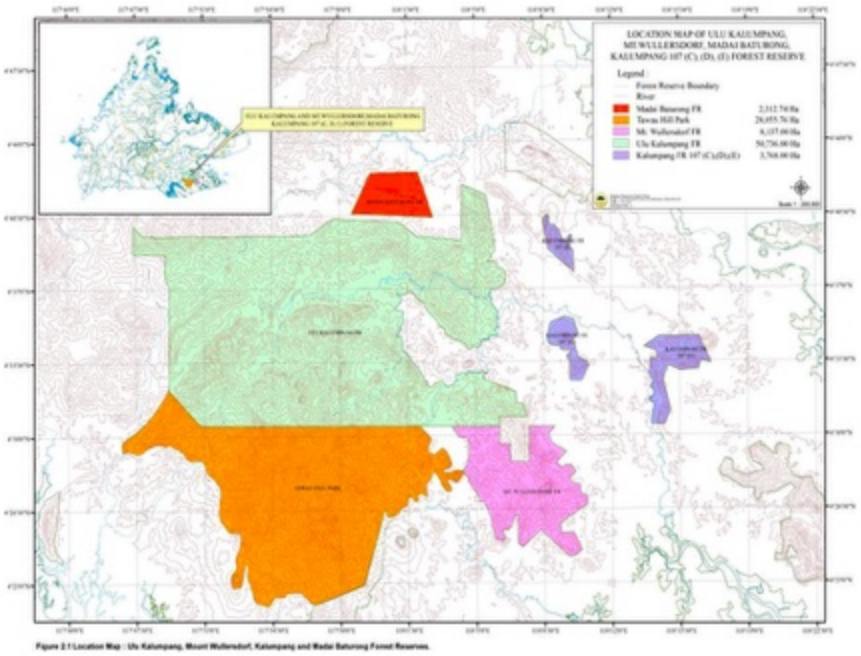


Figure 1: Map (courtesy SFD) showing the location of Tawau Hills NP and surrounding Forest Reserves (Ulu Kalumpang and others)

A faunal survey by Payne and Davies in the late 1970s concluded that orangutans were very few in this part of Sabah (Figure 2). However, the number of orangutan sightings increased subsequently. This increase might be due to easier access to these previously remote parts of Sabah, or to an influx of orangutans resulting from forest conversion to agriculture in the surrounding areas. Aerial surveys by Hutan and SWD in the early 2000s estimated a population of 144 (54-408) individuals in the forests of Ulu Kalumpang.[1] But orangutans are also regularly sighted within the forests of Tawau Hills Park (Figure 2 and 3), although the size of the population has yet to be determined. The goal of our survey was to confirm the presence of a resident orangutan population and to determine potential hotspots for orangutans in the area, with a. particular emphasis at the edge between forest and oil palm plantations.

[1] Ancrenaz, M., Gimenez, O., Ambu, L., Ancrenaz, K., Andau, P., Goossens, B., Payne, J., Tuuga, A., and Lackman-Ancrenaz, I. 2005. Aerial surveys give new estimates for orang-utans in Sabah, Malaysia. *Plos Biology*, 3 (1): 30-37: e3. doi:10.1371/journal.pbio.0030003

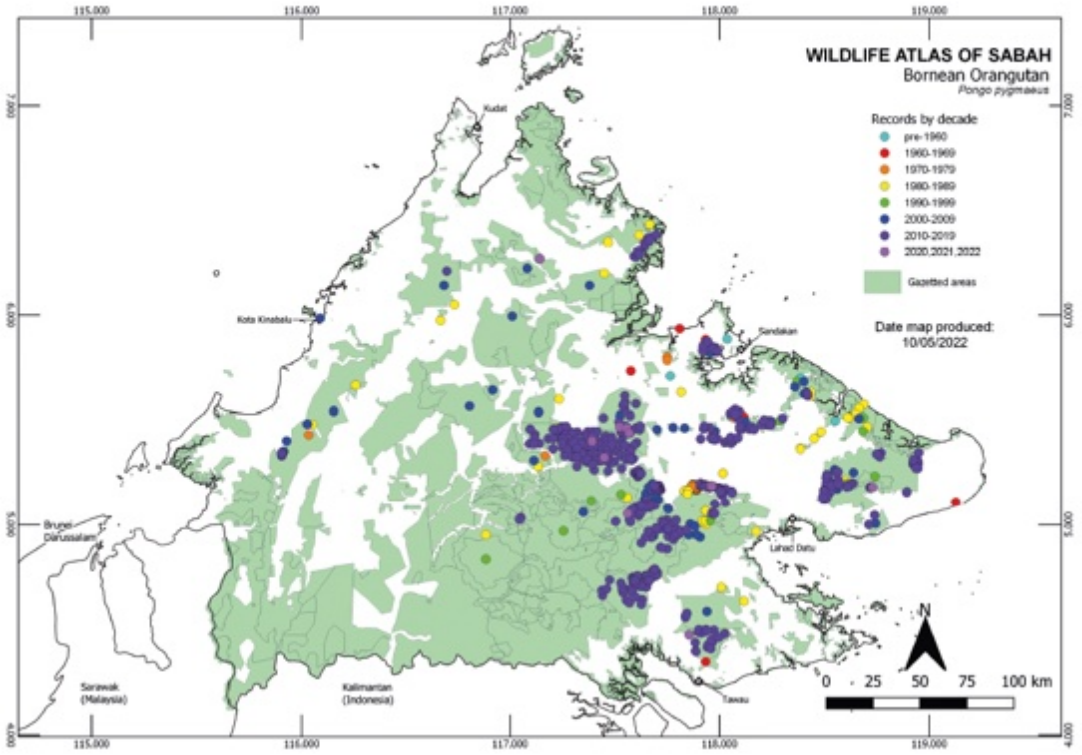


Figure 2: map of Sabah showing orangutan sightings over the past few decades (Courtesy: Sabah Wildlife Atlas)

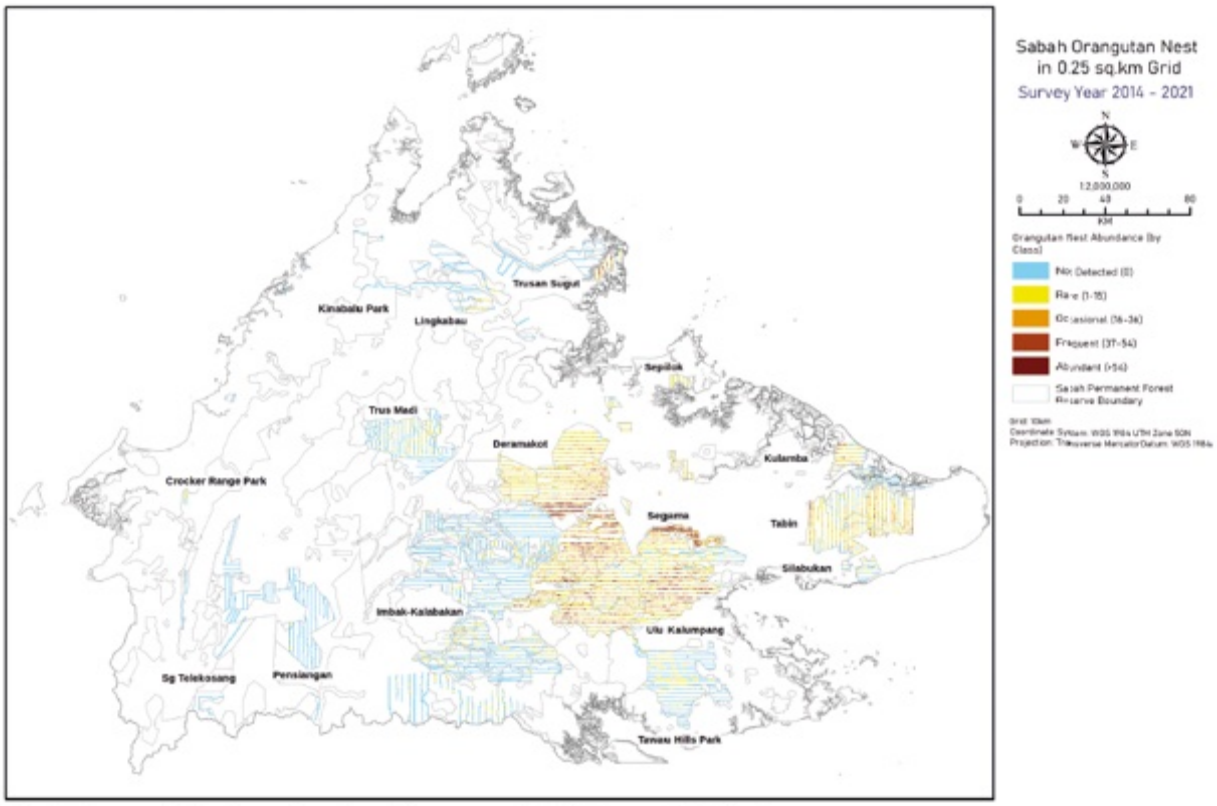


Figure 3: Map showing orangutan nests detected during helicopter flight (Courtesy: WWF, Sabah Atlas of Wildlife)

Methodology

The Hutan members and Sabah Parks staff were divided into several teams operating from the existing substations around the Tawau Hills Park (Substation Balung, Andrassy, Merotai, HQ) and Mount Lucia, as shown in Map 1. Each team used a combination of standardised field methodologies designed explicitly for orangutan surveys (and other taxa), adhering to established protocols in Sabah (Ancrenaz, 2013). Data were collected over a period of eight full days (excluding travel days). Daily excursions were planned in accordance with site accessibility and weather suitability.

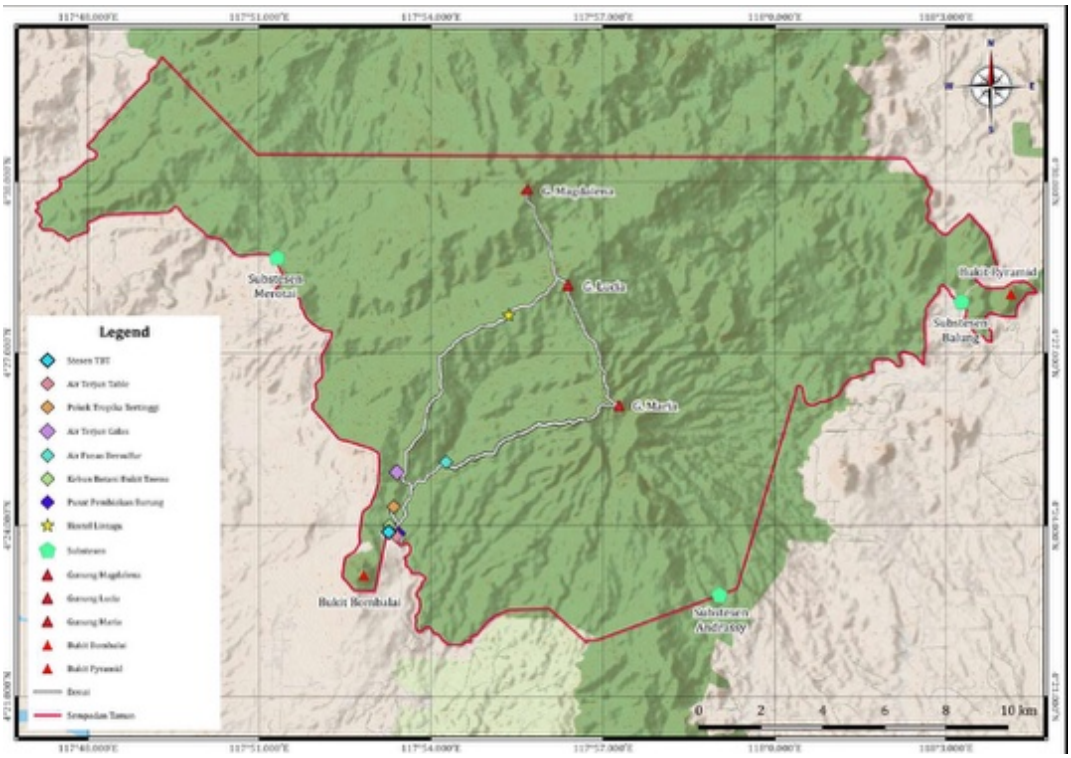


Figure 4: Map showing the location of the various teams during the survey (Courtesy: Tawau Hills Sabah Parks).

During this field expedition, we employed the following methods:

- **Reconnaissance Walks (RWs) :** Reconnaissance walks follow terrain-adapted routes rather than predetermined transects. This flexible approach enables the teams to navigate challenging terrain features, allowing for coverage of greater distances and more extensive areas within limited timeframes. While density estimation is not possible from RW observations, we can calculate linear encounter rates expressed as the number of nests detected per kilometer walked. Each team organised seven points to recce around the vicinity of Tawau Hills Park. The location of all reconnaissance walks is presented in Appendix 1.

- **Botanical Monitoring:** We established botanical monitoring plots (100m × 20m) at each RW location to assess forest condition and composition. Within each plot, we counted and identified all trees with a diameter at breast height (DBH) exceeding 20cm. Forest structure parameters, including canopy openness, small tree presence, and climber abundance, were evaluated using a standardised scoring system ranging from 0 (minimum/absent) to 3 (maximum).

- **Ancillary Data Collection:** Comprehensive environmental data collection included weather conditions, human presence indicators, forest disturbance signs, and topographical features that might influence wildlife observations and distribution patterns.

- **Drone Surveys:** We conducted two distinct types of un-manned aerial vehicle (UAV) surveys:

    - *Daytime Operations*: Drones conducted nest counts along aerial line transects and during random flight patterns. All flights were recorded for subsequent video analysis at the field camp to identify and quantify orangutan nests. These aerial surveys provided critical landscape overviews that informed ground survey planning and optimisation.

    - *Nocturnal Thermal Surveys:* Thermal imaging technology enabled direct detection of orangutans in their nests during nighttime flights. These surveys followed systematic linear transects within 800 m × 800 m quadrats.

    - *Technical Specifications:* Drone operations were conducted with a DJI Mavic 3 thermal (for night surveys) or a DJI Matrice 30 (for day surveys) at a standardised altitude of 70 m, with flight speeds maintained at 8 m/s. Data collection protocols included recording the types of findings, GPS coordinates, timestamps, and behavioural observations for all detected orangutan signs and individuals.

- **Camera traps:** We deployed fifteen camera traps (Model Reconyx Hypefire Professional 2). All cameras were mounted on trees at an average height of 30–60 cm above ground level. Camera location and placement were determined based on the presence of wallows, forest ridges, and observed wildlife tracks. Each camera was configured to take five photos per trigger, with a three-minute quiet period. The cameras were deployed in July 2025 and are expected to be retrieved by the end of September 2025.

- **Bio-acoustic sampling:** We deployed three Audiomoth devices at each substation, totalling 12 devices. Devices were mounted on trees within the forest at a height of 10 meters and located a distance away from noise factors such as vehicles, human activities, and water bodies (rivers and streams). We configured the Audiomoth devices to actively record their surroundings in four different periods: 0500–0800 hours, 1100–1400 hours, 1700–2000 hours, and 2300–0200 hours. We used a frequency of no more than 48 kHz, and the devices were active for 60 seconds every 5 minutes (300 seconds). We left the devices on-site for five days, and they were retrieved.

- **Gibbon survey:** We employed the modified triangulation methodology to estimate gibbon abundance. This approach involves systematic acoustic monitoring of gibbon vocalisations (both long and short calls) during the peak calling period between 06:00 and 08:00. For each detected call, observers recorded the precise time, estimated distance from the listening post, and the bearing of the call. Two survey teams, positioned at separate listening posts (at least 50 to 100 m apart), collected data simultaneously, enabling the spatial mapping of gibbon groups through acoustic triangulation. We conducted surveys over three consecutive mornings at each location to ensure adequate coverage of the sample. We reported a group of gibbons only when the two teams heard the call. Based on our experience in Kinabatangan (a similar habitat), we estimate that a gibbon's long call can be heard at approximately 800 m in the forest. This means that the surface area covered

during our acoustic surveys is 2 km² (0.8 × 2 × 3.14). We collected five sets of gibbon survey data during fieldwork: Substation Andrassy, Merotai, Balung, HQ, and Mount Lucia.

- **Bird Survey**: Avian surveys were carried out concurrently during reconnaissance walks and from each camp substation to maximise field efficiency. Each bird identified by the observers (direct sighting, voice) was listed in the 15 species MacKinnon List. This rapid assessment is suggested as a cost-effective method for conducting bird surveys in the tropics.
- **Frog Survey**: At night, each team organised walks for frog surveys along small streams and rivers found around the vicinity of the substations. We identified frog species based on their calls and on direct sightings.
- **Small Mammal Trapping: We focused our efforts on live-**trapping small mammals around the headquarters of Tawau Hills Park. Within a 200 m length, ten wire-mesh live traps were placed at a twenty-meter distance. We baited each trap with either banana or palm mesocarp fruit. The traps were checked at 0730 hrs and 1530 hrs for five consecutive mornings and evenings. We identified the trapped individuals at the species level before releasing them on the spot. Below is the description of the surrounding landscape for the respective small mammal transects.
- **Night Survey**: One team carried out night spotting from a vehicle opportunistically at nighttime while driving to frog survey locations.

RESULTS OF BIODIVERSITY SURVEYS (excluding orangutans)

At the time of writing, results from camera trapping, bird surveys and bioacoustics survey efforts were not available yet. The results will be added shortly to the Final Report for Tabin.

The weather during fieldwork was either sunny or cloudy.

I.1. Results of rapid gibbon surveys.

Gibbons are widespread and relatively abundant in Tawau Hills Park. Morning calls were heard at all locations every single day of fieldwork. Results of the morning call surveys are presented in Table 1.

Site	Date	Total number of groups heard by any of the two teams	Number of groups heard by two teams and included for analysis	Estimated density (km2)	
Mount Lucia	14/7/2025	8	3	1.5	Av.=1.25 SD=0.25
	15/7/2025	7	2	1	
Balung	13/7/2025	6	2	1	Av.=1.17 SD=0.62
	14/7/2025	7	4	2	
	15/7/2025	6	1	0.5	
HQ Bombalai	12/7/2025	7	4	2	Av.=2.17 SD=0.24
	13/7/2025	7	4	2	
	14/7/2025	9	5	2.5	
Andrassy	12/7/2025	6	3	1.5	Av.=1.33 SD=0.24
	13/7/2025	7	2	1	
	14/7/2025	4	3	1.5	
Merotai	9/7/2025	4	2	1	Av.=0.83 SD=0.24
	10/7/2025	3	1	0.5	
	11/7/2025	2	2	1	

Table 1: Location, date, number of groups heard by the recording teams and final density estimates.

The overall average was 1.36 group/km^2 (SD=0.58; min=0.4 -max=2.5) across all survey locations, which can be considered as average compared to other forests in Sabah.

Despite the apparent differences in mean densities (ranging from 0.83 to 2.17 groups/km^2), the results of an ANOVA test show no statistically significant differences between the five locations ($F = 2.7407$; $df = 4.9$; $p > 0.05$). The results are not significantly different when we account for within-group variability. The only significant difference was found between the gibbon densities estimated at Bombalai and Merotai (Figure 5).

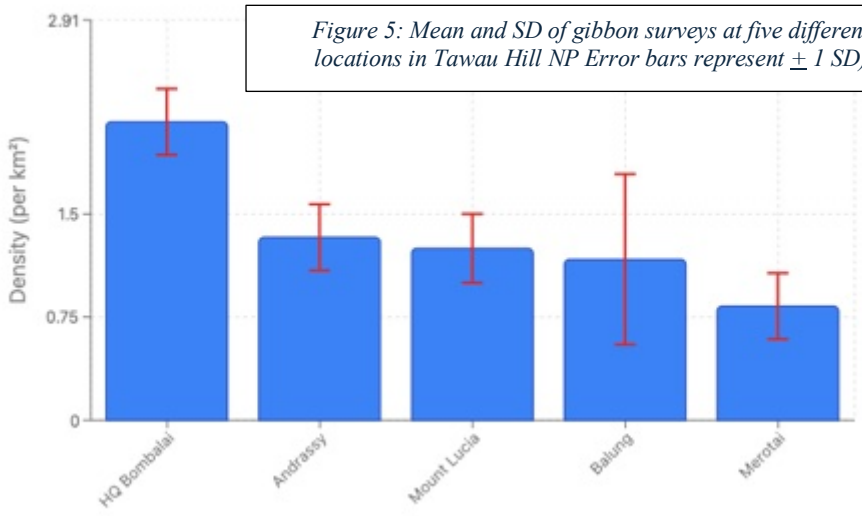


Figure 5: Mean and SD of gibbon surveys at five different locations in Tawau Hill NP Error bars represent ± 1 SD)

Habitat characteristics recorded at each survey area show that the two locations with the highest gibbon abundance (Mount Lucia and HQ Bombalai) were those sites covered with primary forest. Gibbon abundance declines in degraded forests or locations at the periphery of the park close to oil palm plantations: Table 2.

Site	Topography	Forest type	Human Disturbance	Habitat type (within 1 km^2)	Forest stridence	Forest composition
HQ-Bombalai	Hill	Mixed-lowland dipterocarp to hill forest	Roads and Recreational activities	Lowland	Closed canopy with sparse gaps	Primary forest / climax and emergent trees
Andrassy	Hill and Ridges	Degraded Mixed-lowland dipterocarp to hill forest	None at the survey time	Degraded – Replanting area	Open canopy	Pioneer species (laran) and plantation trees (Acasia, sendaman)
Merotai	Hill	Mixed-lowland dipterocarp to hill forest	Plantations adjacent to forest	Degraded forest, next to a river	Closed canopy with sparse gaps	Pioneer and climax species
Balung	Hill	Mixed-lowland dipterocarp to hill forest surrounded by plantation	Roads, Cocoa plantation and next to Bukit Piramid THP	Degraded - Adjacent to cocoa plantation	Open canopy	Pioneer species, with dense shrub understory. Hill forest 500 m ahead
Mt Lucia	Hill	Mixed-lowland dipterocarp to mossy-montane forest	Hostel and helipad	Mixed dipterocarp	Closed canopy	Hill primary forest with emergent trees, with food species such (Mempening, Kapur, and Laran)

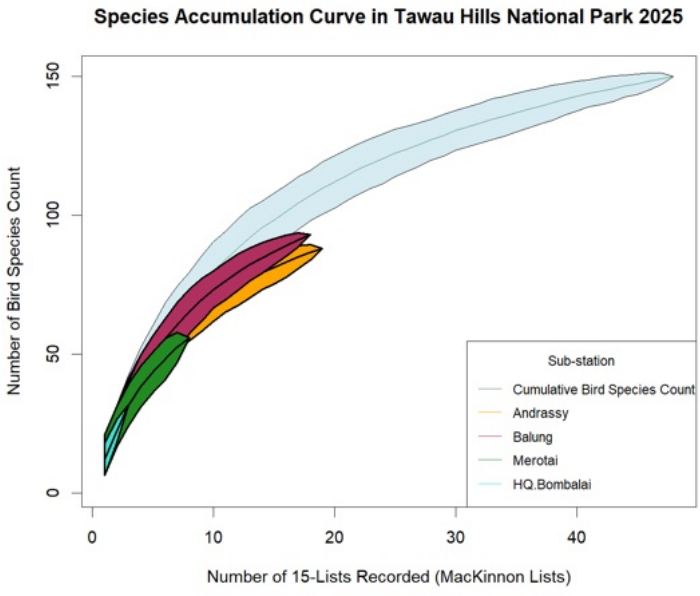
Table 2: Habitat description close to each gibbon survey location

This result shows that the gibbon is a forest-dependent species that is very sensitive to habitat disturbance.

I.2 Results of bird surveys

The graph here shows the species accumulation curve for bird species recorded (with a 95% confidence interval) in Tawau Hills Park. Collectively, the teams completed 48 "15-McKinnon Lists," totaling 150 observed species.

On the graph, we see that the combined and the per-station "Cumulative Bird Species Count" curves are still rising steadily, despite our survey effort of 48 MKLs (when all substations are combined). This trend indicates that the sampling effort was still insufficient to capture the full avian diversity present in Tawau HP. More surveys are required to reach the asymptote and to achieve a more comprehensive inventory.



For each sub-station, the curve's interval is widest in the middle section, suggesting a high variability in the number of detected species.

Substation	Total MacKinnon List	Recorded Entries	Species
Andrassy	20	290	87
Merotai	8	109	56
Balung	17	253	86
HQ-Bombalai	3	39	32

Most Lists were completed in Andrassy and Balung, reflecting a bias in data collection (the best Hutan birders were indeed located at these two stations).

The top five bird species among the 48 complete MK lists are :

- 1. Rhinoceros hornbill (34) – 71% representation in the total number of lists
- 2. Black and yellow broadbill (24) – 50%
- 3. Black hornbill (20)
- 4. Malaysian pied fantail (16)
- 5. Ashy tailorbird (15)

Hornbills are very noisy birds and easily detectable, which could explain their abundance. About a quarter of species recorded during our surveys belong to the families of Pycnonotidae (Bulbuls, 14), Muscicapidae (Flycatchers, 13), Cuculidae (Cuckoos, 12), Nectariniidae (Sunbirds, 12), and Pellorneidae (Babblers, 11). These species are common sightings in disturbed and degraded lowland mixed dipterocarp forests. Some of the survey areas were located in disturbed habitats, adjacent to smallholders' plantations at the border of the Tawau Hills Park, explaining this result. However some forest dependent species were alo recorded within the National Park (four out of ten pitta species for example).

The full list of birds recorded during field work is given in Annex III.

Bioacoustic analysis recorded a total of 73 species, including 25 that had not been identified during the MKL surveys. During camera-trap retrieval session in September 2025, the teams recorded the bird species sighted at Mount Lucia. Notably, the birds recorded were migrant species, typically found at higher elevations. In total the team recorded 62 species, scontributing 20 new species that were not recorded before.

Overall, combining all methodologies, the Hutan team recorded 195 species from 56 families. Twenty three species are endemic to Borneo, while 16 species are listed in the IUCN Red List as Critically Endangered (Helmeted hornbill), Endangered (White-crowned hornbill and Wrinkled hornbill), and Vulnerable (13 species).

I.3. Results of frog surveys:

A total of ten frog species was recorded during fieldwork: Table 3. Overall, these species are commonly found along and within rocky water bodies or river streams, as well as perched on shrubs and dense vegetation along the streams.

Family	**Scientific name**	**Species name**
Ranidae	*Meristogenys jerboa*	Slender torrent frog
	Chalcorana megalonesa	White-lipped frog
	Hylarana nicobariensis	Cricket frog
	Chalcorana raniceps	Jade-backed stream frog
Megophryidae	*Leptolalax frittiniens*	Twittering slender litter frog
Dicroglossidae	*Limnonectes leporinus*	Giant river frog
	Limnonectes kuhlii	Kuhl's creek frog
Bufonidae	*Ansonia spinulifer*	Spiny slender frog
Microhylidae	*Metophrynella sundana*	Tree hole frog
	Kalophrynus heterochirus	Bornean sticky frog

Table 3: list of frog species identified during nocturnal frog surveys.

Meristogenys jerboa (Slender torrent frog)

Chalcorana megalonesa (Jade-backed stream frog)

Limnonectes leporinus (Giant River Frog)

Leptolalax frittinensis (Twittering slender litter frog)

I.4 Results of small mammal trapping

We captured 30 individuals, comprising nine species over five mornings and five evenings. The table below shows the species captured on the established transects.

Species	Scientific Name	SM01	SM02	SM03	SM04	SM05
Dark-tailed tree rat	*Niviventer cremoviter*	-	1	-	-	-
Four-striped ground squirrel	*Lariscus hosei*	1	-	-	-	-
Large treeshrew	*Tupaia longipes*	1	1	-	-	-
Low's squirrel	*Sundasciurus lowi*	-	1	2	3	-
Muller rat	*Sundamys muelleri*	1	1	-	-	-
Plain treeshrew	*Tupaia*	1	1	-	-	2
Rajah's maxomys	*Maxomys rajah*	-	-	1	-	-
Red-spiny Maxomys	*Maxomys surifer*	-	2	-	2	4
Whitehead's maxomys	*Maxomys whiteheadi*	2	1	-	-	2
Total captures		**6**	**8**	**3**	**5**	**8**

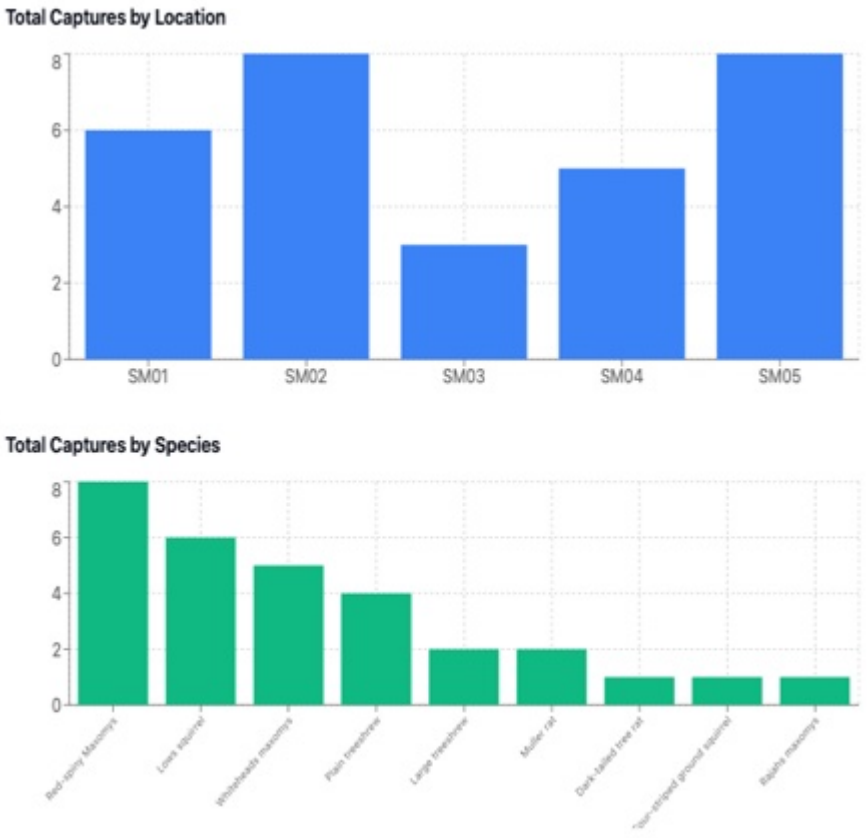
Table 4: List and location of small mammal species and individuals captured during field surveys (darker color indicates higher captures)

The 30 captures were baited with eight bananas and 22 mesocarp kernels.

A chi-Square test of independence shows that species distribution varied significantly between sampling locations (Chi-Square = 39.8; ddf=32; $p<0.05$)

Red-spiny Maxomys rats were the most abundant captures (8 total captures): this species is commonly found throughout the forests of Borneo. The Low's squirrel (a very common forest species) showed an interesting spatial clustering concentrated in SM03 and SM04. SM02 and SM05 had the highest total captures (with eight each).

The Shannon diversity indices vary considerably between locations, with SM02 having the highest species diversity (seven species, index=1.906) and SM03 the lowest (only two species captured, Index=0.637). Most locations show moderate diversity of small mammal species. SM02 was the transect that was further away from any human activity, which may be an explanatory factor for the highest species diversity at this location.



The species accumulation analysis indicates that the sampling completeness is nearly complete for those species that are easily trappable. However, we need to consider the fact that small mammal trapping doesn't sample all species of small mammals, and many more species exist that are not captured in traps baited with bananas or palm fruits (Figure 6).

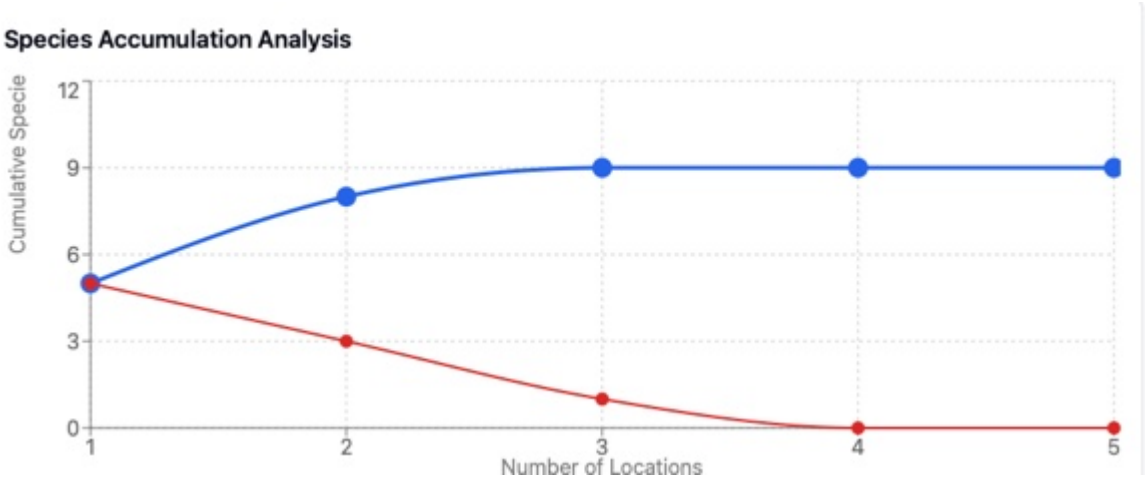


Figure 6: Species accumulation curves for small mammal trapping

Lastly, a Permanova-like (Multivariate Community Analysis using a Bray-Curtis dissimilarity between community compositions) revealed high similarity between SM01 and SM02, but low similarity between SM01 and SM03 or SM04, between SM02 and SM03, or between SM03 and SM05. The mean pairwise distance between the five samples was 0.705. The composition of small mammals was similar for SM01 and SM02 (Pairwise Jaccard Similarity value of 0.5 – 4 shared species); SM01 and SM05 (0.333 – 2 shared species); and SM02 and SM05 (0.429 – 3 shared species). The lowest similarities were found between SM01 and SM03, SM01 and SM04 and SM03 and SM05. Overall, the average shared species between the five sites was 1.4.

The low similarity scores revealed that species distribution was not random across locations and indicated some habitat specialisation between species. The small mammal composition is strongly influenced by local ecological factors that fluctuate at a small scale in the forest. Indeed, several species were associated with environmental conditions characterising degraded forests and forest edges, such as Muller's rat, Whitehead's maxomys, and Rajah's maxomys. Plain treeshrews, a diurnal species, were also commonly captured in disturbed habitats. These species are only slightly influenced by canopy cover. Some other species showed clear location preferences, such as Low's squirrel (SM03 and SM04) or Rajah's maxomys (only at SM03).

The high beta diversity between locations indicated a significant species turnover across the landscape, while the low Jaccard similarity values suggested that each location contributed unique species to the overall regional diversity. These findings suggest environmental gradients and habitat heterogeneity that drive community differences. Different habitats support different functional groups of small mammals.

Interestingly, we captured a four-striped ground squirrel. This endemic squirrel is distinguished by its four narrow black stripes on the back, with orange underparts. It was captured near the "Botanical Park" in a well-preserved forest.

To conclude, our small mammal trapping data reveal a heterogeneous mammal community across the five locations, with strong evidence for habitat-driven species sorting. The significant species turnover between locations indicates that each site contributes unique conservation value. This suggests that the mammalian fauna responds to environmental gradients or habitat differences that create distinct ecological niches. This type of result is typical of tropical mammal communities, where high spatial heterogeneity creates opportunities for ecological specialisation and maintains high regional diversity through species turnover across the landscape

Traps were placed on the ground, on dead logs, and near climbers along the transects (left).

Captured individuals were identified on the spot and immediately released. (right)

Small mammals are identified in the field from our field experience and by checking species ID with Mammal books

A captured maxomys rat, or rather, a large spiny rat. They are distinguished by having bi-coloured tails and defining fur colour with their underparts, specifically their belly.

A Low's squirrel, species commonly found foraging from the ground to the subcanopy in the lowland and less disturbed forests (left).

A four-striped squirrel, endemic to Borneo (right).

I.5. Wildlife recorded during night surveys and ground recce walks.

Species recorded during night surveys included the Island palm civet and the Malay civet, as well as several leopard cats, the Sunda skunk badger, and the Brown wood owl. These species are commonly found in habitats that are disturbed or degraded.

Detailed results collected during recce walks are provided in the Tables included in the following section about orangutan survey results. Overall, more wildlife signs were detected away from the borders of Tawau Hill NP. Indeed, signs of human encroachment (poaching, gaharu) were more often detected close to the boundaries of Tawau Hill NP, with surrounding oil palm estates, than in the interior of the NP.

Several species were recorded regularly at all survey locations, indicating a widespread distribution, in particular, sambar deer, barking deer, and porcupines. Wild boars still occur in Tawau Hill NP, but signs were few and mostly found in the Merotai survey area. This result indicates that the population of wild boars seems to be in an early recovery phase from the African Swine Flu that struck Sabah in late 2020-early 2021[2][3].

Signs of rare and iconic species, included sunbear with signs of presence (clawmarks) detected at all survey sites, a clouded leopard in the Lucia area, and two calls of helmeted hornbills.

Overall, Tawau Hill NP still harbors a diverse community of the large fauna commonly found in Borneo.

Field work at Balung survey site.

[2] Lieb, Z.E., Meijaard.e., Brodie, J.F., Shabrani, A., … Ancrenaz, M.,… Luskin, M.S. 2025. Mapping multiple wild pig species' population dynamics in Southeast Asia during the African Swine Fever outbreak. *Conservation Letters* https://doi.org/10.1111/conl.13105

[3] Meijaard, E., Erman, A., Ancrenaz, M., Goossens, B. 2024. Pig virus imperils food security in Borneo. *Science*, vol. 383, issue 6680, pp. 267. https://www.science.org/doi/10.1126/science.adn3857

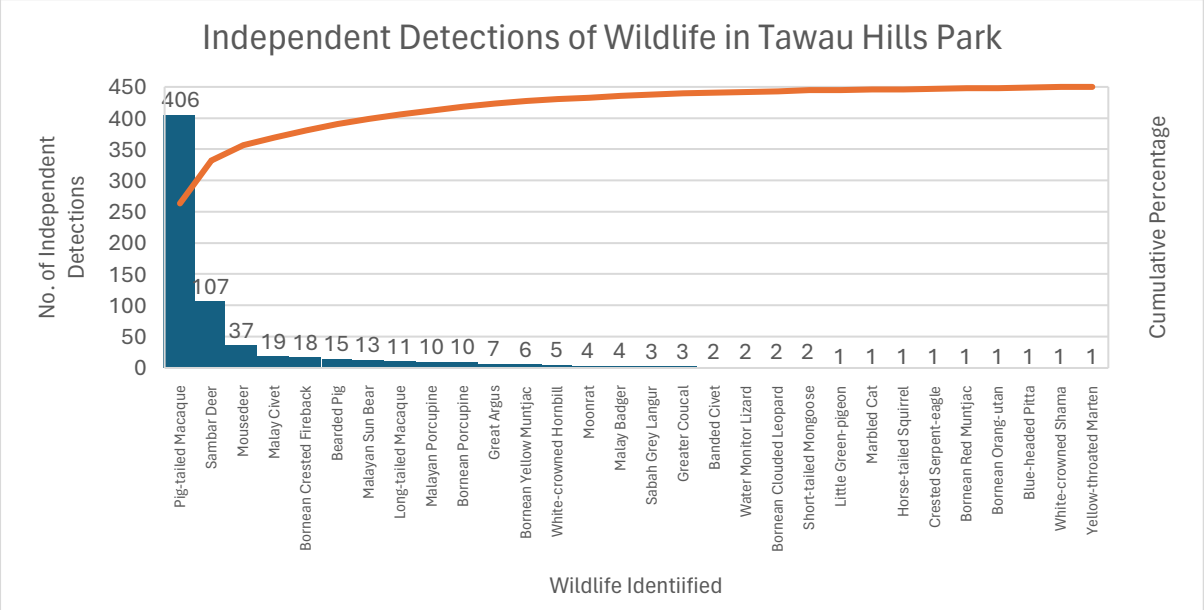
I.6. Camera trapping.

Camera traps were deployed in July 2025 and retrieved at the end of September 2025, except for one unit, which was left at the deployment site because access to private land was not available. **This camera unit is still on site, and we have requested Sabah Park to assist in our efforts to retrieve this pricy piece of equipment.**

We extracted and organised the images from the camera traps using Colorado Parks & Wildlife (CPW) Photo Warehouse data management software. We used a 60-minute cut off to extract independent events of solitary species or large social groups and to avoid recording the same individual of the same species twice.

Captured individuals were then differentiated by size or specific signs. Independent species events that could not be identified were excluded from the analysis. Due to a technical malfunction, two of the cameras operated in time-lapse mode, produced a very large number of images (Andrassy: 43,055; Bombalai-HQ: 11,710), and were excluded from analysis. In total, we analysed the images from 12 camera traps.

We yielded a total of 952 days of sampling effort from this deployment campaign. Of 9,387 images, 7,360 were processed, yielding 695 independent detections. Overall, we **recorded 30 species, comprising 21 mammals, eight birds, and one reptile**. Twelve of which are categorised in the IUCN Red List as Critically Endangered, Endangered, and Vulnerable (Refer to Appendix IV). Out of the 30 species identified, 10 species are endemic to Borneo (Refer to Appendix IV)



The highest recorded independent detections originated from Pig-tailed macaques (Figure above), which contributed 58% of the total independent detections observed for 30 species. This species is among the most frequently captured ones by camera traps in the Kinabatangan floodplain and many other areas in Sabah, as these primates are highly adaptable and common, travel in large groups across all land-use types, and are very common sightings in Sabah. Following species include game species, like sambar deer or mouse deer or beadred pig. This finding is very encouraging, as we can consider Tawau Hill NP a source population for these species, which are declining across most of their range in Sabah due to heavy poaching/hunting pressure. The observation of several pigs in the vicinity of Andrassy (1), Merotai (7), and Balung (7) are also very encouraging. Indeed, the local population of bearded pigs in Sabah was decimated at the end of 2020 following the first outbreak of Arfican swine flue in Borneo. In many places , the entire populations were wiped out. Although most of the pictures were of single individuals instead of a large family group, this data shows that the population may be in early recovery stages in Tawau HP.

Overall, the camera traps detectd eight carnivore species, with the Malay civet and the Malayan sun bear found across all substations, as well as in the vicinity of the HQ.

To conclude, the camera-trapping results show a relatively high diversity of wildlife species, yet low abundance based on independent detections.

Table listing all species detected by camera traps at four distinct sub-station survey areas

No	Common Name	Scientific Name	Andrassy	Balung	HQ-Bombalai	Merotai
1	Banded Civet	*Hemigalus derbyanus*				x
2	Bearded Pig	*Sus barbatus*	x	x		x
3	Blue-headed Pitta	*Hydrornis baudii*	x			
4	Bornean Clouded Leopard	*Neofelis diardi bornensis*				x
5	Bornean Crested Fireback	*Lophura ignita*	x	x	x	x
6	Bornean Orang-utan	*Pongo pygmaeus morio*			x	
7	Bornean Porcupine	*Thecurus crassispinis*		x		x
8	Bornean Yellow Muntjac	*Muntiacus atherodes*	x	x	x	
9	Crested Serpent-eagle	*Spilornis cheela*	x			
10	Great Argus	*Argusianus argus*	x			x
11	Greater Coucal	*Centropus sinensis*		x		
12	Horse-tailed Squirrel	*Sundasciurus hippurus*		x		
13	Little Green-pigeon	*Treron olax*		x		
14	Long-tailed Macaque	*Macaca fascicularis*		x		x
15	Malay Badger	*Mydaus javanensis*				x
16	Malay Civet	*Viverra tangalunga*	x	x	x	x
17	Malayan Porcupine	*Hystrix brachyura*		x		x
18	Malayan Sun Bear	*Helarctos malayanus*	x	x	x	x
19	Marbled Cat	*Pardofelis marmorata*	x			
20	Moonrat	*Echinosorex gymnurus*			x	
21	Mousedeer	*Tragulus sp*	x	x	x	x
22	Pig-tailed Macaque	*Macaca nemestrina*	x	x	x	x
23	Sabah Grey Langur	*Presbytis sabana*		x		
24	Sambar Deer	*Rusa unicolor*	x	x	x	x
25	Short-tailed Mongoose	*Urva brachyurus*		x		
26	Southern Red Muntjac	*Muntiacus muntjak*				x
27	Water Monitor Lizard	*Varanus salvator*			x	
28	White-crowned Hornbill	*Aceros comatus*				x
29	White-crowned Shama	*Copsychus stricklandii*	x			
30	Yellow-throated Marten	*Martes flavigula*			x	
	Total		13	16	11	16

Camera traps near Merotai and Balung were located near active wallows/salt licks and recorded the visit of Sabah grey langur or wild boars.


Camera traps deployed near Bombalai-HQ vicinity captured presence of the Bornean orangutan (left) and the Bornean yellow muntjac (right)


Our camera trap deployment recorded the presence of two felid species: the Bornean clouded leopard and the Marbled cat.






Mineral reservoirs or Salt lick areas attract a wide variety of animals. In this case, we have identified several mammals, including ungulates (Bornean bearded pig and Sambar deer),

carnivores (Bornean sun bear and short-tailed mongoose), and primates (Sabah grey langurs in single individuals to groups of four).

Southern red muntjac and the curious White-crowned hornbill in Merotai.

RESULTS OF ORANGUTAN SURVEYS

1. Ground recce walks

The teams conducted a total of 54.67 km of reconnaissance walks along 29 different routes, and recorded 60 orangutan nests, or approximately 1.10 nests/km (Table 5). We did not record any orangutan direct sighting or calls.

The team in Merotai found a skull of an adult flanged orangutan. Despite an intensive search in the area, we were unable to find any additional bones. The skull was relatively intact and did not give any indication of the possible cause of death.

This skull was entrusted to Sabah Parks at the end of the fieldwork.

Overall, the forest was in pristine conditions inside Tawau NP but more degraded on the outskirts. Food resources available to the orangutans appeared to be more common in low-lying areas and in old, disturbed habitats, due to the presence of pioneer trees and climbing species. Overall, the presence of trees belonging to the Moraceae, Fagaceae, or Ebenaceae families, as well as climbers such as *Gnetum sp.* or *Spatholobus sp.* indicates the relative and widespread abundance of potential orangutan food.

Team	Nb of RW	Total length walked	Nb of OU nests	Km index
Merotai	7	9.854 km	24	2.43 nest /km
Bombalai	5	13.529 km	8	0.59 nests/km
Balung	6	7.465 km	6	0.80 nests/km
Andrassy	7	6.623 km	9	1.36 nest/km
Lucia	4	17.22 km	11	0.64 nest/km
TOTAL	**29**	**54.691**	**60**	**1.10 nest/km**

Table 5: Number of RW, length, number of nests and resulting km index at the five survey locations

Table 6 below provides more details about the various RWs conducted at the five survey areas.

Sub-station	Tr. Nb	Distance transect (km)	Starting	Ending	Objects	Description	Forest Condition
Merotai 10.07.2025	1	1.150	T4R1S	T4R1E	OU Nest	1, WP007, III, 0-10m; Seraya	Good forest for the first 400 m then old logged forest with presence of undergrowth. Hilly and rocky area. OU food +
						1, WP008, III, 20-30m, Urat Mata	
						1, WP009, IV, 20-30m, unk.	
					OU signs	1, WP003, Seraya bark feeding	
						1, WP006, same but old	
					Wildlife	FP Rusa deer	
						FP bearded pig	
Merotai 11.07.2025	2	2.200	T4R2S	T4R2E	Wildlife	FP of Rusa at several locations	Very good forest after 900m. Variation in forest quality between ridge areas (better preserved forest, large trees) vs lower slope areas (disturbance from past logging activities). OU food+
						Signs of sun bear	
						FP of wild boar	
						Active wallow: WP017	
Merotai 12.07.2025	3	0.764	T4R3S	T4R3E	Wildlife	FP Rusa	Trail along river, Disturbed forest (old logging signs)
					Human	FP poachers	
	4	1.370	T4R4S	T4R4E	OU Nest	1, WP028, III, 0-10m, Macaranga	Good quality forest only on hill tops. Lowland heavily disturbed because of past logging activities. OU food ++ in the lowlands
						1, WP029, V, 20-30m, Laran	
						1, WP030, V, 20-30m, Seraya	
						1, WP031, V, 20-30m, Laran	
						1, WP032, III, 0-10m, Unk,	
						1, WP036, I, 20-30m, Unk.	
					Wildlife	FP Rusa deer	
Merotai 13.07.2025	5	1.600	T4R5S	T4R5E	OU nest	1, WP040, V, 20-30m, Mempening	Good quality forest in a valley and ridge tops. A lot of wildlife trails. Toward the end of the trail, close to OPP, more signs of human disturbances
						1, WP044, III, 20-30m, Unk.	
						1, WP045, II, 20-30m, unk.	
						1, WP47, II, 20-30m,Minyak Berok	
						1, WP048, IV, 20-30m, climbers	
						1, WP049, III, 0-10m, unk.	
					Wildlife	FP and signs Rusa deer	
					Human	FP and gaharu poaching close to the OPP	
	6	1.470	T4R6S	T4R6E	OU Nest	1, WP 052: Class III – 20-30m, Unk.	Nice forest on dry soil at about 450 m asl. Closed canopy. Presence of tall trees. Orangutan food +
						1, WP 055: III, 0-10m, Kasai	
						1, WP 056: II, 0-10m,kasai	
						1, WP 057: V, 10-20m, unk.	
						1, WP 58:V, 10-20 m, unk.	
						1, WP 59: III, 10-20 m, unk.	
						1, WP 60: III, 20-30 m, unk.	
					Wildlife	FP Rusa deer	
					Human	2 x notches on Gaharu trees	
Merotai 14.07.2025	7	1.300	T4R7S	T4R7E	OU nest	1, WP062,V, 10-20m, Obah	Old logged forest at the beginning toward more intact forest in the hill top. Old logging roads. OU food +
						1, WP063, III, 0-5m, unk.	
					Wildlife	1 OU skull, WP061	
						Claw marks sunbear	
						FP Rusa deer and Barking deer	
						Active wallow	
					Human	Illegal logging	
Total Merotai		**9.854**				**24 orangutan nests**	**Index = 2.43 nest/km**
Bombalai 09.07.2025	RW 1	3.700	T3RW1S	T3RW1E	OU nest	1, WP003, III, Keruing	Good forest with signs of past disturbance OU food +; OU were spotted in the past
						1, WP0005,III, Seraya	
						1, WP008, IV, Belian	
					Wildlife	FP Rusa, barking deer/Gibbon call	

Bombalai 10.07.2025	RW 2	1.930	T3RW2S	T3RW2E	OU nest	1, WP009,V, Urat Mata	Hilly area – Good forest condition – OU food+
Bombalai 11.07.2025	RW 3	3.700	T3RW3S	T3RW3E	OU nest	None, but one Class III before starting the RW	Hilly area – Good forest but many dead trees – Several active wallows and many animal trails – Signs of poaching OU food -
					Wildlife	FP Rusa and barking deer	
						Mark claws sunbear	
						Gibbon call	
					Human	Poaching (x 2)	
Bombalai 12.07.2025	RW 4	2.300	T3RW4S	T3RW4E	OU nest	1, WP025, III, Keruing	Very steep and hilly – Good forest conditions – Hunting trails OU food +
						1, WP026, III, Keruing	
						1, WP027, IV, Dara2	
						1, WP028, III, Belian	
					Wildlife	FP rusa deer	
						FP wild boars close to wallows	
					Human	Signs of poaching, porcupine traps	
Bombalai 14.07.2025	RW 5	1.890	T3W5S	T3W5E	Ou nest	none	Very hilly – Good condition OU food +
					Wildlife	FP Rusa deer	
						Claw mark sunbear	
						Argus calls	
Total Bombalai		**13,.520 km**				**8 orangutan nests** **OU nests are mostly concentrated close to the edge with OPP and not inside the forest**	**Index = 0.59 nest/km**
Balung 09.07.2025	T1RW1	2.550	T1R1S	T1R1E	OU nest	1, WP006, V, 0-10m, Bayur	Start from OPP – Disturbed forest OU food++
					Wildlife	FP rusa, mouse and barking deer	
						Claw mark sunbear	
Balung 10.07.2025	T1RW2	0.915	T1R2S	T1R2E	OU nest	1, WP014, III, 10-20m, Urat Mata	Hilly area – Disturbed forest OU food -
						1, WP015, III, 10-20m, Seraya	
					Wildlife	Claw mark sunbear	
						FP Rusa deer	
						DS red leaf monkeys	
						Call Bushy and rhinoceros H.	
					Human	Signs of illegal logging	
Balung 11.07.2025	T1 RW 3	1.000	T1R3S	T1R3E	Ou nest	none	Start close to OPP/ Flat / Disturbed forest and extensively used for hunting OU food +
					Wildlife	OU urine smell and feeding signs	
						FP mouse deer / DS pigtail mac	
					Human	FP and active hunting trail	
Balung 12.07.2025	T1 RW 5	1.000	T1R5S	T1R5E	OU nest	1, WP027, II, 10-20m, unk.	Hilly Disturbed forest OU food +
						1, WP028, IV, 10-20 m, unk.	
					Wildlife	Gibbon call / Claw mark sunbear	
Balung 13.07.2025	T1RW4	1.000	T1R4S	T1R4E	OU nest	1, WP032, IV, 10-20m, Dara2	Disturbed forest / Active hunting OU food +
					Wildlife	FP Rusa deer	
					Human	Signs of poaching +	
Balung 14.07.2025	T1RW6	1.000	T1R6S	T1R6E	OU nest	none	Nice forest but old logging activities and roads
					Wildlife	FP Rusa deer	
						Claw marks sunbear	
Total Balung		**7.465 km**				**6 orangutan nests**	**Index = 0.8 nest/km**
Andrassy 09.07.2025	T2 RW 1	1.787	T2-RW1	022	OU nest	3 (cluster less than 150 m apart) WP 002, III, Rengas – WP003, IV, unk. – WP003, V, unk.	Hilly (up and down) - Signs of past logging activities but still nice forest. OU food: +, especially at the beginning (disturbed forest: laran, ficus) then Acorns (mempening)
					Wildlife	Signs of porcupine, sambar deer, sunbear; hornbill cavity DS: redleaf monkey (1 ind.); gibbon (call); argus (call)	
	T2 RW 2	1.640	T2-RW2	037	Wildlife	Signs of porcupine, rusa deer, sunbear	Hilly – Relatively nice forest but many small trees OU food: ++ (laran, zyzzyphus, ficus…)
Andrassy 10.07.2025	T2 RW 3	1.100	T2- RW3	050	OU nests	5 nests in a cluster (< 100 m) 2 same tree, WP 040, IV and V, Obah Puteh – WP 041, V, unk.;	

						WP042, IV, Perapat – WP 045, III, Ampas tebu	
					Wildlife	Signs of Rusa deer and sunbear	RW starts 2 km from base camp. Old logging road: some parts are degraded. OU food: +: ampas tebu, kayu malam, kerodong
Andrassy 11.07.2025	T2 RW 4	0.512	T2-RW4	056	Wildlife	Signs of sunbear	Hilly - Degraded forest with many pioneer trees. OU food: ++
Andrassy 12.07.2025	T2 RW 5	0.510	T2-RW5	069	OU nests	1: WP060, III, Obah merah	Hilly - Old signs of logging. Degraded forest(especially at the beginning of RW)
					Wildlife	Signs: sunbear, samba deer Signs of human activities: old logging camp	
Andrassy 13.07.2025	T2 RW 6	0.552	T2-RW6	079	Wildlife	Signs: porcupine, rusa deer, sunbear	Degraded forest (past logging). OU food: -
Andrassy 14.07.2025	T2RW7	0.522	T2-RW7	085	Wildlife:	Signs: sunbear	Wet and degraded forest. Lot of pioneer trees. OU food: ++
Andrassy		**6.623 km**				**9 orangutans nests**	**Index = 1.36 nests/km**
Lucia 10.07.2025	T5 RW 1	3.650	T5-RW1 (143)	165	OU nests	5: Class III (at 606 m) – IV (655 m) – V (Laran, 2650 m); V (Laran, 2990 m); V (Laran, 3103 m)	Hilly area – Old logging road at the beginning of the RW. Nice forest with large trees. OU food: Ficus, gnetum, sedaman, laran.
					Wildlife	Signs: sunbear, rusa deer (++), barking deer	
Lucia 13.07.2025	RW 1	2,750	Lucia 1 (170)	183	OU nests	2: class IV (936 m); III (2000m).	Hilly landscape – Pristine forest OU food: + (mempening, ficus, kerodong)
					Wildlife	Signs: barking deer, mousedeer, porcupine, sunbear, clouded leopard Calls: Helmeted hornbill	
Lucia 14.07.2025	RW 2	2,768	Lucia 2 (195)	207	OU nest	1: class IV	
					Wildlife	Signs: barking deer	
Lucia 15.07.2025	RW 3	8.040	Lucia 3 (208)	234	OU nest:	3: class III (547 m); V (1.610); V (2.431)	Hilly landscape – Pristine forest OU food: + (kandis)
					Wildlife	Signs: barking deer (+), porcupine, sunbear; samba deer	
						DS: red leaf monkeys (3 ind.)	
Lucia		**17.22 km**				**11 orangutan nests**	**Index = 0.64 nest/km**

Table 6: Details of location, distance, sightings for each RW walked at the five survey locations.

Overall, we detected orangutan nests on 17 out of the 29 RW (detection success of 60%), while 40% had zero nests. The nest encounter rate (or kilometric index) ranges from 0 to 4.76 nest/km. Most areas have right-skewed distributions (few high-density transects, many low/zero-density ones). Figure 7 below shows the average km index and the max km index for each survey area. Merotai stands out with the highest nest kilometric index and the most consistent Encounter rate (SD = 1.84; 71% occupancy rate). Andrassy shows the highest variability (SD = 2.04), indicating a very uneven nest distribution at this site, and Bomabai has the lowest overall performance.

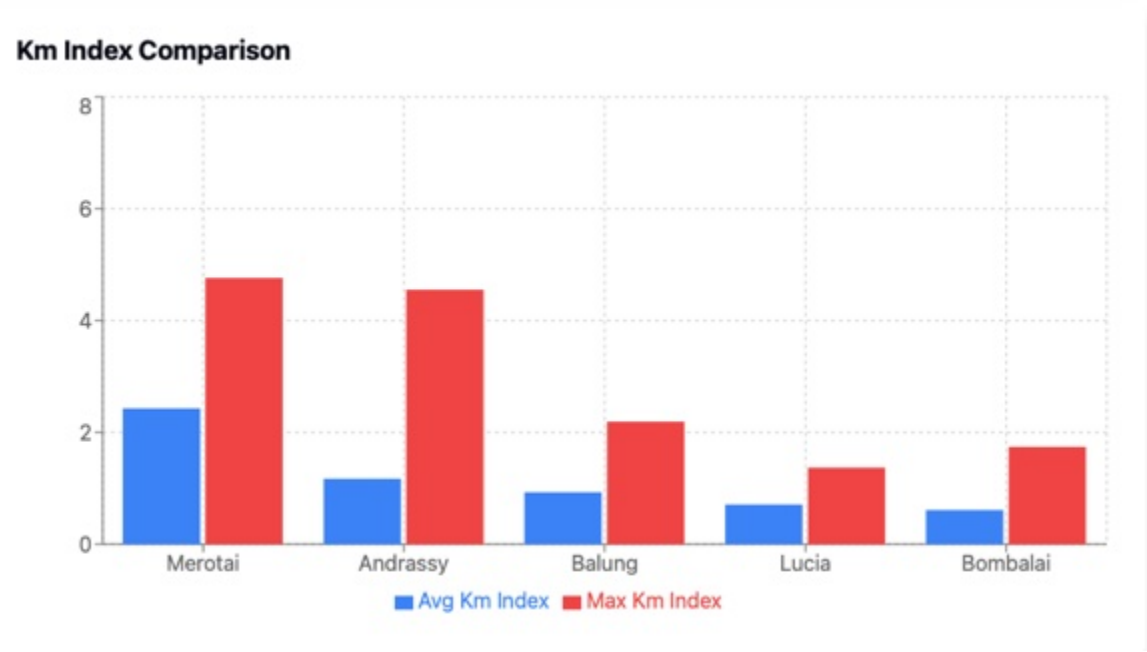


Figure 7: Comparison of orangutan nest km indexes at the five survey locations

Figure 8 represents the result of a simple occupancy rate vs total nests analysis: the X-axis represents the percentage of transects at each survey area that found at least one nest, while the Y-axis represents the absolute number of nests found across all transects at the survey location. Merotai exhibits a high occupancy rate (approximately 71%) and a high number of nests, indicating a habitat with widespread orangutan distribution in this area. Lucia exhibits a low occupancy rate (50%), yet still maintains a moderate number of nests. Orangutans seem to have a patchy distribution in the interior of Tawau Hill NP. In many cases, nests are found in clusters, indicating a seasonal and localised use of the forest resources by orangutans. Bombalai has both a low occupancy rate (approximately 40%) and a low total number of nests, indicating that this area is the least used by orangutans. Despite these differences, the data set shows that all survey areas have similar occupancy patterns across areas (Chi-square: df=4; value=3.875, p>0.05).

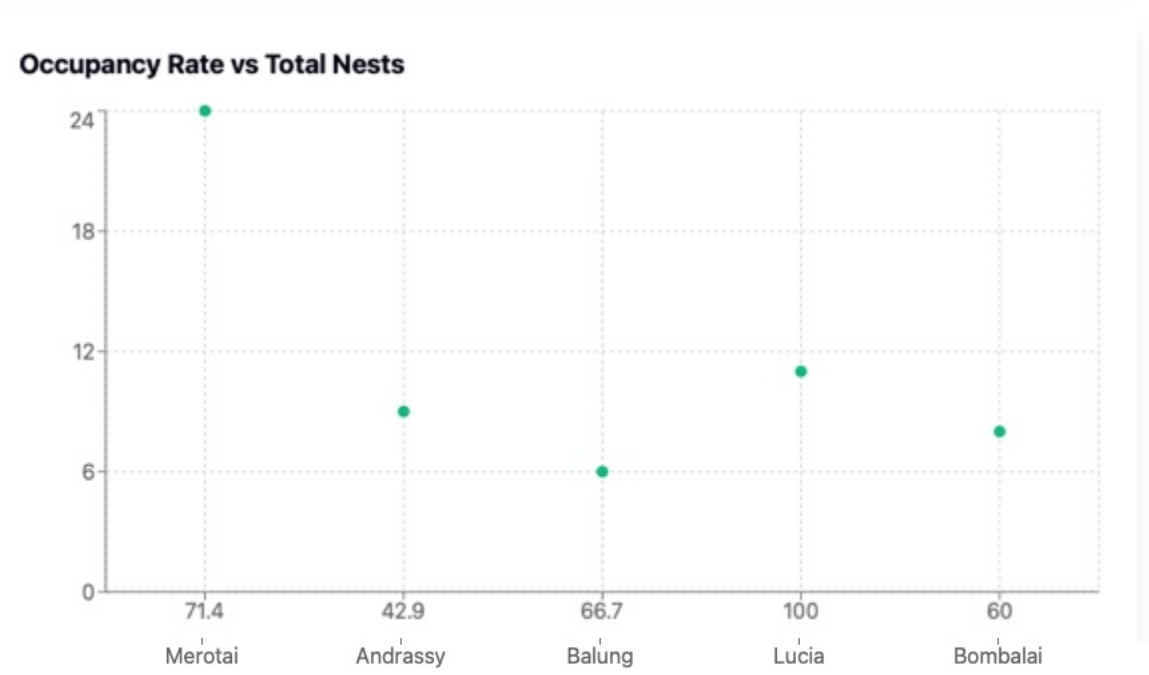


Figure 8: Occupancy rate and total number of nests for each survey site

We then used Pearson's tests to investigate if the kilometric index was correlated to the length of the RWs. The results showed:

- *Distance vs Nest Count*: r=0.181 (weak correlation): longer transects tend to have more nests (this result was expected since the longer we walk in the forest, the more chance we have to detect nests)
- *Distance vs Km index*: r=-0.176 (weak correlation). This result may indicate that longer transects may sample more diverse habitats.
- *Nest count vs Kilometric index:* r=0.881. This strong correlation was also expected since the more nests, the higher the km index is expected to be.

Overall, we found that the nest encounter rate was independent of transect length and that the km index, normalised for different transect lengths, remained constant. These results show that we can use the nest kilometric indexes to compare the five sample areas directly. Both the parametric one-way ANOVA test (df=4.24; F=1.677; p>0.05) and non-parametric Kruskal-Wallis test (H=-3.019, df =4; p>0.05) fail to show any significant difference for the nest km indexes between all sites. Thus, overall, there is no statistically significant difference in nest encounter rates between all five study areas. We also find that only 0.2% of the variance was explained by area difference. Pairwise comparisons revealed that the most significant difference was between Merotai and Bombalai (difference = 1.820). **Merotai had a higher nest km index than the four other survey areas; Bombalai had a lower km index compared to Balung and Andrassy, and Lucia had a lower km index compared to Andrassy and Balung.**
Most nests identified during our surveys were old to very old (Class III: 42.6%; Class IV: 20.4% and Class V: 27.8%). We found one fresh nest and four recent nests across all survey areas. About 50% of the nests were found in dipterocarp trees, while the rest was found in climax tree species (like belian tree) or pioneer trees that are part of the orangutan diet: Pterospermum, Syzygium, Lithocarpus, etc. Trees were more or less evely distributed vertically, with about 30% found within the class 0-10 m above the ground; 27 in the class 10-20 m and 43% in the class 20-30 m. Most of these nests were below the canopy, which may have an impact for nest detection with a drone (see below).

2. Results of drone surveys (orangutan nests and thermal imagery)

Drone flying conditions in Tawau are difficult. In many areas, the terrain is very steep and the signal can be lost very quickly. In this case, the drone returned to its departure site, and the flight was aborted. Additionally, due to the closeness of the forest, detecting nests or orangutans located below the canopy proved challenging.

- *Night surveys*

We used drones at night at the Andrassy, Lucia, and Balung survey sites.

  - Andrassy: The team surveyed an 800 m x 800 m quadrat during three consecutive nights (8-9-10 July 2025) but failed to detect any orangutans. During the survey on July 9th, the team detected two sambar deer, a civet and two groups of red leaf monkeys.

  - Lucia: the team surveyed a quadrat (800 m x 800 m) on the nights of July 13th and 14th, but did not detect any orangutans. On the night of July 13th, the team detected 2 individual red leaf monkeys resting in a tree.

  - Balung: The team carried out three half-an-hour random flights on the night of 12.07.25. During the three flights, they detected one hornbill, one pig-tailed macaque, and one red leaf monkey, all of which were already asleep in different trees.

- *Nest surveys during the day*

During daytime, the team flew the drone above straight lines and looked for orangutan nests. The locations of the lines are given in the maps available in Annexe II.

Table 7 below presents the significant findings of these aerial drone transects.

	Date	Line	Distance (km)	Nb nests	Description
Andrassy	09.07.25	LTA1	0.718	0	Old logging road - Closed canopy with some emergents – Alt.:100 m
		LTA2	0.300	0	Old logging road - Closed canopy with some emergents
	10.07.25	LTA4	0.508	0	Old logging road - Closed canopy with some emergents - Climbers
		LTA3	1.4	0	Closed canopy with some emergents
		LTA6	1.01	0	Closed canopy but after 500 m old logging road and steep hill (Alt: 140 m)
		LTA5	0.689	0	Mixed forest with some open areas – Steep: Alt: 100 m to 150 m
		LTA7	0.588	0	Mixed forest with open and degraded areas (old logging)
		LTA8	1.180	1	Mixed forest with open and degraded areas (old logging) Alt.: 170 m (after 600 m)
TOTAL			**6.393**	**1**	**Aerial Index of Nest Encounter = 0.16 nest/km**
Balong	09.07.25	L1	0.753	0	Hilly – Alt.: high
	10.07.25	L2	0.760	0	Hilly – Follow the border between forest and OPP
	11.07.25	L3	0.945	0	Hilly
	13.07.25	L4	0.500	0	Hilly
	14.07.25	L5	0.580	0	Hilly
TOTAL			**3.538**	**0**	**Aerial index = 0 nest/km**
Lucia	14.07.25	LTL1	2.100	0	Hilly
		LTL2	0.490	0	Hilly
TOTAL			**2.590**	**0**	**Aerial index = 0 nest/km**
Merotai	08.07.25	LTM7	0.340	0	Hilly
		LTM7b	0.918	2	Closed canopy – Boundaries with Landau FR
	09.07.25	Line2	0.905	1	Nice forest, closed canopy – End in OPP (Muis Malewar)
		LTML1	1.100	5	Close to newly planted OPP – Nice forest
		LTML6	1.700	2	Hilly – Nice forest, closed canopy
		LTML5	1.000	3	
TOTAL			**5.963**	**13**	**Aerial index = 2.18 nest/km**

Table 7: Results of line transects flown with a drone at Andrassy during the day

Table 8 presents the average kilometric index obtained from ground RWs (see above) and from drone transects in the four survey areas:

Study Area	Aerial Distance (km)	Aerial Nests	Aerial Nests/km	Ground Distance (km)	Ground Nests	Ground Nests/km	Difference (Ground - Aerial)
Andrassy	6.393	1	0.156	6.623	9	1.359	+1.203
Balong	3.538	0	0.000	7.465	6	0.804	+0.804
Lucia	2.590	0	0.000	17.22	11	0.639	+0.639
Merotai	5.963	13	2.180	9.854	24	2.436	+0.256

Table 8: Average aerial indexes determined from ground Recce walks and drone transects

On average, ground surveys detected 2.36 nests/km vs 1.98 nests/km for drone surveys. 71% of aerial transects detected zero nest vs 33% of ground surveys. A site-level paired t-test reveals a significant difference between the two methods (ground vs. drone): $t = 5.673$, $p < 0.05$. Ground surveys consistently detected more nests than drone surveys across sites in Tawau Hill NP. However, we also find a moderate to strong correlation ($r=0.978$) between methods at the site level (Figure 9).

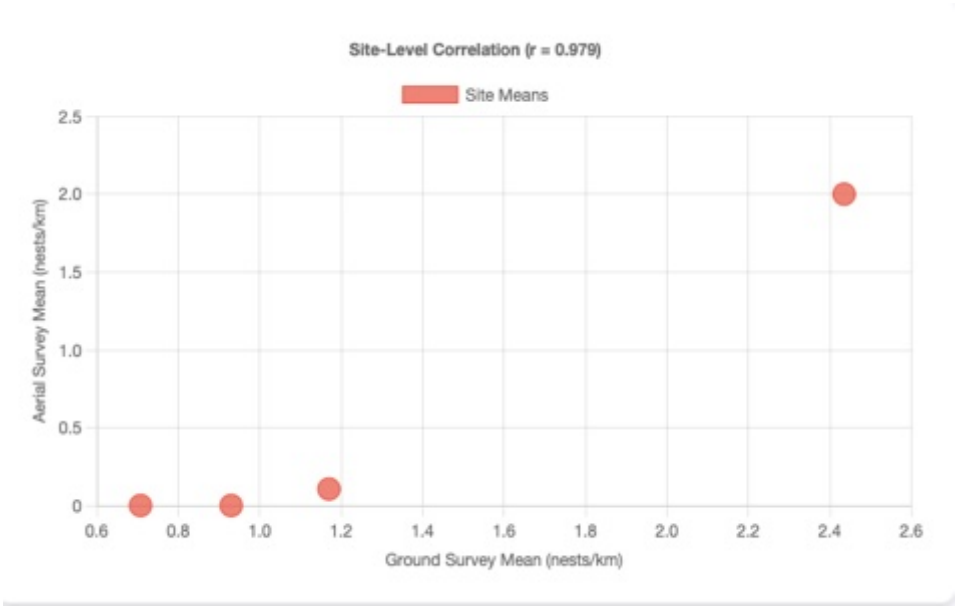


Figure 9: Correlation between aerial and ground km indexes at four different sites

Due to the small sample size of this dataset, we cannot draw a firm conclusion yet. Indeed, we investigated only four different sites in Tawau Hill NP for both drone and ground aerial indexes. However, it appears that aerial surveys with drones may be suitable for rapid assessment in high orangutan density areas, but less reliable in moderate to low-density sites.

One of the outputs of the entire MPOGCF project will be to combine the results of all field expeditions to develop (if possible) a statistical model that will enable the estimation of orangutan nest abundance from drone transects and/or ground recce walks.

Figure 10: Detecting an orangutan with a drone's thermal imagery.

Lastly, the team also used the drone to fly randomly above the canopy during the day to conduct reconnaissance flights. We did not record the distance flown during these flights but reported all GPS locations of any sighting of interest.

In Andrassy, the team recorded the following species over three days of flying:

08.07.25 (1 flight: 20:41 to 21:01):

- Sun bear sleeping on its nest (N 04375384 – E117986726)
- 2 Sambar deer walking

09.07.25 (2 flights):

- Flight nb 1 (17:06 to 17:55 hours):
  - 1 group of 3 sambar deers
  - 2 groups of red leaf monkeys
- Flight nb 2 (20:30 to 21:01 hours):
  - 2 sightings of sambar deer (2 individuals and one individual)
  - 1 individual pig-tailed macaque
- **1 orangutan sleeping in its nest, close to the station (N4375719 – E117985528)**

10.07.25 (3 flights):

- Flight nb 1 (17:22 to 17:42 hours)
  - **2 orangutan nests**
  - Sun bear in its nest (N 4377052 – E117984455)
- Flight Nb 2 (17:43 to 18:02 hours):
  - 2 sambar deer
  - 1 pig-tailed macaque
- Flight nb 3 (20:53 to 21:33 hours):
  - 1 red leaf monkey sleeping
  - 2 sun bears moving and walking in the OPP (21:10 hours)

In Balung, the team carried out random flights on the 09th-10th and July 14th to investigate the presence of orangutan signs at the edge of the forest and within surrounding oil palm plantations:

09.07.25: 1 flight of about 1 km: nothing.

10.07.25: 1 flight to survey a small forest island in nearby oil palm plantations: nothing.
14.07.25: 2 flights over the area up to 1.5 km away from the Balong substation

- Flight nb 1 (17:22 to 18:03 hours):
  - **Detection of one orangutan feeding on tree bark (N 4480550 – E 118057015) at 17:32 pm.**
- Flight nb 2 (18:21 to 18:37 hours): nothing

3. Results of Rapid Forest Assessments:

3.1. Forest structure

The teams completed a total of 84 botanical plots during fieldwork: Table 8.

Area	Nb of plots	Nb of trees	DBH (cm)					Average Score (from 0 to 3)		
			20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers
Andrassy	12	351	242	60	21	13	15	1.53	2.61	2.22
Balong	14	176	50	79	41	6	0	1.5	1.8	2.0
Bombalai	25	732	374	274	84	0	0	2.9	1.18	2.0
Lucia	16	466	189	123	66	29	49	1.85	1.95	1.33
Merotai	17	409	219	60	96	34	0	1.23	2.54	2.46
Total	**84**	**2,124**	**1,074**	**596**	**308**	**82**	**64**			

Table 8: number of plots and composition for each survey site

We recorded a total of 2,124 trees with a Dbh>20 cm, belonging to a minimum of 31 tree families and 58 genera: Table 9.

The Dbh Class 20-30cm class represented 51-69% of trees across all sites. Large trees (>50cm) were rare, ranging from 0% to 16.7%. A coefficient Variation analysis for each class shows a high variability for large trees between sites (CV>100%), a moderate variability for mid-size classes and a lower one for smaller classes (CV

about 45-55%), which is to be expected in midly-distubed tropical forests. Dbh distribution are not independent between study areas (Chi-square = 1087.29; p>0.05), showing that each site has a different distribution of tree sizes. For example, Bombalai and Lucia have a completely different forest structure than other sites: figure 10.

Bombalai and Balong showed characteristics of younger and more disturbed forests with heavy dominance of small trees (20-40cm Dbh), mostly belonging to pioneer genera. Lucia presented the characteristics of a mature forest with the highest proportion of large trees (16.7% >50cm Dbh) mostly belonging to the Dipterocarp family (see details of the plots in Annex III). Andrassy and Merotai showed a mixed-age structure, but larger trees were identified in Andrassy. Within our plots, Bombalai has the highest tree density (29.3 trees/plot) suggesting active regeneration, and Balong the lowest density (12.6 trees/plot). As expected, all locations are heavily skewed toward smaller diameter classes (20-30cm dominant in most areas). But it is worth noting that three locations (Balong, Bombalai, Merotai) completely lack trees >60cm Dbh, showing a more disturbed status. Lucia and Andrassy are the only sites with large mature trees (>60cm). Balung showed a strong presence of medium-sized trees (green), and Merotai with a more balanced spread across multiple size classes

Figure 11: Percentage of Tree Dbh distribution at five survey areas.

3.2 Forest composition

The Dipterocarapaceae trees dominate forest composition at the five study areas (Figure 12). Genera belonging to climax species with a widespread distribution included Dipterocarpaceae (Shorea, Parashorea, Dryobalanops and Dipterocarpus), Diospyros, Lithocarpus, Eusideron zwagerii (these two last genera being widespread but uncommon). The commonest pioneer trees identified in the plots were Macaranga, Duabanga, Neolamarckia,

and Pterospermum: these trees characterize forest disturbance. These trees are commonly used by orangutans as source of food or for nesting.

A chi-square analysis reveals striking differences in family composition between sites (Chi-square = 1644.42, $p<0.01$). However the cohort of non-identifed trees limits the value of the composition (especially Lucia, although most of non-identifed trees presumably belong to the Dipterocarpaceae family as well). Despite family dominance (Dipterocarpaceae), Bombalai has the most diverse family composition. However, Balung shows a more balanced composition compared to other sites. Andrassy in the contrary shows a relative abundance of Euphorbiaceae, genera indicative of forest disturbance

		Andrassy	Balung	Bombalai	Lucia	Merotai
Achariaceae	Hydnocarpus			20		
Annacardiaceae	Gluta	2	3	1		
	Koordersiodendron		1			
	Dracontomelon			1		
Aquifoliaceae	Ilex cymosa	1				
Bombaceae	Durio			1		
Burseraceae	Canarium			4		
Combretaceae	Terminalia	1				
Chrysobalanaceae	Maranthes		1			
	Parinari		3			
Glusiaceae	Garcinia			1		1
Dilleniaceae	Dillenia	1				10
Dipterocarpacae	Dipterocarpus	5		104	4	14
	Dryobalanops	8	2	107	53	36
	Hopea			25	7	
	Parashorea	7	9	108	38	27
	Shorea	38	41	292		41
	Vatica	8				1
Ebenaceae	Diospyros	2	6	10	1	10
Euphorbiaceae	Macaranga	90		2	2	6
	Mallotus					1
Erythoxylaceae	Erythroxylum cuneatum			8		3
Fabaceae	Parkia			1		
	Sindora			8		
	Excelsia kompassa					1
Fagaceae	Lithocarpus	4	2	2	5	3
	Milletia			2		
Lauraceae	Eusideroxylon zwagerii		1	5	1	9
	Litsea			1		
Lecythidaceae	Planchonia vallida			1		2
Lythraceae	Duabanga moluccana	1	10		1	2
	Sonneratia	5				
Malvaceae	Heritiera			1		

	Scaphium macropodum			3		
Melastomataceae	Memecylon levigatum					2
Moraceae	Artocarpus					1
	Ficus					2
Myrtaceae	Syzigium	2				
	Eugenia			1		
Myristicaceae				1		
Phyllanthaceae	Baccaurea			2		
	Cleisthantus megacarpus			3		5
	Glochidion borneensis				2	
Polygalaceae	Xanthophyllum		1			22
Rubiaceae	Nauclea	3	3			
	Neonauclea					4
	Neolamarckia cadamba	2	37		3	21
Sapindaceae	Dimocarpus			1		
	Paranephelium					1
	Pometia pinnata					7
Sapotaceae	Madhuca				1	
Simaroubaceae	Irvingia			2		
Sterculiaceae	Pterospermum		22	8		28
Tetramelaceae	Octomeles	1	9			13
Unknown		169	23		338	130
	Trapikal	1	2			6
	Katalis daun halus			2		
	Kubin			3		
	Togob			1		

Table 9: List of tree families and genera identified in botanical plots

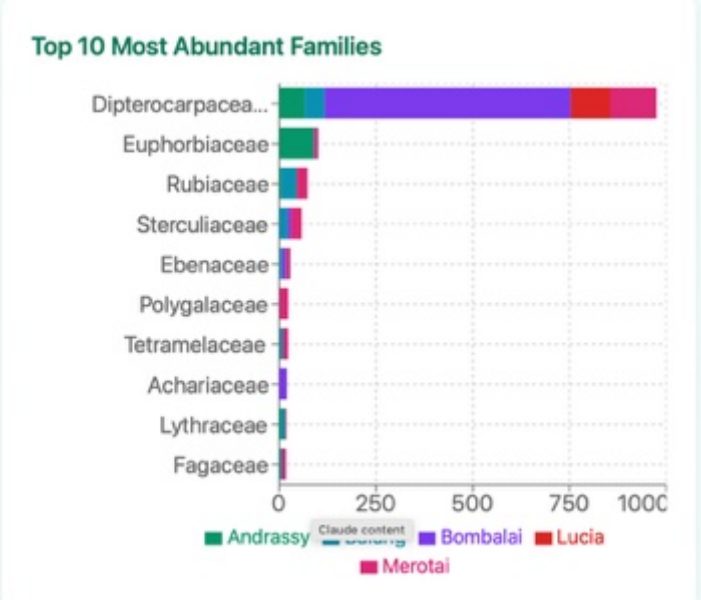


Figure 12: Most abundan tree famlies identified in the botanical plots at five survey areas

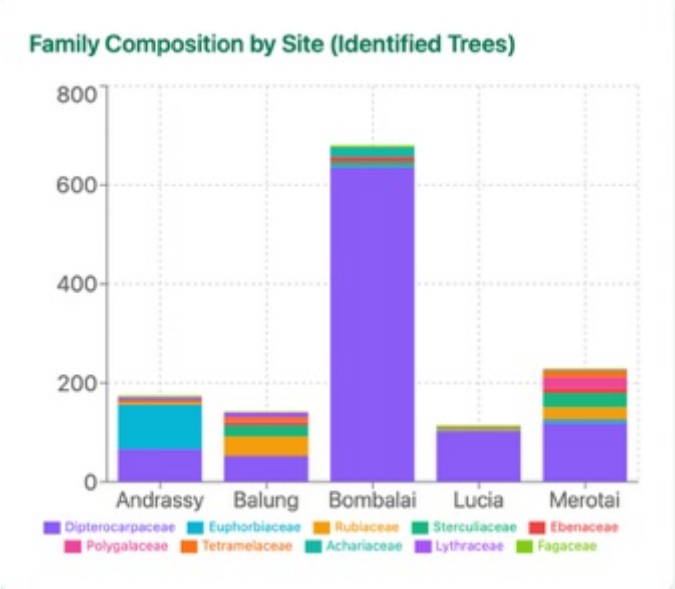


Figure 13: Tree family composition at five study areas

	Andrassy	Balung	Bombalai	Lucia	Merotai
Dipterocarpaceae	66	52	636	102	119
Ebenaceae	2	6	10	1	10
Euphorbiaceae	90	0	2	2	7
Fagaceae	4	2	4	5	3
Rubiaceae	5	40	0	3	25
Sterculiaceae	0	22	8	0	28

Table 10: Contribution of the six commonest tree families in the botanical plots for five study areas

We now compare Dipterocarp trees (that are not a favorite food source for orangutans except during mass fruiting seasons, which happen once every few years only) and five families that are part of the regular orangutan diet: Table 10. The ratio "Dipterocarpaceae:Others" ranges from 0.65:1 (Andrassy) to 19.88:1 (Bombalai) - a 30-fold difference: Figure 14. A chi-Square shows highly significant difference between Dipterocarps vs other families at the five sites (Chi-suare = 398.14, df=4, $p<0.01$). This indicates that the relative abundance of Dipterocarps compared to other families is not uniform and varies a lot between sites. Bombalai, Lucia and Merotai shows dipterocarp dominance, while Balung and Andrassy show a more uniform distribution.

All these sites represent different forest types. Bombalai appears to be a lowland dipterocarp forest, while Balung and Andrassy show more mixed forest characteristics with greater family diversity. Sites with lower dipterocarp ratios (Andrassy, Balung) may characterize disturbed areas where pioneer species (Euphorbiaceae, Sterculiaceae) are more abundant.

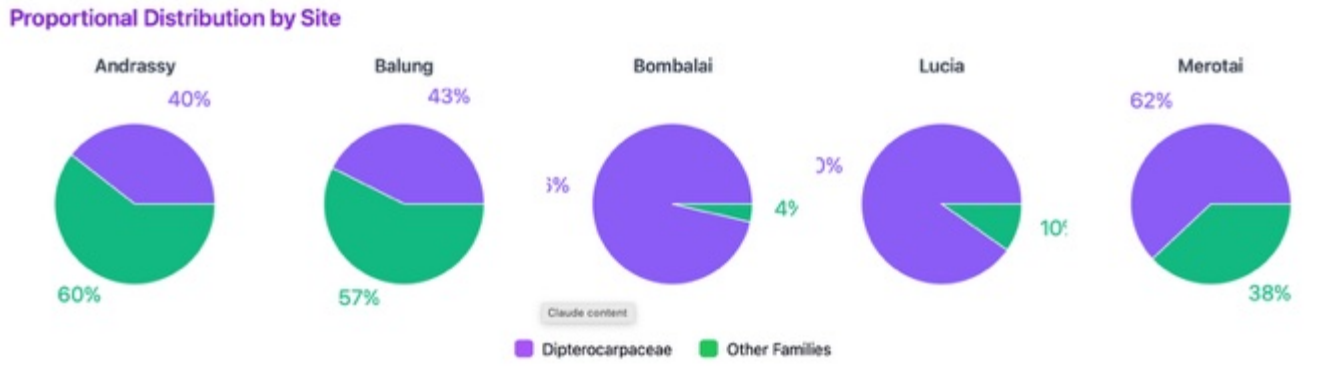


Figure 14: propotional distribution of trees identified in the botanical plots at five survey areas: Dipetrocarps vs 5 families of food trees for orangutans

Table 8 above shows the average scores for canopy closure, small trees and climbers at all the botanical plots assessed at the five survey areas. Balong and Merotai present the lowest average score, indicating that some parts of the forest were open, reflecting a more disturbed forest structure at these two sites. Small trees are widespread among the plots, in Andrassy and Merotai in particular. Climbers also present relatively high score, above the 2 value, except in Bombalai.

The Orangutan nest kilometrix indexes were higher at Andrassy and Merotai, two sites characterized by a more diverse forest not dominated by Dipterocarp trees and with a significant number of small trees (compared to large ones). Both of these sites are also populated with tree genera that are prime orangutan food sources, which may provide an underlying reason for our findings.

Conclusions about orangutan surveys

Overall, we found orangutan nests at all five survey locations, demonstrating that the species is widespread across Tawau Hill NP. We also detected two orangutans during drone surveys, one in Balung and another in Andrassy.

Nests tended to be slightly more common in areas bordering the edges of the NP. However, despite our extensive search efforts, the teams did not record any signs of orangutan activity within oil palm plantations bordering the forest. This finding indicates that, unlike in Kinabatangan and other sites, orangutans in Tawau Hill NP tend to remain inside the protected forests and have not yet penetrated nearby oil palm plantations.

Overall, we observed fewer nests within the interior of Tawau Hill NP (Lucia) than at other sites. It appears that orangutans are predominantly distributed in forests that are more diverse than dipterocarp-dominated areas. This result was expected given orangutan preference for lowland areas with diverse tree composition.

However, since there is no statistical difference between sites, we estimate the overall mean kilometric index for the entire Tawau Hill NP to be 1.10 nests/km (SD=0.77 nests/km). Although we cannot derive a density estimate from linear kilometric indices obtained from recce walks, based on results from previous expeditions, we can hypothesize that the overall orangutan density across Tawau Hill NP approximates 0.1 to 0.2 orangutans/km², or fewer than 50 individuals for the entire NP. **Although this number will be refined at the end of the current project when all data have been analyzed, we can already conclude that Tawau Hill NP is home to a significant orangutan population, a result worth emphasizing given the paucity of data available about orangutans in this NP.**

Often, the nests we detected were clumped together, suggesting seasonal use of resources. Orangutans will spend several days at the same site when food sources are available (ripe fruits) before moving to another location in the forest. Our interviews with local park staff reinforced this finding, as people in many areas reported that orangutan presence fluctuates seasonally according to fruit availability at the site.

In conclusion, Tawau Hill NP is home to a resident orangutan population. With climate change, we can expect orangutans and other wildlife species to move toward higher elevation forests. Keeping Tawau Hill NP connected with other lowland forest areas inhabited by orangutans is a conservation priority to allow orangutans living outside the NP to migrate in when forest changes begin to occur as a result of climate change.

Annex I: Brief Specifics of the Field Expedition carried out in Tawau Hill NP

Location: Tabin Wildlife Reserve (West and South West border)
Substations: HQ Bombalai, Balung, Andrassy, Merotai

Date: 07.07.2025 to 16.07.2025 (2 travel days, 8 working days)

Staff involved:

- Hartiman Bin Abdul Rahman, OURS, Hutan
- Suhaimi Bin Bahrani, OURS, Hutan
- Azli Bin Etin, OURS, Hutan
- Herman Bin Suali, OURS, Hutan
- Mohd Daisah Bin Kapar, OURS, Hutan
- Waslee Bin Maharan, OURS, Hutan
- Bahrani Bin Elahan, OURS, Hutan
- Muhd Azizi Sulaiman Bin Bahrani, OURS, Hutan
- Muhammad Asim Addin Bin Zainal Abidin, OURS, Hutan
- Khairul Mizan Bin Johry, OURS, Hutan
- Vhielcey Villey, OURS, Hutan
- Hardiman bin Abdul Rahman, OURS, Hutan
- Mohd Faisal bin Asmara, OURS, Hutan
- Hamisah bin Elahan, OURS, Hutan
- Rusiman bin Rukimin, OURS, Hutan
- Eddie bin Ahmad, WSP, Hutan
- Hasbollah bin Sinyor, WSP, Hutan
- Mahathir bin Ratag, WSP, Hutan
- Ahmad Sapie bin Kapar, WSP, Hutan
- Azman bin Abdullah, WSP, Hutan
- Selamat bin Suali, WSP, Hutan
- Mohammad Fazdhil bin Ormat, WSP, Hutan
- Muhammad Hasraf bin Hasbollah, WSP, Hutan
- Mohd Fazlee bin Sarathy, WSP, Hutan
- Amanda Shia Kang Ping, WSP, Hutan
- Rahadi Edwan bin Halid, PANGI, Hutan
- Johari bin Junaidi, PANGI, Hutan
- Sabah Parks: Roslie Hamid, Andy Martin, Jalumin Sipail, Aeril Amputong, Marcell Odin, Ajirulla Jatulah, Aidi Lairy, Rosley bin Hamid, Frederick Gansau, Mitun Jay, Charles Embon, Mohd Ibnu Abdullah bin Nordin, Jasnam Lumuk

Adjacent area type: Oil palm plantations

Team composition *(K: Car driver D; Drone Pilot)*

Team 1 Stesen Balung (Bukit Pyramid)

- **Ketua:** Mohd Suhaimi bin Bahrani
- **Ahli:** Khairul Mizan bin Johry; Bahrani bin Elahan (K); Mahathir bin Ratag (D); Azman bin Abdullah (D)
- **Kenderaan:** SJK6450

Team 2 Substesen Andrassy

- **Ketua:** Hamisah bin Elahan
- **Ahli:** Vhielcey Villey; Mohammad Azizi Suhaiman Bin Bahrani; Mohd Daisah bin Kapar; Ahmad Sapie bin Kapar; Mohd Fazlee bin Sarathy
- **Kenderaan:** SAA8499X

Team 3 Stesen Bombalai

- **Ketua:** Waslee bin Maharan

- **Ahli:** Muhammad Asim Addin Bin Zainal Abidin; Rusiman bin Rukimin; Johari bin Junaidi; Hasbollah bin Sinyor; Mohd Fazdhil bin Ormat; Mohammad Hasraf bin Hasbollah; Shia Kang Ping Amanda
- **Kenderaan:** SAB5992K

Team 4 Substesen Merotai
- **Ketua:** Mohd Faisal bin Asmara
- **Ahli:** Hardiman bin Abdul Rahman; Eddie bin Ahmad (DK); Selamat bin Suali (D)
- **Kenderaan:** SYQ5651

Team Drone Substesen Andrassy & Gunung Lucia
- **Ketua:** Hartiman bin Abdul Rahman (D)
- **Ahli:** Azli bin Etin; Herman bin Suali; Rahadi Edwan bin Halid

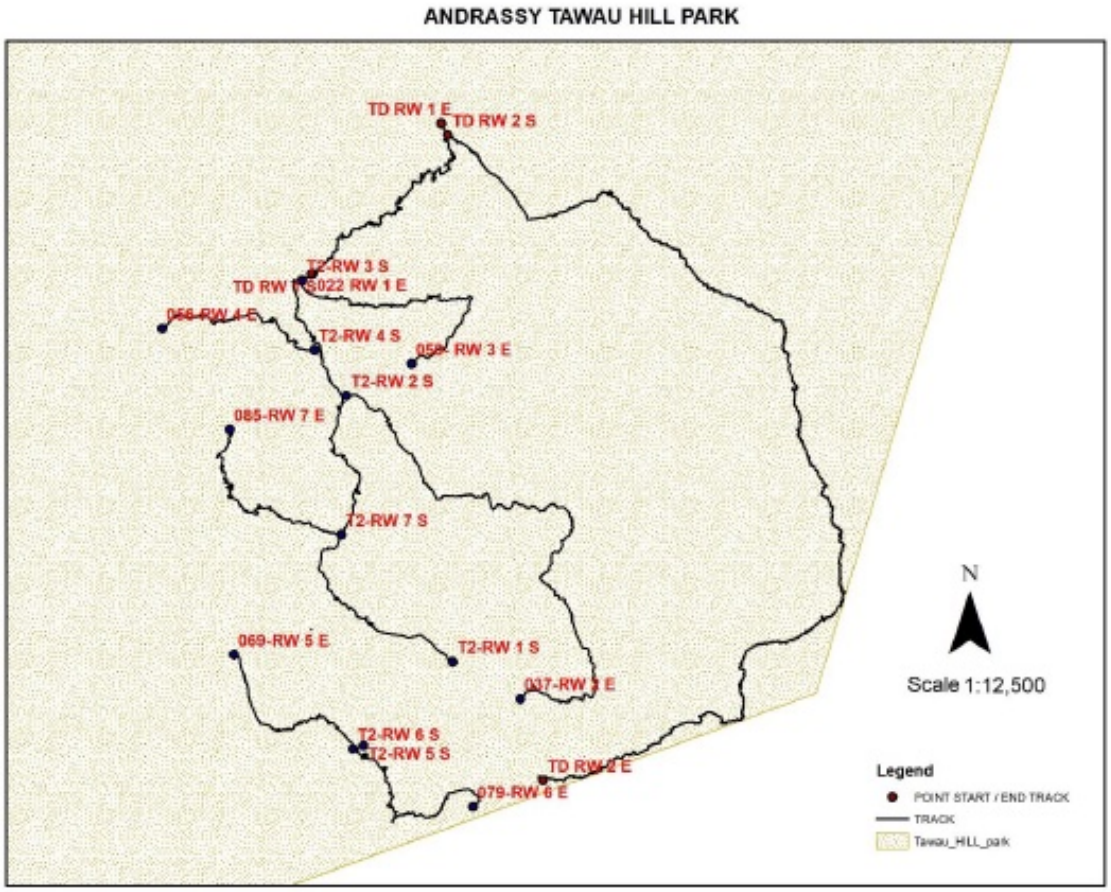
Work timeline

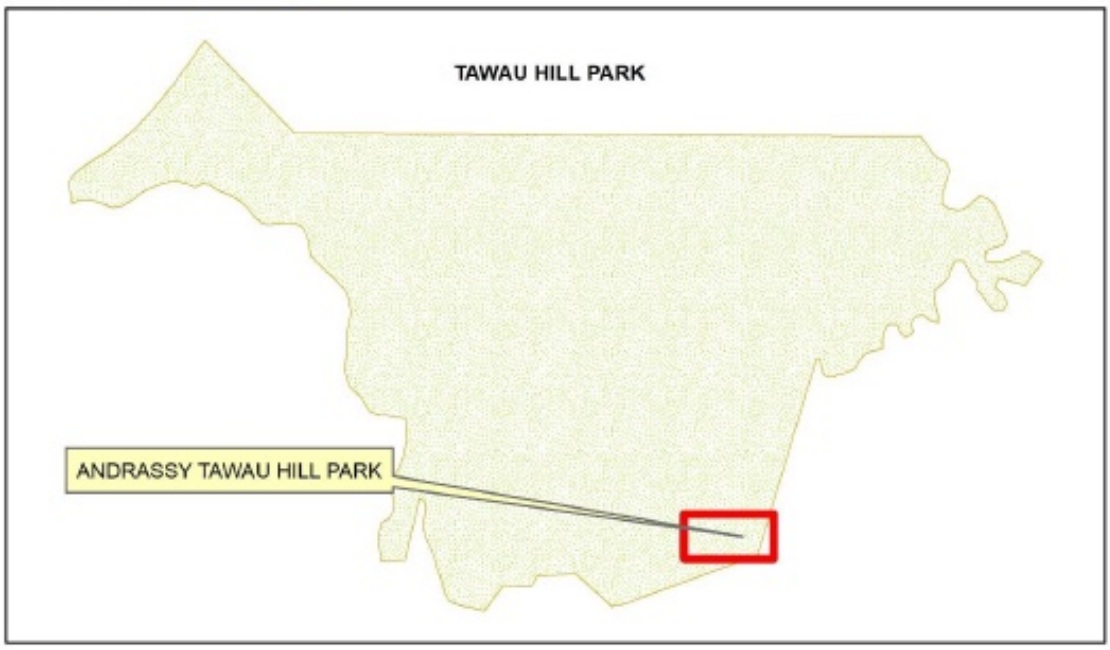
07.07.2025 - At 8:00 am, the OURS and WSP teams gathered at the OURS office and began loading all equipment into the cars and departed for Tawau Hills Park. The team arrived in the evening and assembled at the Tawau Hills Park hall. At 8:00 pm, we gathered together with all our teams, including WSP, and were joined by several staff members from Sabah Parks to discuss the activities we would conduct and team divisions.

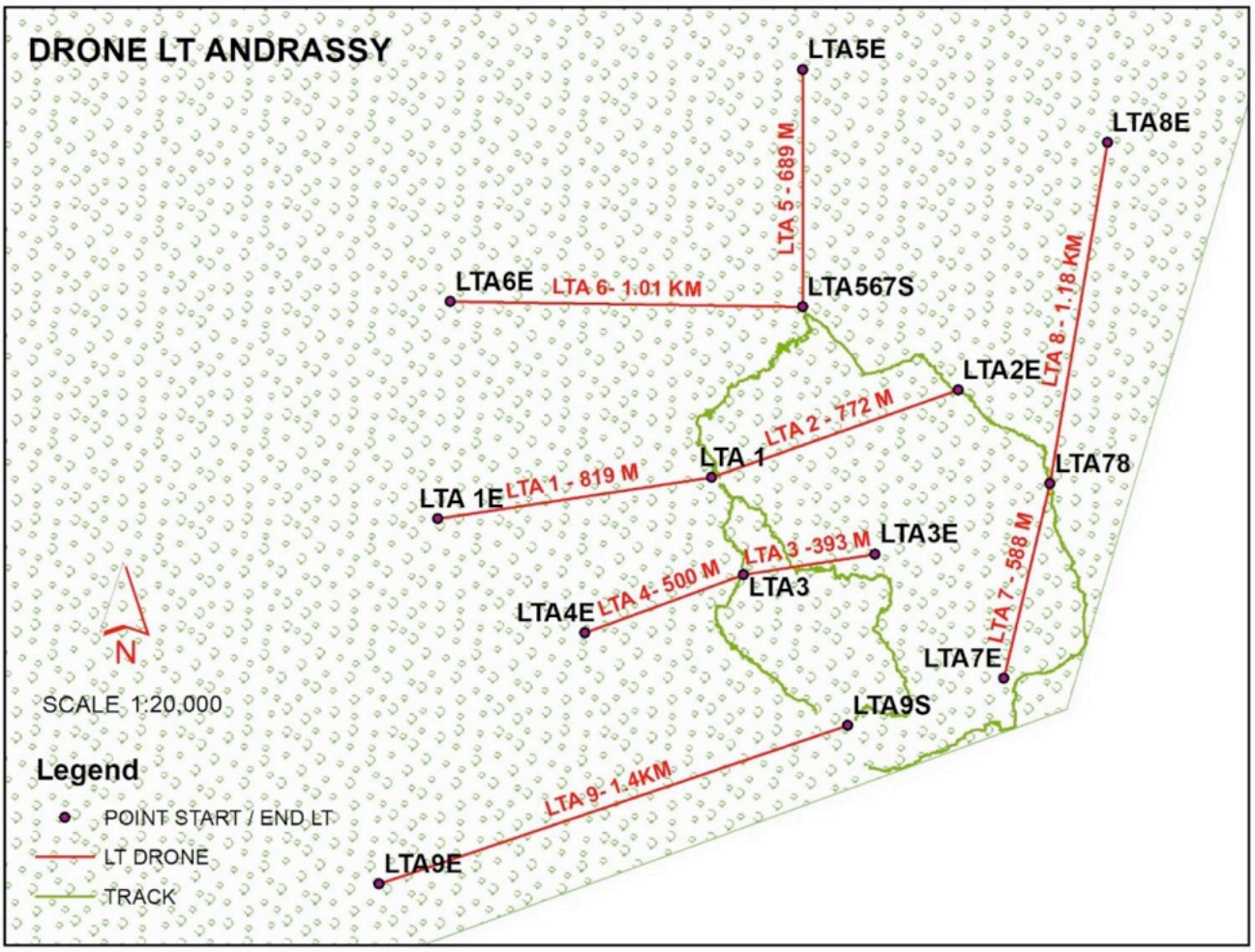
08.07.2025 to 15.07.2025 - Teams were divided into 5 teams: Team Drone, Team Balung, Team Andrassy, Team Merotai, and Team Bombalai. Each team began moving to its respective station or substation and conducted research activities. On 15.07.2025, all teams moved back to gather at the Tawau Hills Park hall. In the evening, we double-checked all the data we had collected and equipment to ensure nothing was left behind.

16.07.2025 - We packed all work equipment and personal belongings into the cars. After ensuring no equipment/items were left behind, we all departed from Tawau Hills Park back to Kampung Sukau, Kinabatangan.

Annex II: Maps showing the location of various field activities.



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LTA5E
LTA8E
LTA 5 - 689 M
LTA 8 - 1.18 KM
LTA6E
LTA 6- 1.01 KM
LTA567S
LTA2E
LTA 2 - 772 M
LTA 1
LTA78
LTA 1E
LTA 1 - 819 M
LTA3E
LTA 3 -393 M
LTA 4- 500 M
LTA3
LTA4E
LTA 7 - 588 M
LTA7E
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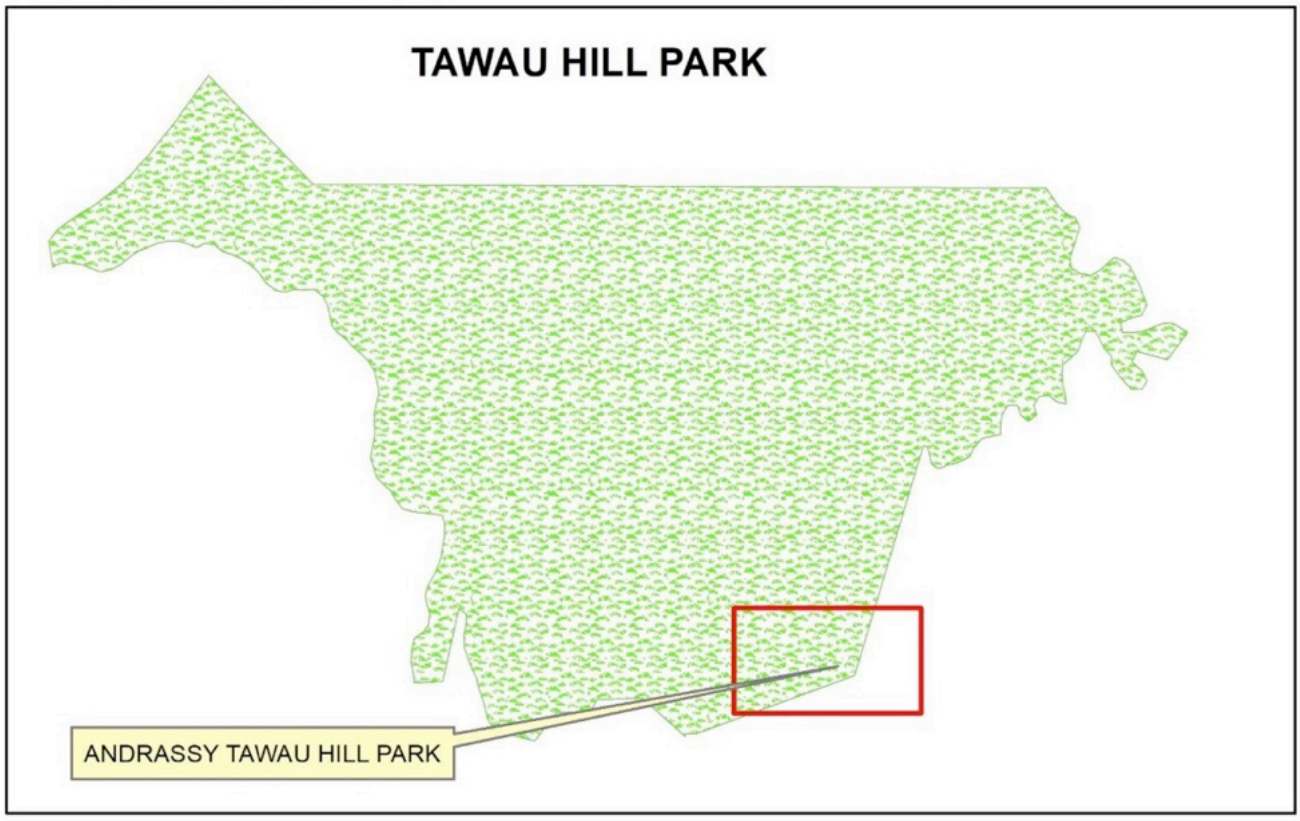
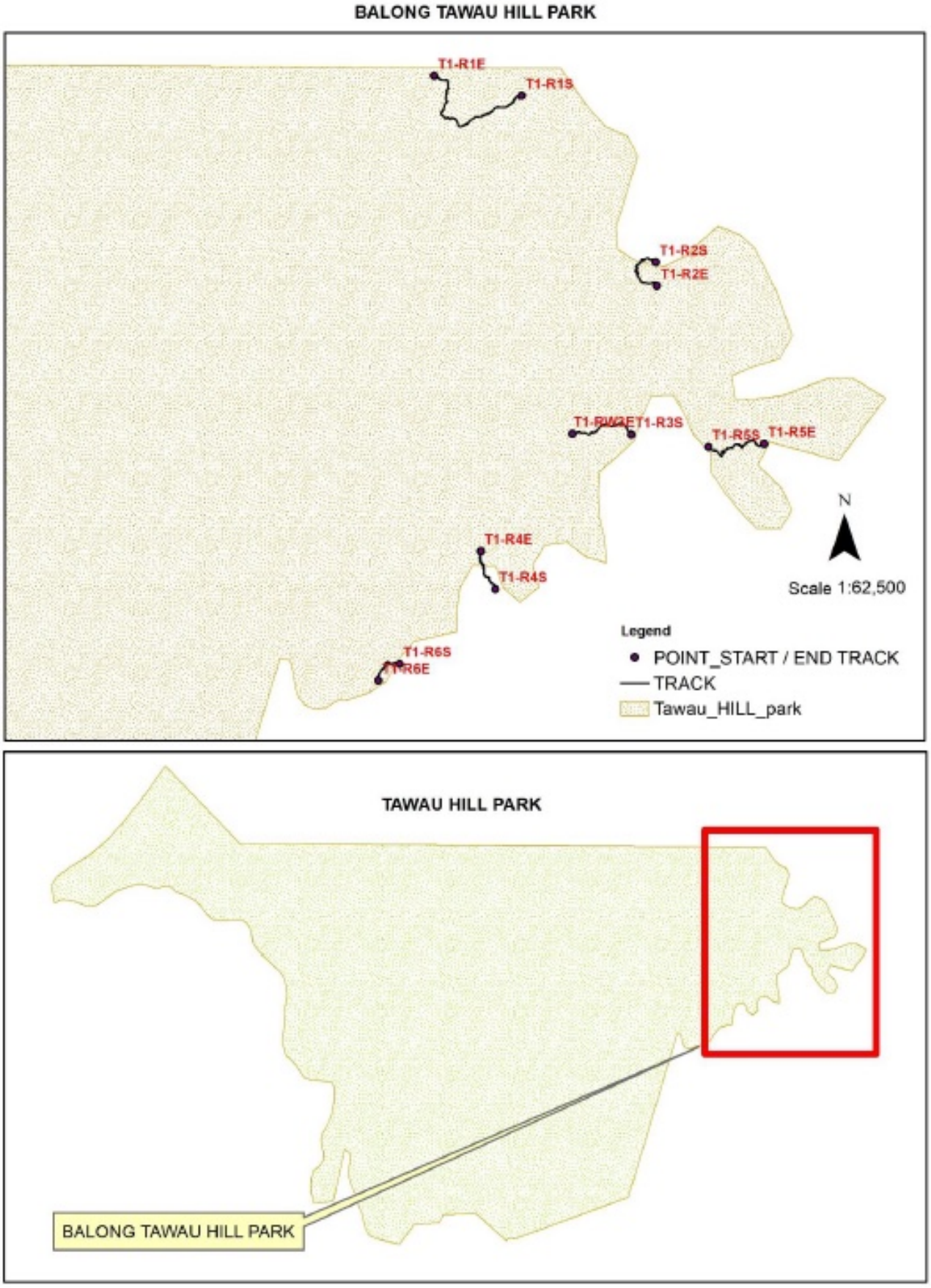
Legend
POINT START / END LT
LT DRONE
TRACK
LTA 9- 1.4KM
LTA9E


TAWAU HILL PARK
ANDRASSY TAWAU HILL PARK


BALONG TAWAU HILL PARK
T1-R1E
T1-R1S
T1-R2S
T1-R2E
T1-R3S
T1-R5S
T1-R5E
T1-R4E
T1-R4S
T1-R6S
T1-R6E
N
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POINT_START / END TRACK
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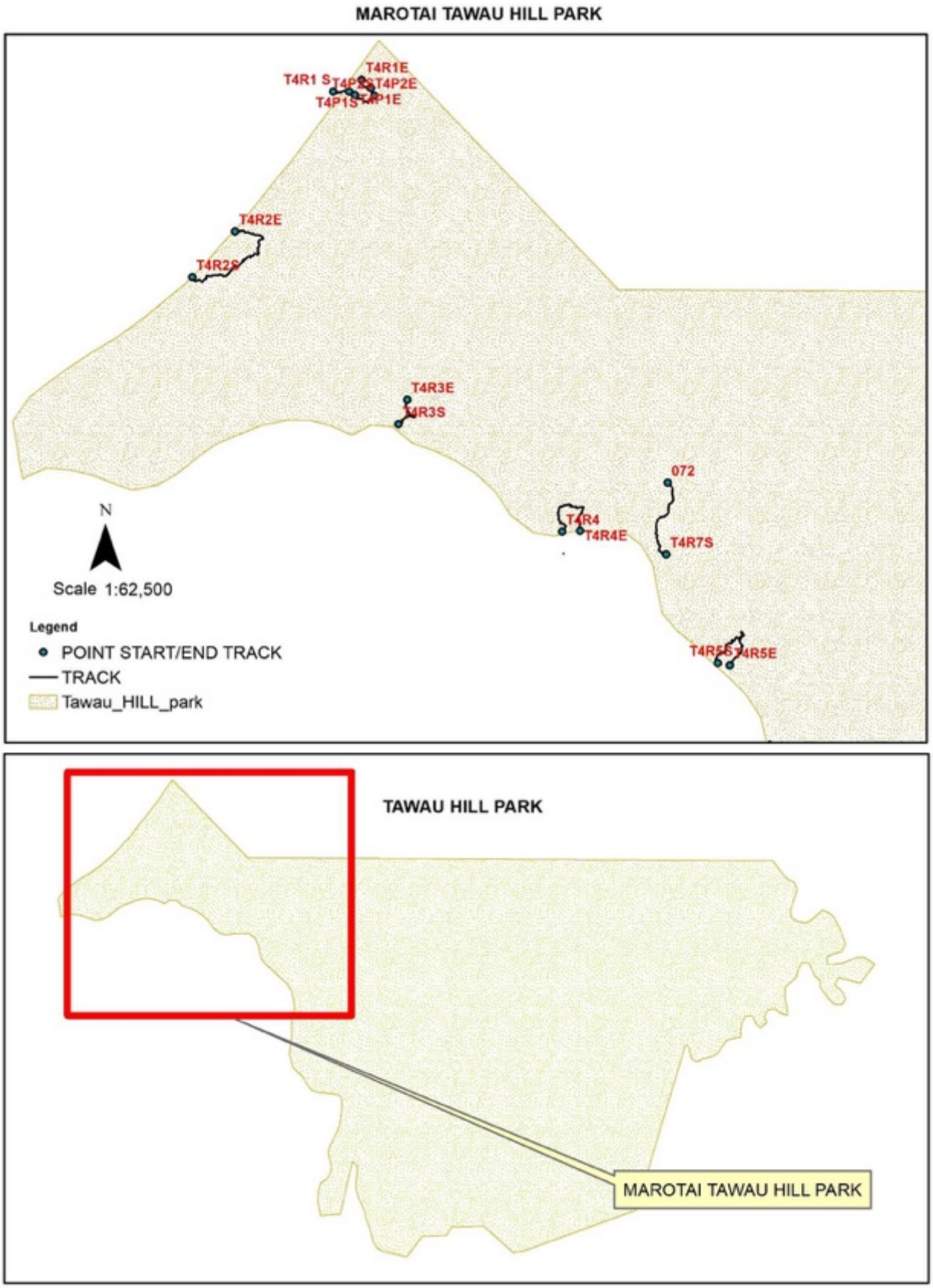
Tawau_HILL_park
TAWAU HILL PARK
BALONG TAWAU HILL PARK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T4P2E
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T4P1E
T4R2E
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T4R3S
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T4R5S
T4R5E
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POINT START/END TRACK
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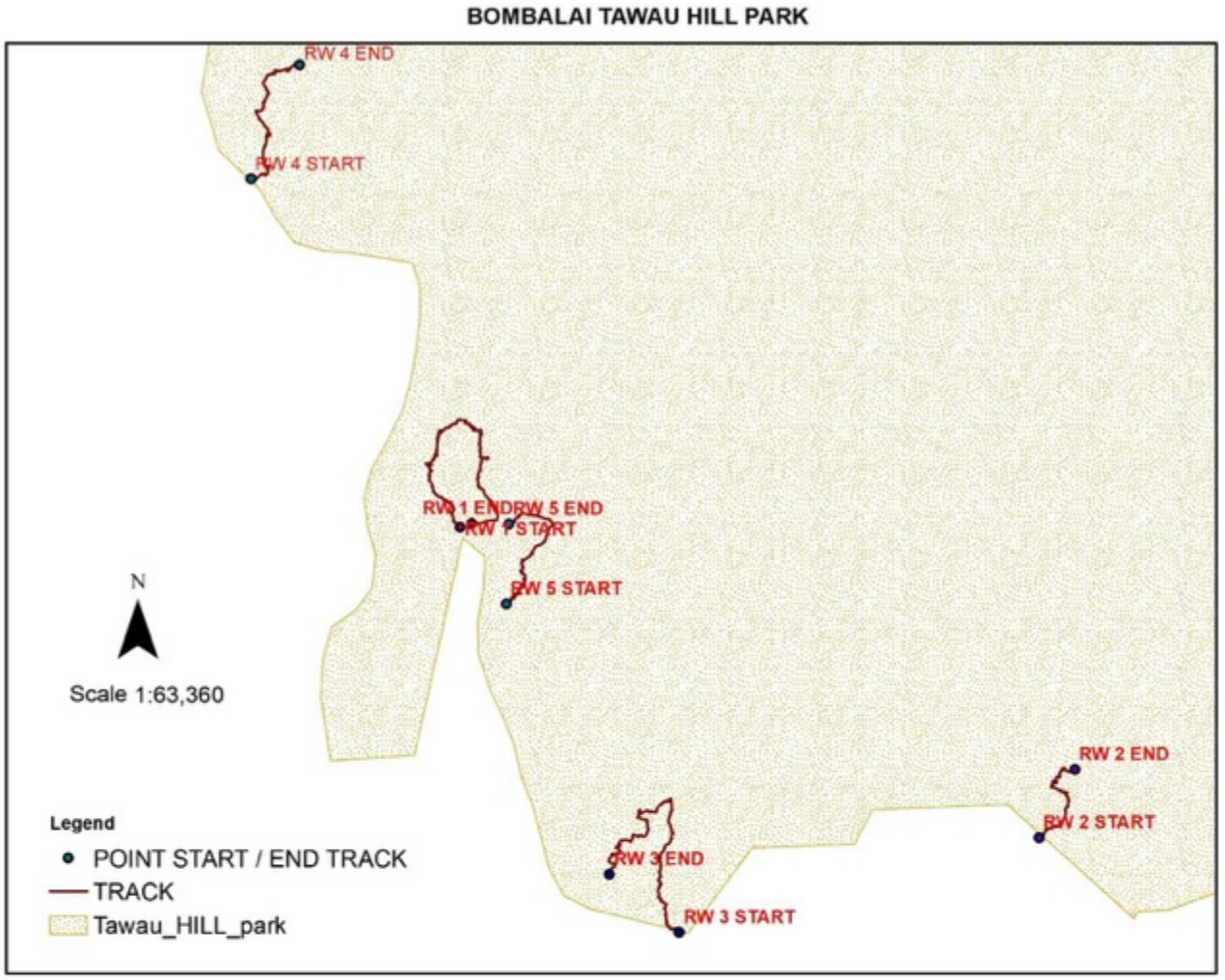
TAWAU HILL PARK
MAROTAI TAWAU HILL PARK


BOMBALAI TAWAU HILL PARK
RW 4 END
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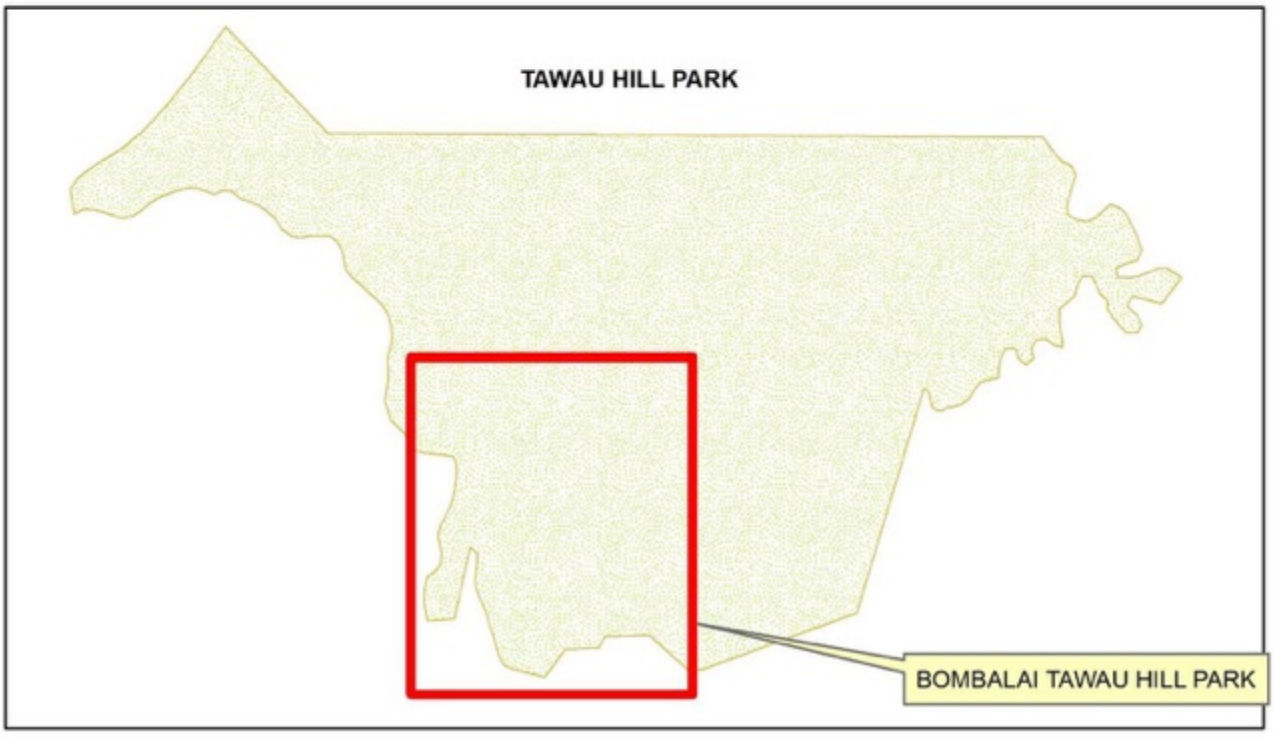
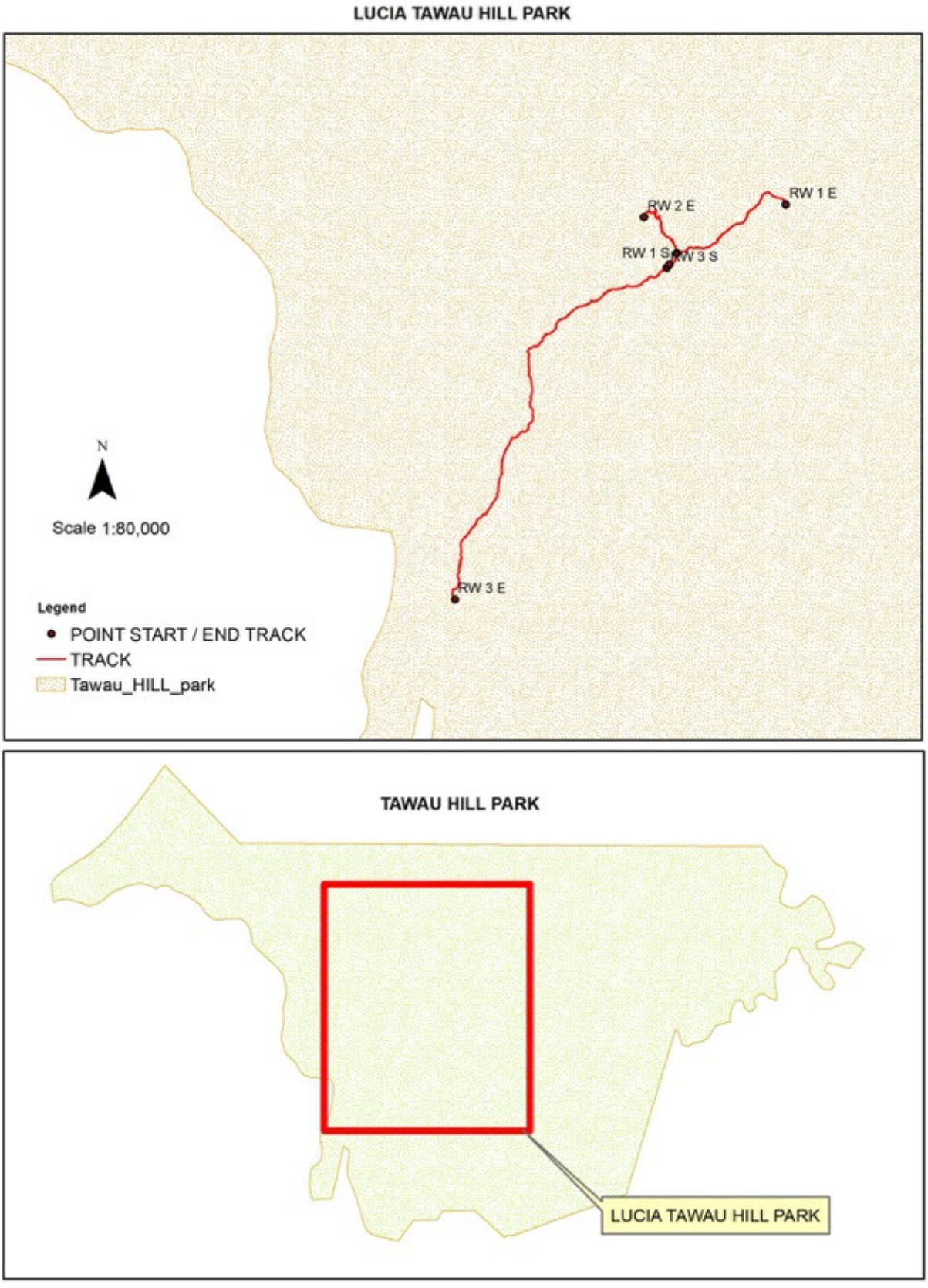
RW 1 END
RW 5 END
RW 1 START
RW 5 START
N
Scale 1:63,360
RW 2 END
RW 2 START
RW 3 END
RW 3 START
Legend
POINT START / END TRACK
TRACK
Tawau_HILL_park


TAWAU HILL PARK
BOMBALAI TAWAU HILL PARK


LUCIA TAWAU HILL PARK
RW 2 E
RW 1 E
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Scale 1:80,000
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Tawau_HILL_park
TAWAU HILL PARK
LUCIA TAWAU HILL PARK

Annex III: Composition of Botanical Plots during recce walks and orangutan surveys

- Andrassy (12 plots)

Plot	Tree species	DBH (cm)					Score (from 0 to 3)			Comments	
		20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers		
WP 04-06 T2-RW1-P1 09.07.25	Parashorea sp.	2								Hilly – Dry Many seedlings	3 OU nests along RW
	Vatica sp.	2	1								
	Dipterocarpus sp.		1								
	Unknown	13	5								
	Gluta sp.	1									
	Lithocarpus sp		1								
	Terminalia catappa			1			2	3	3		
WP 09-12 T2-RW1-P2 09.07.25	Unknown	38	15	1	3					Ridge top – Dry Many seedlings	
	Dryobalanops sp.			1							
	Lithocarpus sp.	1									
	Shorea sp.		1				2	3	1		
WP 18-19 T2-RW1-P3 09.07.25	Dryobalanops sp.	2								Ridge top - Flat – Dry 1 Kapur merah>100cm dbh Many seedlings	
	Shorea sp.	8	2	3							
	Unknown	15	7	1	1		2	3	2.66		
Plot 1 WP 25-27 09.07.25	Unknown	18	4	4						Hilly – Dry (bit wet)	1 OU nest along RW
	Shorea sp.	2	1	1		1					
	Sonneratia sp.		1								
	Parashorea. Sp.				1	1	2	2	1		
Plot 2 WP 29-30 09.07.25	Unknown	15	1	1	1	2				Hilly - Dry	
	Dipterocarpus sp.	2								Hilly – Dry Follow an old loggng road	
	Dryobalanops. sp				1	2					
	Shorea sp.				1	2					
	Parashorea. Sp.			1	1		2	3	3		
Plot 3 WP 34-35 09.07.25	Shorea sp.		1	1		4				Hilly – Dry Lot of large trees but canopy is open	
	Unknown	8		1	1						
	Lithocarpus sp.				1	1					
	Dryobalanops sp.					1					
	Dipterocarpus sp.			1							
	Parashorea. Sp.				1		1	2	2		
T2-RW3-P1 WP 39-44 10.07.2025	Vatica sp.		5							Hilly – Dry Many seedlings 1 OU nest	4 OU nests along RW
	Sonneratia. Sp.	4									
	Unknown	2									
	Shorea sp.	1	2		1						
	Nauclea sp.	1									
	Syzygium sp.			1			2	3	2		
T2-RW3-P2	Shorea sp.					1				Wet – Semi hilly	

WP48-49 10.07.25	Unknown	9									
	Shorea sp.			2			2	3	2.33		
WP 52-53 T2-RW4-P1 11.07.25	Shorea sp.		1							Hilly – Dry Many seedlings Degraded forest with a lot of gingers and climbers	No OU nest
	Dyospyros sp.	1	1								
	Dryobalanops sp.		1								
	Ilex cymosa		1								
	Dipterocarpus sp.		1								
	Unknown		1	1							
	Tropikal	1									
	Glua sp.	1					1	3	3		
WP 63-66 T2-RW5-P1 12.07.25	Macaranga sp.	30								Hilly – Dry Old logging road Degraded – many pioneer trees Open canopy	1 OU nest along RW
	Neolamarckia cadamba		1								
	Octomeles sumatrana		1								
	Duabanga mollucana		1				0.33	1	1.33		
T2-RW6-P1 WP 75-77 13.07.25	Shorea sp.	1								Hilly – Dry Degraded forest Many seedlings and bushes	No OU nest
	Macaranga gigantea	30									
	Macaranga. sp.	30					1	2.33	2.33		
T2-RW7-P1 WP 84-85 14.07.25	Nauclea sp.	1	1							Flatish – Dry Degraded forest Rattan, ginger ++ OU food +	No OU nest
	Syzygium sp.	1									
	Shorea sp.	1									
	Neolamarckia cadamba		1								
	Dillenia sp.	1									
	Unknown		1				1	3	3		

Total	**242**	**60**	**21**	**13**	**15**	**1.53**	**2.61**	**2.22**	**Total Nb trees: 351**	

- Balung (14 plots)

Plot	Tree species	DBH (cm)					Score (from 0 to 3)			Comments	
		20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers		
T1-P1 WP T1P1S – T1P1E 09.07.25	Shorea sp.		2		2					Degraded forest A lot of climbers and open areas OU Food +	1 OU nest along RW
	Pterospermum sp.	1	1			1					
	Duabanga moluccana		2	2	1						
	Ranggu		1								
	Unknown		1		2						
	Neolamarckia cadamba		4	1							
	Octomeles sumatrana		1				1	1	3		
T1-P2 WPT1P2S-T1P2E 09.07.25	Octomeles sumatrana	1	1	2						Degraded forest along the river Many pioneer species	
	Laran	1	2	2							
	Bayur		1	3							

	Magas		1	2						Larger trees away from the river	
	Seraya			2			1	1	3		
T1-P3 WP T1P3S – T1P3E 09.07.25	Parashorea	1								Degraded and open forest A lot of pioneers	
	Shorea		2								
	Neolamarckia	3									
	Duabanga mollucana	2									
	Pterospermum	2					1	1	2		
T1-P4 WP T1P4S – T1P4E 09.07.25	Pterospermum	2		1						Degraded and open forest A lot of pioneers	
	Octomeles	2	1								
	Neolamarckia	1	1								
	Shorea	1	2				1.3	1.3	2		
T1-P5 WPT1P5S – T1P5E 09.07.25	Unknown		2							Degraded and open forest A lot of pioneers	
	Parinari sp.	1		2							
	Unknown		2	1							
	Neolamarckia cadamba		1								
	Octomeles		1				1	1.3	2		
T1P1D2 WP T1P1D2S – T1P1D2E 10.07.25	Shorea		5							Dry and hilly forest Large trees away from the RW	2 OU nests along RW
	Neolamarckia	2									
	Parashorea	2	2								
	Unknown	2	2				2	3	2		
T1P2D2 WP T1P2D2S – T1P2D2E 10.07.25	Dyospyros	1	1							Dry and hilly Many small trees OU Food +	
	Gluta		2	1							
	Neolamarckia		3	1							
	Pterospermum		1	1							
	Shorea		3	2			2	3	2		
T1P1D3 WP T1P1D3S – T1P1D3E 11.07.25	Pterospermum	1								Degraded forest Few large trees Open areas OU Food +	No nest
	Shorea			2							
	Unknown	1					1	3	3		
T1P2D3 WP T1P2D3S – T1P2D3E 11.07.25	Trapikal	1	1							Flat and dry Disturbed forest Many small trees Open areas OU food +	
	Unknown		1	1							
	Laran		1								
	Seraya		1	1			2	2	1		
T1P1D4 WP T1P1D4S – T1P1D4E 12.07.25	Unknown	1	3	1						Lot of small trees and climbers Large trees away from RW	2 nests along RW
	Dryobalanops	1			1						
	Neolamarckia		2				2	2	1		
T1P2D4 WP T1P2D4S T1P2D4E 12.07.25	Nauclea		2	1						Dry and hilly Many small trees and climbers Ou food+	
	Neolamarckia		1	2							
	Pterospermum		1	2			2	2	1		
T1P1D5 WP T1P1D5S – T1P1D5E 13.07.25	Neolamarckia		3							Dry and hilly Many small trees and climbers OU food ++	1 nest along RW
	Xanthophyllum	1									
	Eusideroxylon zwagerii		1								

	Maranthes corymbosa	1									
	Shorea	1		1							
	Pterospermum	1	1								
	Unknown			1			1.3	1	1		
T1P2D5 WP T1P2D5S – T1P2D5E	Shorea	2	3	2						Disturbed forest Many small trees	
	Unknown	1									
	Parashorea		1								
	Neolamarckia cadamba	2	2				1.6	2	2.3		
T1P1D6 WP T1P1D6S – T1P1D6E 14.07.25	Neolamarckia	2								Hilly and dry OU food +	No nest
	Pterospermum	2									
	Shorea	2	5	2							
	Parashorea	2	1								
	Dyospyros	2		2							
	Lithocarpus	1	1				1.6	2	2.3		
Total Trees – Average scores		**50**	**79**	**41**	**6**	**0**	**1.5**	**1.8**	**2.0**	**Tot. Nb trees: 176**	

- Bombalai (25 plots)

Plot	Tree species	DBH (cm)					Score (from 0 to 3)			Comments	
		20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers		
Plot 1	Shorea	5	3							Nice forest – rather closed canopy – Flat and dry	Tpotal of 3 OU nests observed along the RW
	Diospyros	2									
	Cleistanthus megacarpus	3									
	Dryobalanops sp.	2	3								
	Hydnocarpus sp.	3									
	Shorea	2									
	Canarium sp.	1									
	Milletia sp.	2									
	Parashorea	1	2								
	Dipterocarpus	3					3	2	1.6		
Plot 2	Parashorea	3	2							Nice forest with closed canopy – Hilly and dry	
	Hydnocarpus sp.	3									
	Shorea	6	4	2							
	Baccaurea sp.	1									
	Garcinia parviflora	1									
	Dryobalanops sp.	3	4								
	Eusideroxylon zwageri	1									
	Dipterocarpus	4	**2**				3	2	2		
Plot 3	Parashorea	2								Nice forest with closed canopy – Hilly and dry –	
	Baccaurea sp.	1									
	Myristicacea	1									

	Dipterocarpus		1	1						OU food: gnetum dll	
	Dryobalanops sp.	4	2								
	Dipterocarpus	3	3								
	Gluta sp.	1									
	Dracontomelon sp.		1								
	Eusideroxylon zwagerii		1				3	2	2		
	Shorea	6	3	2						Nice forest with closed canopy – Hilly and dry –	
	Pou kijang		1								
	Dipterocarpus	2									
	Dimocarpus longan	1									
	Hydnocarpus sp.	1									
	Dipterocarpus	3									
	Sindora. Sp.		1								
Plot 4	Parashorea		1				3	1	2.6		
	Parashorea	3	1							Nice forest with closed canopy – Hilly and dry	
	Dipterocarpus	2		1							
	Shorea	4	3								
	Macarangga sp.	2									
	Sindora. Sp.	2									
	Planchonia valida		1								
Plot 5	Diospyros	1					3	1	2		
	Parashorea	3	2	3						Nice forest with closed canopy – Hilly and dry	1 OU nest along RW (900 m)
	Dipterocarpus	1	2								
	Canarium sp.	2									
	Shorea	5	5	1							
	Shorea	2	1								
Plot1b	Diospyros	2					3	1	2		
	Parashorea	2	3	2						Nice forest with closed canopy – Hilly and dry	
	Dipterocarpus	4	2								
	Shorea	4	2								
	Pterospermum sp.	4									
	Diospyros	2									
	Dungun	1									
Plot 2b	Shorea			1			3	1	2		
	Shorea	1								Nice forest with closed canopy – Flat and dry	
	Dryobalanops sp.	1	2								
	Shorea	4	2	1							
	Parashorea	5	4	4							
Plot 3b	Pterospermum sp.	3	1				2	1	2		
	Dipterocarpus	2	2							Nice forest with closed canopy – Hilly and dry	No OU nest
	Majau	1									
	Shorea	3	2	1							
Plot 1c	Dryobalanops sp.	1	2	1							

	Shorea	3	1	2							
	Hopea	1	1	3							
	Durio	1									
	Shorea		1								
	Canarium sp.		1				3	1	2		
	Shorea	5	4	1						Nice forest with closed canopy – Hilly and dry – Many small size tree recuits	
	Dryobalanops sp.	3	3		1						
	Shorea	1	1								
Plot 2c	Dipterocarpus	1	2				3	1	2		
	Dryobalanops sp.	2	1	1						Nice forest – Large trees – Dry – Ridge top	
	Dipterocarpus	1									
	Shorea	4	4	1							
	Petai	1									
	Parashorea			1							
	Shorea	1	1								
	Hydnocarpus sp.		1								
Plot 3c	Shorea	4	**2**	1			3	1	2		
	Dryobalanops sp.	3	2	1						Flat and dry – Ridge top – large trees	
	Shorea	6	7	2							
	Dipterocarpus	4	2	1							
	Hydnocarpus sp.	1									
	Shorea	4	4								
Plot 4c	Erythroxylum cuneatum		2	1			3	1	2		
	Shorea	1	3							Flat and dry – Ridge top – Large trees – Closed canopy	
	Sindora. Sp.		2								
	Erythroxylum cuneatum	4	1								
	Shorea	4	3	1							
	Dryobalanops sp.	3	2	1							
	Shorea	1	2								
Plot 5c	Dipterocarpus	3					3	1	2		
	Shorea	4	2	1						Hilly Dry – Close to a river – Nice forest -Large trees and closed canopy	
	Shorea	3	2								
	kapur	2	4	1							
	Dipterocarpus	2	1								
	Hydnocarpus sp.	4	2								
	Kubin	3									
Plot 6 c	Hopea	2	**4**				3	1	2		
	Shorea	4	2	2						Hilly Dry – Close to a river – Nice forest -Large trees and closed canopy	
	Dipterocarpus	2	1								
	Dryobalanops sp.	2	3	1							
	Hopea	2	4								
	Hydnocarpus sp.	2	3								
Plot 7c	Shorea	3	1								

	Parashorea	2	**3**	2			3	1	2		
	Dipterocarpus	3	3	1						Hill – Dry – Ridge Top – Large trees and closed canopy	4 OU nests (all clustered at 1620 m)
	Shorea	5	5	2							
	Shorea	3	2								
	Dryobalanops sp.	1	2	1							
Plot 1d	Parashorea	2	3	3			3	1	2		
	Dipterocarpus	5	4	2						Hill – Dry – Ridge Top – Large trees and closed canopy	
	Scaphium macropodum		2								
	Dryobalanops sp.	2	3								
	Shorea	4	5								
	Parashorea	2	1								
Plot 2d	Katalis daun halus		1				3	1	2		
	Shorea	3	2	1						Hill – Dry – Ridge Top – Large trees and closed canopy	
	Dryobalanops sp.	2	1								
	Shorea	5	2								
	Eusideroxylon zwagerii	2									
	Dryobalanops sp.	3	4								
	Parashorea	2	3	1							
	Scaphium macropodum		1								
Plot 3d	Litsea. Sp.	1					3	1	2		
	Shorea	3	2	2						Hill – Dry – Ridge Top – Large trees and closed canopy	
	Parashorea	2	3	3							
	Shorea	3	1								
	Dipterocarpus	3	2								
	Hopea	1	3	2							
Plot 4d	Dryobalanops sp.	2	3				3	1	2		
	Parashorea	2	3	2						Hill – Dry – Ridge Top – Large trees and closed canopy	
	Dipterocarpus	3	1								
	Shorea	1	2								
	Diospyros	1									
	Shorea	4	3	3							
Plot 5D	Dryobalanops sp.	2	4	3			3	1	2		
	Dipterocarpus	3	1							Flat – Dry – Ridge top – Large trees – Closed canopy	No OU nest
	Shorea	2	1								
	urat mata	2	4								
	Katalis daun halus		1								
	seraya	2	3								
	Eugenia. Sp.	1									
	Dryobalanops sp.	2	2								
Plot 1E	Pou kijang	1					2.3	1	2		
	Dipterocarpus	4	3							Hill – Dry – Ridge top – Large trees – Closed canopy	
Plot 2E	Dryobalanops sp.	4	3								

	Eusideroxylon zwagerii	1									
	Shorea	1	1								
	Shorea	3	1								
	Hopea	2									
	Togob		1								
	Sindora. Sp.		**1**				3	1	1.6		
	Shorea	4	2	2						Hill – Dry – Ridge top – Large trees – Closed canopy – Ficus and Gnetum (fruits)	
	Shorea	3	2								
	Parashorea	1	3	2							
	Diospyros	2									
Plot 3E	Dipterocarpus	3	2				3	1	2		
	Parashorea	2	1	3						Hill – Dry – Ridge top – Large trees – Open canopy following large tree fall	
	Dipterocarpus	3	1								
	Shorea	2									
	Shorea	3	2	2							
Plot 4E	Shorea		3	2			2.6	1	2		
	Dipterocarpus	3	2							Flat – Dry – Close to a river – Closed canopy and large trees	
	Dryobalanops sp.	2									
	Shorea	3	3	2							
	Shorea		2								
	Parashorea	4	2	1							
Plot 5E	Lithocarpus	2					3	2.6	2		
Tot. trees – Average score		**374**	**274**	**84**			**2.9**	**1.18**	**2.0**	**Tot. nb trees: 732**	

- Lucia (16 plots)

Plot	Tree species	DBH (cm)					Score (from 0 to 3)			Comments	
		20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers		
Plot 1L	Glochidion borneensis		1		1					Hilly – Dry – Canopy semi-open based on kartz and along a river OU food: + (Uncaria, Diospyros, Buak2)	5 OU nests Old logging signs – Dry and tall forest Along a river OU food: Ficus, macaranga, gnetum
	unknown	1		3							
	Shorea	2		1		3					
	unknown				1						
	Dryobalanops				2						
	Eusideroxylon zwagerii				1						
	Parashorea				1		2	2	2		
Plot 2L	Macaranga	2								Top ridge – Dry- Follows an old logging road – Disturbed forest with small pioneer trees Ou food: ++ (Ficus)	
	Neolamarckia	3									
	Duabangga moluccana	1					0	2	1.5		
Plot 1La	Hopea					4 >100				Hill – Dry – Closed canopy and large to very	2 OU nests – Dry and tall forest

	Dipterocarpus		4							large trees (4>100cm Dbh) OU food: Ficus, Mempening	OU food: mempening, Ficus, kerodong
	Unknown	2	5	2							
	Shorea		1		1	2	2.6	2	2		
Plot2La	Hopea		1	1						Hilly – Dry – Top ridge – Closed canopy	
	Shorea			3		2					
	Dryobalanops			1	4						
	Lithocarpus		1								
	unknown	12	3	3			1.6	2	1.3		
Plot 3La	Dryobalanops		1		2	10				Hilly – Dry – Top ridge – Closed canopy	
	Shorea			1		6					
	unknown	21	3	8	3		2	2	1		
Plot 4la	unknown	23	14	10	1	4	2	2	1	Dry – Hill	
Plot5La	unknown	23	18	5						Dry – Hill – Ridge top – Many small trees – Closed canopy	
	Shorea			1							
	Hopea			1			2	2	1		
Plot 1Lb	unknown	7	17	1	1	1				Hill – Dry – large trees	1 OU nest
	Shorea				2	1					
	Dryobalanops		2			3	2.3	2	1		
Plot2Lb	unknown	9	15			2				Hill – Dry – large trees – Closed canopy	
	Lithocarpus		1								
	Dryobalanops		2	5	4	1					
	Shorea		3	1			1	1	1		
Plot3Lb	unknown	11	3			1				Hill – Dry – large trees – Closed canopy	
	Dryobalanops		1			2	2	2	2		
Plot 1Lc	Dryobalanops		1	4		1				Hill – Dry – large trees – Closed canopy	1 OU nest
	unknown	4	5	2							
	Diospyros		1								
	Shorea			1							
	Madhuca sp.			1			2.6	2.6	1		
plot 2Lc	unknown	15	5			1				Hill – Dry – large trees – Closed canopy	
	Dryobalanops			1	1	1					
	Shorea			1			1.3	1.3	1		
Plot 3LC	Dryobalanops		1			1				Hill – Dry – Nice forest but also small trees and canopy semi-closed	
	unknown	6	4	1	1		2	2	1.3		
Plot 4LC	unknown	12		2		2				Hill – Dry – large trees – Closed canopy	
	Dryobalanops										
	Lithocarpus	1									
	Shorea					1					
	Parashorea				2		2.3	2.3	1.6		
Plot 5LC	unknown	14	2							Hill – Dry – large trees – Closed canopy	
	Dryobalanops		1		1		2	2	1.6		
Plot 6LC	Parashorea			2							

	unknown	20	5	4						Hill – Dry – Nice forest but also small trees and canopy semi-closed	
	Lithocarpus		2				2	2	1		
Tot. trees – Average score		**189**	**123**	**66**	**29**	**49**	**1.85**	**1.95**	**1.33**	**Tot. nb trees: 456**	

- Merotai (17 plots)

Plot	Tree species	DBH (cm)					Score (from 0 to 3)			Comments	
		20-30	30-40	40-50	50-60	>60	Canopy	Small trees	Climbers		
T4P2	Parashorea			6						Old logging signs – Open canopy – many pioneer and recruits, climbers OU food: ++	5 OU nests OU food: ++
	Dryobalanops			6							
	Shorea		1								
	Unknown	9									
	Unknown	5									
	Eusideroxylon zwagerii	4									
	Erythroxylum cuneatum			3							
	Duabanga moluccana	1									
	Neolamarckia cadamba			3			1	3	3		
T4P1	Shorea				3					Hill – Dry - large trees but many recruits, climbers ++ OU food: + (Spatholobus)	
	Dryobalanops				3						
	BAYUR	3	1								
	Parashorea	3		1							
	Dipterocarpus			1							
	Trapikal			1			1	2	3		
P3R2	Shorea	1								Hill – Dry Canopy open in many places – Msny small trees OIU food: +	No OU nest
	Parashorea	2	2								
	neolamarckia cadamba	2	2								
	Eusideroxylon zwagerii	2	3								
	Octomeles sumatrana			1							
	Dryobalanops			1							
	Unknown	3									
	Unknown	4					1	3	3		
Plot 4	Shorea			4						Hill – Dry – Closed canopy – Large trees OU food: +	
	Parashorea			5							
	Dryobalanops			5							
	Vatica	1									
	Dipterocarpus			1							
	Garcinia parviflora	1									
	Unknown	4									
	Unknown	2									

	Unknown	3					1	2	1		
Plot 2	Duabanga moluccana	1								Hill – Dry - Degraded forest – Open canopy	
	Unknown		5								
	Unknown	3									
	Unknown	2									
	Unknown			1							
Plot 1	Pterospermum	9	1							Semi-inundated – Open canopy – Close to a river – Pterosermum ++	
	Clesitanthus megacarpus	2									
	Octomeles sumatrana		2								
	Planchonia valida	1									
	Neonauclea	1									
Plot 13L6	Macaranga	2								Flat – Dry – Close to river -Few large trees – Climbers ++	7 OU nests
	Octomeles sumatrana			3							
	neolamarckia cadamba		4								
	Planchonia valida		1								
	Shorea		4								
	Pterospermum		5								
	Unknown	3									
	Unknown	4									
Plot1L4	Pterospermum	3		4						Flat – Dry – Many small trees – Open canopy – Degraded forest – 2 OU nests OU food: ++	
	Shorea	4	2								
	Macaranga			4							
	Trapikal			4							
	neolamarckia cadamba		2								
	Octomeles sumatrana			2							
	Dryobalanops			2							
	Unknown	7									
	Unknown	6					0	3	3		
Plot2L4	Dipterocarpus		2							Hill – Dry – Many small trees – Open canopy – Degraded forest OU food: ++	
	Octomeles sumatrana				3						
	Trapikal		1								
	neolamarckia cadamba			6							
	Unknown	6									
	Unknown	6									
	Lithocarpus	3					0	3	3		
Plot1RW6	Xanthophyllum	10								Hill – Dry – Many small trees – Climbers ++	13 OU nests
	Diospyros	5									
	Shorea			4							
	Dryobalanops			4							
	Unknown	6									
	Unknown	6									

	Unknown	7									
	Unknown		6				2	3	3		
Plot 2RW6	Ficus					1				Hill – Dry – Closed canopy – Large trees	
	Dipterocarpus				5						
	Dryobalanops				3						
	Pometia pinnata	2									
	Diospyros	2									
	Octomeles sumatrana	2									
	Parashorea				2						
	Unknown	9									
	Unknown		3								
	Unknown			3			1	2	2		
Plot3RW6	Shorea				3					Hill – Dry – Closed canopy – Large trees – Climbers + OU food: +	
	Dryobalanops				2						
	Diospyros	3									
	Unknown	2									
	Unknown	2									
	Unknown	3					2	2	1		
Plot1RW6	Shorea			3						Hill – Dry – Closed canopy – OU food: +	
	Memecylon laevigatum	2									
	Artocarpus			1							
	Membuakat	1									
	Parashorea										
	Dipterocarpus					1	2	2	3		
Plot2RW5	Dryobalanops			4						Hill – Dry – Semiclosed canopy and many small trees	
	Shorea			5							
	Parashorea		4								
	Paranephelium	5									
	Xanthophyllum	4									
	Pometia pinnata	5									
	Dillenia	4									
	Unknown	4									
	Unknown			4			1	3	3		
Plot3R2R5	Ficus	1								Hill - Dry	
	Pterospermum	1									
	Mallotus	1									
	Shorea		1								
	Parashorea		1				2	2	2		
2 L7	neolamarckia cadamba		2							Hill - Dry	3 OU nests
	Shorea		1								
	Excelsa lompassia					1					
	Dillenia	6									

	xanthophyllum	3									
	Parashorea		1								
	Dryobalanops	1									
	Pterospermum	1					2	3	2		
1L7	Clesitanthus megacarpus	3								Hill - Dry	
	Neonauclea		3								
	Dipterocarpus			4							
	Shorea				5						
	Dryobalanops				5						
	Xanthophyllum	5									
Tot. trees -Average score		**219**	**60**	**96**	**34**		**1.23**	**2.54**	**2.46**	**Tot. Nb trees: 409**	

i.b Keadaan hutan di kawasan Substesen Balung

Annex IV: List of birds recorded during fieldwork (195 species)

Appendix 1 (List of 195 bird species recorded in Tawau Hills Park from combined methods: MacKinnon List (MKL), Checklist (CL), and Bio-acoustic)

Family	Common Name	Scientific Name	Migratory	IUCN STATUS	Endemism	Merotai	Andrassy	Balung	HQ-Bombalai	Lucia-CL	MKL	Acoustic
ACCIPITRIDAE	Bat Hawk	Macheiramphus alcinus	-	LC	-	-	-	-	-	-	-	Yes
ACCIPITRIDAE	Black Eagle	Ictinaetus malaiensis	-	LC	-	Yes	-	Yes	-	-	Yes	-
ACCIPITRIDAE	Brahminy Kite	Haliastur indus	-	LC	-	Yes	-	-	-	-	Yes	-
ACCIPITRIDAE	Changeable Hawk-Eagle	Nisaetus cirrhatus	-	LC	-	-	Yes	-	-	-	Yes	Yes
ACCIPITRIDAE	Crested Serpent Eagle	Spilornis cheela	-	LC	-	Yes	-	Yes	Yes	Yes	Yes	Yes
ACCIPITRIDAE	Lesser Fish-Eagle	Icthyophaga humilis	-	NT	-	Yes	-	-	-	-	Yes	-
ACCIPITRIDAE	Mountain Serpent Eagle	Spilornis kinabaluensis	-	VU	Yes	-	Yes	-	-	-	Yes	-
ACCIPITRIDAE	Wallace's Hawk Eagle	Nisaetus nanus	-	LC	-	-	Yes	-	-	-	Yes	-
ACCIPITRIDAE	White-bellied Sea-Eagle	Icthyophaga leucogaster	-	LC	-	-	Yes	Yes	-	-	Yes	-
AEGITHINIDAE	Common Iora	Aegithina tiphia	-	LC	-	-	Yes	Yes	-	-	Yes	-
AEGITHINIDAE	Green Iora	Aegithina viridissima	-	NT	-	-	Yes	-	-	-	Yes	-
ALCEDINIDAE	Banded Kingfisher	Lacedo pulchella	-	LC	Yes	-	Yes	-	Yes	-	Yes	Yes
ALCEDINIDAE	Blue-eared Kingfisher	Alcedo meninting	-	LC	-	Yes	-	Yes	-	Yes	Yes	-
ALCEDINIDAE	Collared Kingfisher	Todiramphus chloris	-	LC	-	Yes	-	Yes	-	-	Yes	-
ALCEDINIDAE	Malaysian Blue-banded Kingfisher	Alcedo peninsulae	-	NT	-	-	-	-	Yes	-	Yes	-
ALCEDINIDAE	Rufous-backed Dwarf-Kingfisher	Ceyx rufidorsa	-	LC	-	Yes	Yes	Yes	Yes	-	Yes	-
ALCEDINIDAE	Stork-billed Kingfisher	Pelargopsis capensis	-	LC	-	Yes	-	-	Yes	-	Yes	-
ANHINGIDAE	Oriental Darter	Anhinga mela - gaster	-	LC	-	Yes	-	-	-	-	Yes	-

APODIDAE	Asian Palm Swift	Cypsiurus balasiensis	-	LC	-	-	-	Yes	-	-	Yes	-
APODIDAE	Brown-backed Needletail	Hirundapus giganteus	-	LC	-	-	-	-	-	Yes	-	-
APODIDAE	Silver-rumped Spinetail	Rhaphidura leucopygialis	-	LC	-	-	-	Yes	-	Yes	Yes	-
ARDEIDAE	Black-crowned Night-Heron	Nycticorax nycticorax	-	LC	-	-	-	-	-	-	-	Yes
ARDEIDAE	Gray Heron	Ardea cinerea	Yes	LC	-	-	-	-	-	-	-	Yes
ARDEIDAE	Little Egret	Egretta garzetta	Yes	LC	-	Yes	-	-	-	-	Yes	-
BUCEROTIDAE	Black Hornbill	Anthracoceros malayanus	-	VU	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BUCEROTIDAE	Bushy-crested Hornbill	A - rrhinus galeritus	-	NT	-	-	Yes	Yes	Yes	Yes	Yes	Yes
BUCEROTIDAE	Helmeted Hornbill	Rhi - plax vigil	-	CR	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BUCEROTIDAE	Rhi - ceros Hornbill	Buceros rhi - ceros	-	VU	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BUCEROTIDAE	White-crowned Hornbill	Berenicornis comatus	-	EN	-	Yes	Yes	Yes	Yes	-	Yes	-
BUCEROTIDAE	Wreathed Hornbill	Rhyticeros undulatus	-	VU	-	Yes	Yes	Yes	-	-	Yes	Yes
BUCEROTIDAE	Wrinkled Hornbill	Rhabdotorrhinus corrugatus	-	EN	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CALYPTOMENIDAE	Green Broadbill	Calyptomena viridis	-	NT	-	-	-	Yes	-	-	Yes	Yes
CAMPEPHAGIDAE	Black-winged Flycatcher-Shrike	Hemipus hirundinaceus	-	LC	-	-	Yes	-	-	-	Yes	-
CAPRIMULGIDAE	Malaysian Eared Nightjar	Lyncornis temminckii	-	LC	-	-	Yes	-	-	-	Yes	Yes
CISTICOLIDAE	Ashy Tailorbird	Orthotomus ruficeps	-	LC	-	Yes	Yes	Yes	-	-	Yes	Yes
CISTICOLIDAE	Dark-necked Tailorbird	Orthotomus atrogularis	-	LC	-	-	-	-	-	Yes	-	-
CISTICOLIDAE	Rufous-tailed Tailorbird	Orthotomus sericeus	-	LC	-	Yes	Yes	Yes	-	-	Yes	Yes
CISTICOLIDAE	Yellow-bellied Prinia	Prinia flaviventris	-	LC	-	Yes	Yes	Yes	-	-	Yes	Yes
COLUMBIDAE	Asian Emerald Dove	Chalcophaps indica	-	LC	-	Yes	-	Yes	-	-	Yes	Yes
COLUMBIDAE	Green Imperial-Pigeon	Ducula aenea	-	NT	-	Yes	-	-	-	-	Yes	-

COLUMBIDAE	Little Green Pigeon	Treron olax	-	LC	-	-	Yes	-	-	-	Yes	-
COLUMBIDAE	Spotted Dove	Spilopelia chinensis	-	LC	-	Yes	-	Yes	-	-	Yes	-
COLUMBIDAE	Zebra Dove	Geopelia striata	-	LC	-	Yes	-	-	-	-	Yes	-
CORACIIDAE	Dollarbird	Eurystomus orientalis	-	LC	-	-	Yes	-	-	-	Yes	-
CORVIDAE	Black Magpie	Platysmurus atterimus	-	LC	Yes	-	-	-	-	-	-	Yes
CORVIDAE	Bornean Black Magpie	Platysmurus aterrimus	-	NE	Yes	-	Yes	-	-	-	Yes	-
CORVIDAE	Sunda Crow	Corvus enca	-	LC	-	Yes	Yes	Yes	-	-	Yes	Yes
CUCULIDAE	Banded Bay Cuckoo	Cacomantis sonneratii	Yes	LC	-	-	-	-	-	-	-	Yes
CUCULIDAE	Chestnut-bellied Malkoha	Phaenicophaeus sumatranus	-	NT	-	-	-	-	-	-	-	Yes
CUCULIDAE	Chestnut-breasted Malkoha	Phaenicophaeus curvirostris	-	LC	-	-	Yes	Yes	Yes	-	Yes	-
CUCULIDAE	Chestnut-Winged Cuckoo	Clamator coromandus	Yes	LC	-	-	-	Yes	-	-	-	-
CUCULIDAE	Greater Coucal	Centropus sinensis	-	LC	-	-	Yes	Yes	-	Yes	Yes	-
CUCULIDAE	Indian Cuckoo	Cuculus micropterus	-	LC	-	-	Yes	-	-	-	Yes	-
CUCULIDAE	Lesser Coucal	Centropus bengalensis	-	LC	-	Yes	-	-	-	-	Yes	-
CUCULIDAE	Plaintive Cuckoo	Cacomantis merulinus	-	LC	-	-	Yes	Yes	-	Yes	Yes	-
CUCULIDAE	Raffles's Malkoha	Rhi - rtha chlorophaea	-	LC	-	-	Yes	Yes	-	Yes	Yes	-
CUCULIDAE	Short-toed Coucal	Centropus rectunguis	-	LC	-	-	Yes	-	-	-	Yes	-
CUCULIDAE	Square-tailed Drongo-Cuckoo	Surniculus lugubris	Yes	LC	-	-	-	-	Yes	-	Yes	-
CUCULIDAE	Sunda Brush Cuckoo	Cacomantis sepulcralis	-	LC	-	-	-	-	-	Yes	-	-
DICAEIDAE	Crimson-breasted Flowerpecker	Prio - chilus percussus	-	LC	-	-	-	Yes	-	-	Yes	-
DICAEIDAE	Orange-bellied Flowerpecker	Dicaeum trigo - stigma	-	LC	-	-	Yes	Yes	Yes	Yes	Yes	-

DICAEIDAE	Yellow-breasted Flowerpecker	Prio - chilus maculatus	-	LC	-	-	-	-	Yes	-	Yes	-
DICAEIDAE	Yellow-rumped Flowerpecker	Prio - chilus xanthopygius	-	LC	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes
DICRURIDAE	Greater Racket-tailed Drongo	Dicrurus paradiseus	-	LC	-	-	Yes	-	Yes	-	Yes	-
ESTRILDIDAE	Chestnut Munia	Lonchura atricapilla	-	LC	-	Yes	-	Yes	-	-	Yes	-
ESTRILDIDAE	Dusky Munia	Lonchura fuscans	-	LC	Yes	-	-	Yes	-	-	Yes	-
EURYLAIMIDAE	Banded Broadbill	Eurylaimus javanicus	-	NT	-	-	-	-	-	-	-	Yes
EURYLAIMIDAE	Black-and-yellow Broadbill	Eurylaimus ochromalus	-	NT	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FALCONIDAE	White-fronted Falconet	Microhierax latifrons	-	NT	Yes	Yes	-	-	-	-	Yes	-
HEMIPROCNIDAE	Whiskered Treeswift	Hemiprocne comata	-	LC	-	-	Yes	-	-	Yes	Yes	-
HIRUNDINIDAE	Pacific Swallow	Hirundo javanica	-	LC	-	-	Yes	Yes	Yes	-	Yes	-
IRENIDAE	Asian Fairy-Bluebird	Irena puella	-	LC	-	Yes	Yes	-	-	-	Yes	Yes
IRENIDAE	Greater Green Leafbird	Chloropsis sonnerati	-	LC	-	-	Yes	-	-	-	Yes	-
IRENIDAE	Lesser Green Leafbird	Chloropsis cya - pogon	-	NT	-	-	Yes	Yes	Yes	-	Yes	-
LANIIDAE	Long-tailed Shrike	Lanius schach	Yes	LC	-	Yes	-	-	-	-	Yes	-
LANIIDAE	Tiger Shrike	Lanius tigrinus	Yes	LC	-	-	-	Yes	-	-	-	-
LEIOTHRICHIDARE	Brown Fulvetta	Alcippe brunneicauda	-	NT	-	Yes	-	Yes	-	Yes	Yes	-
LOCUSTELLIDAE	Striated Grassbird	Megalurus palustris	-	LC	-	Yes	-	-	-	-	Yes	-
MEGALAIMIDAE	Blue-eared Barbet	Psilopogon duvaucelii	-	LC	-	-	-	-	-	-	-	Yes
MEGALAIMIDAE	Red-crowned Barbet	Psilopogon rafflesii	-	NT	-	-	-	Yes	-	-	Yes	-
MEROPIDAE	Blue-throated Bee-eater	Merops viridis	-	LC	-	Yes	-	-	-	-	Yes	-
MEROPIDAE	Red-bearded Bee-eater	Nyctyornis amictus	-	LC	-	-	Yes	-	-	Yes	Yes	-
MONARCHIDAE	Black-naped Monarch	Hypothymis azurea	-	LC	-	Yes	-	-	-	Yes	Yes	Yes

MONARCHIDAE	Blyth's Paradise Flycatcher	Terpsiphone affinis	-	LC	-	-	Yes	-	-	Yes	Yes	-
MUSCICAPIDAE	Bornean Blue Flycatcher	Cyornis superbus	-	LC	Yes	-	-	-	-	-	-	Yes
MUSCICAPIDAE	Bornean Whistling Trush	Myophonus borneensis	-	LC	Yes	-	Yes	-	-	-	Yes	-
MUSCICAPIDAE	Chestnut-naped Forktail	Enicurus ruficapillus	-	NT	-	-	Yes	-	-	Yes	Yes	-
MUSCICAPIDAE	Ferrugi - us Flycatcher	Muscicapa ferruginea	Yes	LC	-	-	-	-	-	Yes	-	-
MUSCICAPIDAE	Gray-chested Jungle-Flycatcher	Cyornis umbratilis	-	NT	-	-	-	-	-	-	-	Yes
MUSCICAPIDAE	Gray-headed Canary-Flycatcher	Culicicapa ceylonensis	-	LC	-	-	-	-	-	Yes	-	-
MUSCICAPIDAE	Gray-streaked Flycatcher	Muscicapa griseisticta	Yes	LC	-	-	-	-	-	Yes	-	-
MUSCICAPIDAE	Malaysian Blue Flycatcher	Cyornis turcosus	-	NT	-	-	Yes	Yes	-	-	Yes	-
MUSCICAPIDAE	Oriental Magpie-Robin	Copsychus saularis	-	LC	-	Yes	Yes	-	Yes	-	Yes	-
MUSCICAPIDAE	Pale Blue Flycatcher	Cyornis unicolor	-	LC	-	-	-	-	-	-	-	Yes
MUSCICAPIDAE	Rufous-tailed Shama	Copsychus pyrropygus	-	NT	-	-	-	-	-	-	-	Yes
MUSCICAPIDAE	Verditer Flycatcher	Eumyias thalassinus	-	LC	-	-	-	-	-	Yes	-	-
MUSCICAPIDAE	White-crowned Shama	Copsychus stricklandii	-	LC	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes
NECTARINIIDAE	Bornean Spiderhunter	Arach - thera everetti	-	LC	Yes	Yes	-	-	-	Yes	Yes	-
NECTARINIIDAE	Brown-throated Sunbird	Anthreptes malacensis	-	LC	-	Yes	-	Yes	-	-	Yes	-
NECTARINIIDAE	Crimson Sunbird	Aethopyga siparaja	-	LC	-	-	Yes	Yes	-	-	Yes	Yes
NECTARINIIDAE	Little Spiderhunter	Arach - thera longirostra	-	LC	-	Yes	Yes	Yes	-	Yes	Yes	Yes
NECTARINIIDAE	Long-billed Spiderhunter	Arach - thera robusta	-	LC	-	-	Yes	Yes	-	-	Yes	-
NECTARINIIDAE	Plain Sunbird	Anthreptes simplex	-	LC	-	-	-	-	-	-	Yes	-

NECTARINIIDAE	Purple-naped Spiderhunter	Kurochkinegramma hypogrammicum	-	NE	-	-	-	-	-	-	-	Yes
NECTARINIIDAE	Ruby Cheek Sunbird	Chalcoparia singalensis	-	LC	-	-	-	Yes	-	-	Yes	-
NECTARINIIDAE	Spectacled Spiderhunter	Arach - thera flavigaster	-	LC	-	-	-	Yes	-	-	Yes	-
NECTARINIIDAE	Temminck's Sunbird	Aethopyga temminckii	-	LC	-	-	-	-	-	Yes	-	-
NECTARINIIDAE	Thick-billed Spiderhunter	Arach - thera crassirostris	-	LC	-	Yes	-	-	-	-	Yes	-
NECTARINIIDAE	Yellow-eared Spiderhunter	Arach - thera chrysogenys	-	LC	-	-	Yes	-	-	Yes	Yes	-
ORIOLIDAE	Dark-throated Oriole	Oriolus xantho - tus	-	LC	-	-	-	-	-	-	-	Yes
PASSERIDAE	Eurasian Tree Sparrow	Passer montanus	-	LC	-	-	Yes	Yes	Yes	-	Yes	-
PELLORNEIDAE	Abbott's Babbler	Malacocincla abbotti	-	LC	-	-	-	Yes	-	-	Yes	-
PELLORNEIDAE	Black-capped Babbler	Pellorneum capistratoides	-	LC	Yes	-	-	Yes	-	-	Yes	Yes
PELLORNEIDAE	Black-throated Wren-Babbler	Turdinus atrigularis	-	NT	Yes	-	-	-	-	-	-	Yes
PELLORNEIDAE	Ferrugi - us Babbler	Pellorneum bicolor	-	LC	-	-	-	-	-	-	-	Yes
PELLORNEIDAE	Horsfield's Babbler	Malacocincla sepiaria	-	LC	-	-	Yes	Yes	-	-	Yes	Yes
PELLORNEIDAE	Moustached Babbler	Malacopteron magnirostre	-	LC	-	-	Yes	-	-	Yes	Yes	-
PELLORNEIDAE	Rufous-crowned Babbler	Malacopteron magnum	-	NT	-	Yes	Yes	Yes	-	Yes	Yes	-
PELLORNEIDAE	Short-tailed Babbler	Pellorneum malaccense	-	NT	-	-	Yes	Yes	Yes	Yes	Yes	Yes
PELLORNEIDAE	Sooty-capped Babbler	Malacopteron affine	-	LC	-	-	Yes	-	-	-	Yes	Yes
PELLORNEIDAE	Striped Wren-Babbler	Ke - pia striata	-	NT	-	-	-	-	-	Yes	-	-
PELLORNEIDAE	White-chested Babbler	Pellorneum rostratum	-	LC	-	-	Yes	-	-	-	Yes	-
PHASIANIDAE	Bulwer's Pheasant	Lophura bulweri	-	VU	-	-	-	-	-	Yes	-	-
PHASIANIDAE	Crested Fireback	Lophura ignita	-	VU	Yes	-	-	-	Yes	-	Yes	-
PHASIANIDAE	Crested Partridge	Rollulus rouloul	-	NT	-	-	Yes	-	-	-	Yes	-

PHASIANIDAE	Great Argus	Argusianus argus	-	VU	-	-	Yes	Yes	Yes	Yes	Yes	Yes
PHASIANIDAE	Sabah Partridge	Tropicoperdix graydoni	-	NT	Yes	Yes	-	Yes	-	-	Yes	-
PHYLLOSCOPIDAE	Arctic Warbler	Phylloscopus borealis	Yes	LC	-	-	-	-	-	Yes	-	-
PICIDAE	Crimson-winged Woodpecker	Picus puniceus	-	LC	-	-	-	-	-	Yes	-	-
PICIDAE	Great Slaty Woodpecker	Mulleripicus pulverulentus	-	VU	-	Yes	Yes	-	-	-	Yes	-
PICIDAE	Maroon Woodpecker	Blythipicus rubigi - sus	-	LC	-	-	-	-	-	-	-	Yes
PICIDAE	Rufous Woodpecker	Micropternus brachyurus	-	LC	-	-	Yes	Yes	-	-	Yes	Yes
PICIDAE	White-bellied Woodpecker	Dryocopus javensis	-	LC	-	-	Yes	Yes	-	-	Yes	Yes
PICUMINAE	Buff-necked Woodpecker	Meiglyptes tukki	-	NT	-	Yes	-	-	-	-	Yes	-
PICUMINAE	Buff-rumped Woodpecker	Meiglyptes grammithorax	-	LC	-	-	Yes	-	Yes	Yes	Yes	-
PICUMINAE	Gray and buff Woodpecker	Hemicircus concretus	-	LC	-	-	Yes	-	-	-	Yes	-
PITTIDAE	Black-crowned Pitta	Erythropitta ussheri	-	LC	Yes	-	-	Yes	-	-	Yes	Yes
PITTIDAE	Blue-headed Pitta	Hydrornis baudii	-	VU	Yes	-	-	Yes	-	Yes	Yes	-
PITTIDAE	Bornean Banded Pitta	Hydrornis schwaneri	-	LC	Yes	-	-	-	-	Yes	-	-
PITTIDAE	Hooded Pitta	Pitta sordida	-	LC	-	Yes	-	-	-	-	Yes	Yes
PITYRIASIDAE	Bornean Bristlehead	Pityriasis gym - cephala	-	VU	Yes	-	-	-	-	-	-	Yes
PSITTACULIDAE	Blue-crowned Hanging Parrot	Loriculus galgulus	-	LC	-	Yes	Yes	Yes	-	Yes	Yes	-
PYC - - TIDAE	Black-headed Bulbul	Microtarsus mela - cephalos	-	LC	-	-	Yes	-	-	-	Yes	Yes
PYC - - TIDAE	Charlotte's Bulbul	Iole charlottae	-	NT	-	-	-	Yes	-	-	Yes	-
PYC - - TIDAE	Cinereous Bulbul	Hemixos cinereus	-	LC	-	-	-	-	-	Yes	-	-
PYC - - TIDAE	Cream-eyed Bulbul	Pyc - - tus pseudosimplex	-	LC	-	Yes	-	-	-	-	Yes	-
PYC - - TIDAE	Cream-vented Bulbul	Pyc - - tus simplex	-	LC	-	Yes	-	-	-	Yes	Yes	-

PYC - - TIDAE	Grey-cheeked Bulbul	Alophoixus tephrogenys	-	VU	-	-	-	Yes	-	-	Yes	Yes
PYC - - TIDAE	Hairy-backed Bulbul	Tricholestes criniger	-	LC	-	-	-	-	Yes	Yes	Yes	-
PYC - - TIDAE	Hook-billed Bulbul	Setornis criniger	-	VU	-	-	Yes	Yes	-	-	Yes	-
PYC - - TIDAE	Olive-winged Bulbul	Pyc - - tus plumosus	-	LC	-	-	-	Yes	-	-	Yes	-
PYC - - TIDAE	Red-eyed Bulbul	Pyc - - tus brunneus	-	LC	-	Yes	Yes	Yes	-	Yes	Yes	-
PYC - - TIDAE	Spectacled Bulbul	Rubigula erythropthalmos	-	LC	-	Yes	Yes	Yes	-	Yes	Yes	Yes
PYC - - TIDAE	Streaked Bulbul	Ixos malaccensis	-	NT	-	-	Yes	Yes	-	-	Yes	-
PYC - - TIDAE	Yellow-bellied Bulbul	Alophoixus phaeocephalus	-	LC	-	-	-	Yes	-	-	Yes	Yes
PYC - - TIDAE	Yellow-vented Bulbul	Pyc - - tus goiavier	-	LC	-	-	Yes	Yes	-	-	Yes	-
RALLIDAE	Eurasian Moorhen	Gallinula chloropus	Yes	LC	-	-	-	-	-	-	-	Yes
RALLIDAE	Slaty-legged Crake	Rallina eurizo - ides	Yes	LC	-	-	-	-	-	-	-	Yes
RALLIDAE	White-breasted Waterhern	Amaurornis pheonicurus	-	LC	-	-	-	Yes	-	-	Yes	-
RAMPHASTIDAE	Black-eared Barbet	Psilopogon duvaucelii	-	LC	-	-	Yes	Yes	Yes	Yes	Yes	-
RAMPHASTIDAE	Brown Barbet	Caloramphus fuligi - sus	-	LC	Yes	-	Yes	-	-	-	Yes	Yes
RAMPHASTIDAE	Golden-naped Barbet	Psilopogon pulcherrimus	-	LC	Yes	-	Yes	-	Yes	-	Yes	-
RAMPHASTIDAE	Gold-whiskered Barbet	Psilopogon chrysopogon	-	LC	Yes	-	Yes	Yes	-	Yes	Yes	Yes
RAMPHASTIDAE	Red-throated Barbet	Psilopogon mystacopha - s	-	NT	-	-	Yes	Yes	-	Yes	Yes	Yes
RAMPHASTIDAE	Yellow-crowned Barbet	Psilopogon henricii	-	NT	-	-	Yes	Yes	Yes	Yes	Yes	Yes
RHIPIDURIDAE	Malaysian Pied Fantail	Rhipidura javanica	-	LC	-	Yes	Yes	Yes	-	-	Yes	-
RHIPIDURIDAE	Spotted Fantail	Rhipidura perlata	-	LC	-	-	-	-	-	Yes	-	-
SCOLOPACIDAE	Common Sandpiper	Actitis hypoleucos	Yes	LC	-	-	-	Yes	-	-	Yes	-
SCOLOPACIDAE	Wood Sandpiper	Tringa glareola	Yes	LC	-	-	-	Yes	-	-	Yes	-
SITTIDAE	Velvet-fronted Nuthatch	Sitta frontalis	-	LC	-	-	-	-	-	Yes	-	-
STRIGIDAE	Barred Eagle-Owl	Ketupa sumatrana	-	NT	-	-	-	Yes	-	-	Yes	-

STRIGIDAE	Brown-wood Owl	Strix leptogrammica	-	LC	-	-	Yes	-	-	-	Yes	-
STRIGIDAE	Reddish Scops-Owl	Otus rufescens	-	NT	-	-	-	Yes	-	-	Yes	-
STURNIDAE	Asian Glossy Starling	Aplonis panayensis	-	LC	-	-	-	Yes	-	-	Yes	-
STURNIDAE	Common Hill Myna	Gracula religiosa	-	LC	-	Yes	Yes	Yes	Yes	-	Yes	-
STURNIDAE	Crested Myna	Acridotheres cristatellus	-	LC	-	-	Yes	-	-	-	Yes	-
STURNIDAE	Javan Myna	Acridotheres javanicus	-	VU	-	-	-	-	Yes	-	Yes	-
TEPHRODORNITHIDAE	Large Woodshrike	Tephrodornis virgatus	Yes	LC	-	-	-	-	-	-	-	Yes
TIMALIIDAE	Black-throated Babbler	Stachyris nigricollis	-	NT	-	-	Yes	-	-	-	Yes	Yes
TIMALIIDAE	Bold-striped Tit-Babbler	Mixornis bornensis	-	LC	-	Yes	-	Yes	-	-	Yes	Yes
TIMALIIDAE	Chestnut-rumped Babbler	Stachyris maculata	-	NT	-	-	-	-	-	-	-	Yes
TIMALIIDAE	Fluffy-backed Tit-Babbler	Macronus ptilosus	-	NT	-	-	Yes	-	-	Yes	Yes	Yes
TIMALIIDAE	Gray-headed Babbler	Stachyris poliocephala	-	LC	-	-	-	-	-	Yes	-	-
TIMALIIDAE	Gray-hooded Babbler	Cya - derma bicolor	-	LC	-	-	Yes	-	-	Yes	Yes	Yes
TIMALIIDAE	Grey-headed Babbler	Stachyris poliocephala	-	LC	-	-	-	Yes	-	-	Yes	-
TIMALIIDAE	Rufous-fronted Babbler	Cya - derma rufifrons	-	LC	-	-	-	-	-	-	-	Yes
TIMALIIDAE	Sunda Scimitar-Babbler	Pomatorhinus bornensis	-	LC	-	-	-	-	-	Yes	-	Yes
TROGONIDAE	Diard's Trogon	Harpactes diardii	-	NT	-	Yes	Yes	Yes	-	Yes	Yes	Yes
TROGONIDAE	Red-naped Trogon	Harpactes kasumba	-	NT	-	-	-	-	-	-	-	Yes
TROGONIDAE	Scarlet-rumped Trogon	Harpactes duvaucelii	-	NT	-	Yes	Yes	-	-	Yes	Yes	-
TYTONIDAE	Oriental Bay-Owl	Phodilus badius	-	LC	-	-	-	Yes	-	-	Yes	-
VANGIDAE	Maroon-breasted Philentoma	Philentoma velata	-	NT	-	-	-	-	-	-	-	Yes
VANGIDAE	Rufous-winged Philentoma	Philentoma pyrhoptera	-	LC	-	-	Yes	-	-	-	Yes	Yes

VIREONIDAE	White-bellied Erphonis	Erpornis zantholeuca	-	LC	-	-	-	Yes	-	-	Yes	Yes
ZOSTEROPIDAE	Black-capped White-eye	Zosterops atricapilla	-	LC	Yes	Yes	-	-	-	-	Yes	-

Keynote: In IUCN Column: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Not Evaluated (NE), DD (Data Deficient).

Appendix V: the 30 Species Identified from Camera traps

Common Name	Scientific Name	Endemism	IUCN	Andrassy	Balung	HQ-Bombalai	Merotai
Banded-Civet	*Hemigalus-derbyanus*		NT	-	-	-	x
Bearded-Pig	*Sus-barbatus*	Yes	VU	x	x	-	x
Blue-headed-Pitta	*Hydrornis-baudii*	Yes	VU	x	-	-	-
Bornean-Clouded-Leopard	*Neofelis-diardi-bornensis*	Yes	VU	-	-	-	x
Bornean-Crested-Fireback	*Lophura-ignita*	Yes	VU	x	x	x	x
Bornean-Orang-utan	*Pongo-pygmaeus-morio*	Yes	CR	-	-	x	-
Bornean-Porcupine	*Thecurus-crassispinis*	Yes	LC	-	x	-	x
Bornean-Yellow-Muntjac	*Muntiacus-atherodes*	Yes	NT	x	x	x	-
Crested-Serpent-eagle	*Spilornis-cheela*		LC	x	-	-	-
Great-Argus-	*Argusianus-argus*		VU	x	-	-	x
Greater-Coucal	*Centropus-sinensis*		LC	-	x	-	-
Horse-tailed-Squirrel	*Sundasciurus-hippurus*		NT	-	x	-	-
Little-Green-pigeon	*Treron-olax*		LC	-	x	-	-
Long-tailed-Macaque	*Macaca-fascicularis*		EN	-	x	-	x
Malay-Badger	*Mydaus-javanensis*		LC	-	-	-	x
Malay-Civet	*Viverra-tangalunga*		LC	x	x	x	x
Malayan-Porcupine	*Hystrix-brachyura*		LC	-	x	-	x
Malayan-Sun-Bear	*Helarctos-malayanus-*	Yes	VU	x	x	x	x
Marbled-Cat	*Pardofelis-marmorata*		NT	x	-	-	-
Moonrat	*Echinosorex-gymnura*		LC	-	-	x	-
Mousedeer	*Tragulus-sp*		-	x	x	x	x
Pig-tailed-Macaque	*Macaca-nemestrina*		EN	x	x	x	x
Sabah-Grizzled-Langur	*Presbytis-sabana*	Yes	EN	-	x	-	-
Sambar-Deer	*Rusa-unicolor*		VU	x	x	x	x
Short-tailed-Mongoose	*Urva-brachyura*		NT	-	x	-	-
Southern-Red-Muntjac	*Muntiacus-muntjak*		LC	-	-	-	x
Water-Monitor-Lizard	*Varanus-salvator*		LC	-	-	x	-
White-crowned-Hornbill	*Aceros-comatus*		EN	-	-	-	x
White-crowned-Shama	*Copsychus-stricklandii*	Yes	NE	x	-	-	-
		Total-Species-Count		13	16	11	16

Keynote:-In-IUCN-Column:--Critically-Endangered-(CR),-Endangered-(EN),-Vulnerable-(VU),-Near-Threatened-(NT),--Not-Evaluated-(NE),-DD-(Data-Deficient).