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RESEARCH ARTICLE

Rapid assessments of bird species richness in selected forest eco-parks in Perak, Peninsular Malaysia

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ABSTRACT

Observations on avifauna were conducted across 10 forest eco-parks (FEPs) in Perak from 19 to 26 April 2024 to document and update avifaunal species richness. Two teams of six observers conducted direct observations using cameras and binoculars. Over the eight-day survey period, each team concurrently covered five sites, with each site surveyed for a total of 10 hours per site. Overall, a total of 132 bird species from 44 families were recorded. The family Pycnonotidae showed the highest species richness, encompassing 10.6% (14spp.) of the total species documented in the study. Resident birds dominated the observations, accounting for 87.9% (116spp.), while insectivorous species were the most common feeding guild, comprising 47.7% (63spp.) of the total species recorded. The most widespread and frequently encountered species were the Oriental Magpie-robin (*Copsychus saularis*), Black-headed Bulbul (*Brachypodius atriceps*), and Red-eyed Bulbul (*Pycnonotus brunneus*). According to the Wildlife Conservation Act 2010, 112 species are classified as Totally Protected (TP), and 10 species as Protected (P). Based on the IUCN Red List of Threatened Species, two species are listed as Endangered (EN), and three as Vulnerable (VU). This record emphasized the role of these sites as important refuges for species of conservation concern. Among all sites, Kaki Bukit Larut FEP recorded the highest species richness, representing 38.6% (51spp.) of the total species. Bird species richness varied between sites, with low to moderate Jaccard similarity values (J = 0.05-0.33), reflecting high species turnover and highlighting distinct avian communities across the study area. The highest similarity was between Kledang Saiong and Papan FEPs (J = 0.33), while Sungai Salu FEP exhibited the most distinct species (J = 0.05). Hypothetically, habitat structure, elevation, geographic location, food availability, and rainfall may be among the most influential factors shaping bird species richness across the forest eco-parks in this study, as highlighted in prior research. These findings demonstrate the ecological uniqueness of each forest eco-park and emphasize the importance of conserving multiple sites to preserve regional bird diversity. This study also provides essential baseline data for stakeholders, including the Perak State Forestry Department, the Department of Wildlife and National Parks, the Perak State Government, ecotourism planners, and Non-Governmental Organizations (NGOs), to inform future conservation planning and biodiversity monitoring efforts within Perak's forested landscapes.

1. INTRODUCTION

Perak, the second-largest state in Peninsular Malaysia, is renowned for its stunning natural landscape, lush forests, and abundant biodiversity, including a diverse array of captivating bird species. The state supports approximately 62.0% of the 814 bird species recorded in Malaysia, underscoring its significance as a vital refuge for national avian biodiversity and conservation efforts (MNS Perak Bird Group, 2006; MNS Bird Conservation Council, 2021). Birds play a crucial role in ecosystems by facilitating seed dispersal, pollination, regulating insect and small animal populations, and serving as indicators of ecosystem health (Zakaria et al., 2005; Whelan et al., 2008; Ong et al., 2022; Gargi, 2023; Arazmi et al., 2025).

Based on the National Forestry Policy 1978 (Revised 1992) and the National Forestry Act 1984 (Act 313), forest eco-parks (FEPs) are designated areas of forest classified as Amenity Forests that aim to maintain a sufficient area for conservation, education, recreation, and ecotourism, and are often located within permanent forest reserves (Government of Malaysia, 1992; Government of Malaysia, 1984). These parks serve as vital green spaces for public engagement while preserving biodiversity and ecosystem functions. Perak state features 13 forest eco-parks that play a crucial role in environmental education, ecotourism, biodiversity research,

and monitoring, with some located near urban centers (Perak Forestry Department, 2021). Beyond their recreational value, forest eco-parks also contribute significantly to in-situ conservation efforts by providing vital habitats for flora and fauna, including both residents and migratory birds. The areas are managed primarily by the Forestry Department of Peninsular Malaysia and the Perak State Forestry Department, where they often include basic infrastructure such as nature trails, interpretive signage, and canopy walkways to support low-impact visitation (Forestry Department of Peninsular Malaysia, 2016).

Despite their significance, comprehensive data on bird species richness specifically within many forest eco-parks in Perak remain limited. To date, avifaunal documentation has only been reported for Lata Kekabu FEP, as recorded by Yussainy et al. (2022). There are currently no unpublished reports or citizen science records, such as eBird, that offer site-specific data on the forest eco-parks in Perak. Therefore, this study was conducted to document and update avifaunal species richness in 10 selected forest eco-parks in Perak. The 10 forest eco-parks surveyed in this study were selected in consultation with the Perak State Forestry Department, based on their official designation under the National Forestry Act, accessibility for research, the lack of published data, and their significance as recreational and ecotourism sites. The findings aim to contribute to regional biodiversity information and support the development of effective future conservation and monitoring strategies.

2. MATERIALS AND METHODS

2.1. Study sites

The study was conducted at 10 forest eco-parks in Perak, as illustrated in Figure 1, with their respective coordinates listed in Table 1. The forest eco-parks are located within seven forest reserves across five forest districts (Hulu Perak, Larut & Matang, Kuala Kangsar, Kinta/ Manjung, and Perak Selatan) in the state. Each site features established forest trails and offers diverse natural habitats, ranging from lowland to hill dipterocarp forests, as well as freshwater ecosystems like rivers and streams. A brief description of the habitat types for the study sites is listed in Table 2. Additionally, these forest eco-parks are equipped with basic visitor facilities, including interpretive signage, gazebos, rest shelters, camping areas, and public amenities. Visitors may access the forest eco-parks between 8:00 a.m. and 6:00 p.m. (Perak Forestry Department, 2021). The research teams also encounter visitors at all study sites during the surveys, except for Papan FEP and Sungai Salu FEP.

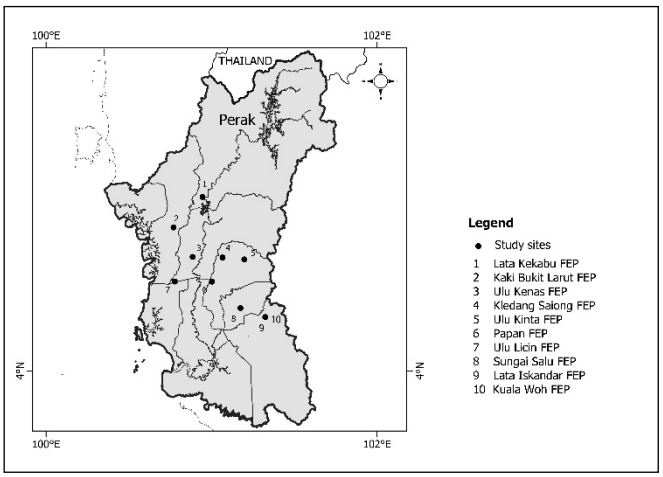

Figure 1: The location of the study sites

Table 1: The coordinates of the study sites

No.	Forest Eco-Park (FEP)	Forest Reserve (FR)	Coordinates	
			Latitude	Longitude
1.	Lata Kekabu FEP	Bintang Hijau FR	N 05°02'58.1"	E 100°56'43.3"
2.	Kaki Bukit Larut FEP	Bukit Larut FR	N 04°51'57.3"	E 100°46'14.0"
3.	Ulu Kenas FEP	Bubu FR	N 04°41'14.8"	E 100°53'10.2"
5.	Kledang Saiong FEP	Kledang Saiong FR	N 04°41'02.3"	E 101°03'59.5"
4.	Ulu Kinta FEP	Bukit Kinta FR	N 04°40'20.2"	E 101°11'52.6"
6.	Papan FEP	Kledang Saiong FR	N 04°32'17.7"	E 101°00'09.7"
7.	Ulu Licin FEP	Bubu FR	N 04°32'20.1"	E 100°46'41.6"
8.	Sungai Salu FEP	Bujang Melaka FR	N 04°22'43.1"	E 101°10'27.5"
9.	Lata Iskandar FEP	Bukit Tapah FR	N 04°19'27.5"	E 101°19'29.3"
10.	Kuala Woh FEP	Bukit Tapah FR	N 04°19'28.3"	E 101°19'28.4"

Table 2: Brief description of habitat types for the study sites

No.	Forest Eco-Park (FEP)	Forest Reserve (FR)	Habitat Type (Surveyed area only)	Elevation (m)
1.	Lata Kekabu FEP	Bintang Hijau FR	LDF, CO, R, S, LL	95
2.	Kaki Bukit Larut FEP	Bukit Larut FR	HDF, CO, S, LL	517
3.	Ulu Kenas FEP	Bubu FR	LDF, CO, R, S, LL	87
5.	Kledang Saiong FEP	Kledang Saiong FR	LDF, CO, R, S, LL	127
4.	Ulu Kinta FEP	Bukit Kinta FR	LDF, CO, R, S, LL	161
6.	Papan FEP	Kledang Saiong FR	LDF, CO, R, S, LL	110
7.	Ulu Licin FEP	Bubu FR	LDF, CO, R, S, LL	100
8.	Sungai Salu FEP	Bujang Melaka FR	LDF, CO, R, W, LL	33
9.	Lata Iskandar FEP	Bukit Tapah FR	HDF, CO, R, W, LL	425
10.	Kuala Woh FEP	Bukit Tapah FR	LDF, CO, R, S, LL	147

Note: LDF – Lowland dipterocarp forest; CO – Canopy opening; R – River; S – Stream; W – Waterfall; LL – Leaf litter

2.2. Field methods

Avifaunal surveys were conducted over eight days, from April 19 to 26, 2024. The surveys were done in April, as this month typically experiences shorter and less frequent rainfall compared to the wet season, which usually occurs

from October to January (Davison & Yeap, 2023). This timing also allowed for better accessibility to the sites, facilitating fieldwork and increasing the likelihood of detecting various bird species. The documentation on avifauna encompasses a diverse range of bird groups that can be observed by the public or birdwatchers within the forest eco-parks, rather than focusing solely on migratory species. Migratory birds typically arrive in Peninsular Malaysia and Singapore in July and August, with substantial numbers arriving from September to November. From March until late May, migrant populations return north for the spring season (Jeyarajasingam & Pearson, 2012). Therefore, this study acknowledges that conducting surveys during different seasons, such as the breeding season, the peak migration period, or during hot or rainy months, might yield additional species that were not recorded in this study.

Two teams of six observers conducted direct observations equipped with binoculars (10 x 42 mm) and cameras with a lens (400-600mm). The surveys only cover the areas surrounding the eco-park entrance and visitor facilities accessible by walking along the boardwalks, paved walkways, or bridges, excluding the forest trails. Thus, this study acknowledged this limitation, and it is possible that additional species foraging in the forest interior may not have been recorded in this study. The surveys were divided into two sessions: the morning session, from 7:00 a.m. to 11:00 a.m., and the evening session, from 4:30 p.m. to 6:30 p.m. Over the eight-day survey period, each team concurrently covered five sites, with each site surveyed for 10 hours (two morning sessions and one evening session). Direct observations were limited to daytime due to rainfall and safety concerns that restricted nighttime observations. No birdcall audio was used to attract birds during the surveys. Bird species identifications were done based on Robson (2014) and Puan et al. (2020). No audio recordings are used to confirm species identification, especially for cryptic or canopy-dwelling species.

2.3. Data analysis

A checklist of bird species recorded at the study sites was created based on the surveys. The bird species richness was analyzed based on their presence-absence data, status in Malaysia, feeding guilds, global conservation status, and regional protection status. The residency status of the birds was determined in accordance with the "Checklist of the Birds of Malaysia" (MNS Bird Conservation Council, 2021). The species were broadly classified into six major feeding guilds based on their primary diets (see Table 3), with references from Myers (2016) and Nor Hashim & Ramli (2013). The global conservation status was referenced from the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2025), while regional protection status was identified in accordance with the Wildlife Conservation Act (WCA) (2010).

Additionally, a dendrogram was constructed using the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) clustering method based on the Jaccard Similarity Index to assess the similarity in bird species among the 10 forest eco-parks. The Jaccard Similarity Index was applied because this study relied exclusively on species presence–absence data (binary dataset) across the study sites. Species abundance, or relative frequency data, was not collected in this study, as direct observation methods do not reliably distinguish individual counts. Thus, the community similarity was interpreted using presence–absence data to minimize bias. The analysis was performed using Paleontological Statistics (PAST) software (Hammer et al., 2001).

Table 3: The definition of avian feeding guilds for this study

Feeding Guild	Definition
Insectivore	Species that primarily feed on insects.
Frugivore	Species that primarily feed on fruits.
Carnivore	Species that primarily feed on small mammals, birds, reptiles, and fish.
Nectarivore	Species that primarily feed on the nectar of flowers.
Granivore	Species that primarily feed on grains or seeds.
Omnivore	Species that feed on both plants and animals.

3. RESULT AND DISCUSSION

A total of 132 bird species from 44 families were recorded across 10 forest eco-parks (see Table 4). The family Pycnonotidae, comprising 10.6% (14spp.) of the total species documented in the study, exhibited the highest species richness among all avian families observed in the study areas. Following Pycnonotidae, the family Muscicapidae accounted for 8.3% (11spp.) of the total species, while both Megalaimidae and Nectariniidae each comprised 6.1% (8spp.) of the total species. This finding aligns with previous studies that have reported bulbuls as the most species-rich and frequently observed understorey family in the lowland dipterocarp ecosystems of Peninsular Malaysia (Mansor & Sah, 2012; Nor Hashim & Ramli, 2013; Shafie et al., 2018; Yussainy et al., 2022; Munian et al., 2023). The bulbuls are generalist frugivorous species that can thrive across a broad range of habitat types, reflecting their adaptability to varying environmental conditions (Ponpituk et al., 2020). They are recognized as an ecologically important frugivorous group in Asia, with a vital role in facilitating seed dispersal, especially in disturbed or degraded habitats (Sankamethawee et al., 2011; Shakya & Sheldon, 2017; Corlett, 2017).

According to the "Checklist of the Birds of Malaysia" by the MNS Bird Conservation Council (2021), bird species found in the forest eco-parks can be classified into four categories based on their status: resident, migratory, both

resident and migrant, and introduced species (see Figure 2). Among these categories, resident birds were the most prevalent, comprising 87.9% (116spp.) of the 132 species observed in the forest eco-parks. The dominance of resident species reported in this study is consistent with published surveys from other forest habitats in Peninsular Malaysia, including freshwater wetlands and coastal zones (Rajpar & Zakaria, 2012; Rajpar et al., 2017; Yussainy et al., 2022; Mokhter et al., 2022; Munian et al., 2023; Mahyudin et al., 2024). The resident birds are recorded as always present in the area throughout the year, but migratory bird communities visit the area periodically, changing their habitat preferences (Rajpar & Zakaria, 2012). This finding underscores the significance of these habitats for local avifauna, as they provide essential resources for their survival. Additionally, the presence of migratory and introduced species highlights the dynamic nature of these ecosystems and their ability to support a diverse range of bird populations.

Besides that, the forest eco-parks support a diverse range of bird feeding guilds, which can be categorized into six groups based on their primary dietary preferences: insectivores, frugivores, carnivores, nectarivores, granivores, and omnivores (see Figure 3). Among these, insectivorous species were the most dominant, comprising 47.7% (63spp.) of the 132 bird species recorded. This dominance is likely attributed to the abundance of food sources and the availability of forest canopy cover in the eco-parks, which support foraging and nesting activities. The presence of rivers, streams, leaf litter, shady areas, and rainfall in the study sites might provide ideal microhabitats for insects, a food source for insectivorous birds (Greenberg, 1987; Yule & Yong, 2004; Turner & Foster, 2009; Trentini et al., 2018; Mansor et al., 2019; Hasmi et al., 2023). Research by Mansor and Sah (2012) indicates that insectivorous bird species are the most prevalent feeding group in the forest interior compared to the forest edge. Similarly, Azman et al. (2011) found that insectivores constituted a more dominant feeding guild in secondary forests than in monoculture plantations.

Furthermore, the Oriental Magpie-robin (*Copsychus saularis*), Black-headed Bulbul (*Brachypodius atriceps*), and Red-eyed Bulbul (*Pycnonotus brunneus*) were identified as the most common and widely distributed species across the study areas, with each being recorded in eight of the surveyed forest eco-parks. These species are recognized as common residents in Peninsular Malaysia (Robson, 2014; Puan et al., 2020). They are generalists with a high adaptability to environmental changes. They are found not only in the understorey of lowland primary forests but also readily inhabit secondary forests, including forest edges and disturbed habitats (Robson, 2014; Myers, 2016; Puan et al., 2020). This ecological flexibility likely contributes to their widespread distribution and dominance across the surveyed forest eco-parks.

According to the IUCN Red List of Threatened Species (IUCN, 2025), the forest eco-parks collectively support two Endangered (EN) and three Vulnerable (VU) bird species, highlighting the conservation significance of these habitats for globally threatened avian species (see Table 4). The globally threatened species are Greater Green Leafbird (*Chloropsis sonnerati*), Wrinkled Hornbill (*Rhabdotorrhinus corrugatus*), Wreathed Hornbill (*Rhyticeros undulatus*), Grey-cheeked Bulbul (*Alophoixus tephrogenys*), and Javan Myna (*Acridotheres javanicus*). These threatened species were observed across multiple sites, namely Lata Kekabu FEP, Kaki Bukit Larut FEP, Ulu Kenas FEP, Papan FEP, Ulu Licin FEP, Sungai Salu FEP, and Kuala Woh FEP. This result suggests that these sites harbor important habitats and should be prioritized for specific conservation efforts. In addition, the forest eco-parks also provide critical habitat for 112 Totally Protected (TP) bird species and 10 Protected (P) species, as designated under the Wildlife Conservation Act (WCA, 2010), underscoring their vital role in supporting nationally safeguarded avian biodiversity.

A comparative analysis of the 10 forest eco-parks revealed that Kaki Bukit Larut FEP recorded the highest species richness, representing 38.6% (51spp.) of the total species recorded throughout the study (see Table 4). Situated within the Bukit Larut Forest Reserve that reaches an elevation of more than 1,200m, the forest eco-park encompasses a broad elevational gradient from lowland to hill dipterocarp forests, offering a diverse array of forest strata and habitat types that support a wide range of bird species (Halim & Norazlimi, 2024). Bukit Larut FR is reported to host approximately 255 bird species across its landscape (Cornell Lab of Ornithology, 2025), highlighting its significance as a key avian biodiversity hotspot in the region. Apart from that, there was no rain during the survey period, which may have influenced the accessibility and visibility of the observers.

The pairwise Jaccard Similarity Index analysis shows that bird species richness varied notably across the forest eco-parks, with low to moderate Jaccard similarity values (J = 0.05-0.33), indicating diverse avian communities (see Figure 4). We hypothesize that this result may be influenced by differences in habitat structure, elevation, geographic location, food availability, and disturbance levels. According to a review by Halim and Norazlimi (2024) on bird ecological research, habitats with greater structural complexity offer a wider range of ecological niches, thereby supporting a diverse community of birds to coexist. Similarly, several studies conducted in Peninsular Malaysia have reported that bird species richness

tends to increase with improved forest habitat quality and food availability, while it declines in areas experiencing higher levels of habitat disturbance (Soh et al., 2006; Azman et al., 2011; Mansor & Sah, 2012; Bing et al., 2013; Munian et al., 2023).

The highest similarity value was recorded between Kledang Saiong FEP and Papan FEP (J = 0.33), suggesting that these two eco-parks share a considerable proportion of bird species. The high similarity observed between Kledang Saiong FEP and Papan FEP was primarily driven by the presence of 18 species, including the Black-headed Bulbul, Yellow-vented Bulbul, Oriental Magpie-robin, White-rumped Shama, White-throated Kingfisher, and Scarlet-backed Flowerpecker (see Table 4), which are widespread and dominant in both sites. The observed similarity is also likely due to their close geographic proximity, similar altitudinal gradients, and comparable forest habitat characteristics. They are both situated within Kledang Saiong FR, which facilitates the occurrence of overlapping avian communities.

Conversely, Sungai Salu FEP exhibited very low similarity with the other sites (J = 0.05), indicating minimal overlap in bird species. The lower similarity between Sungai Salu FEP and other sites is likely attributed to the limited availability of food resources and rainfall, resulting in low species counts. The lack of fruiting trees may affect the presence of birds at the study site, as they rely on these trees for food, roosting, and nesting opportunities (Buba & Jaafar, 2021; Li et al., 2025). The occurrence of birds and observer visibility might also be affected by the rainfall during one of the morning sessions. Although tropical seabirds were observed more often perching rather than foraging during rainfall, similar patterns can be seen in the understorey birds, where fewer birds were observed during rainfall, which explains the lesser number of species that can be observed during rainy days (Ramli & Norazlimi, 2017; De Pascalis et al., 2022).

Table 4: Checklist of avifaunal species recorded across the forest eco-parks during the present study

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	Forest Eco-Park (FEP)									
						A	B	C	D	E	F	G	H	I	J
1	Accipitridae	Rufous-bellied Eagle	*Lophotriorchis kienerii* [R, M]	NT	TP	/									
2	Accipitridae	Crested Serpent-eagle	*Spilornis cheela*	LC	TP		/		/	/		/			/
3	Accipitridae	Oriental Honey-buzzard	*Pernis ptilorhynchus* [R, M]	LC	TP									/	
4	Alcedinidae	Malay Blue-banded Kingfisher	*Alcedo peninsulae*	NT	TP	/									
5	Alcedinidae	Common Kingfisher	*Alcedo atthis* [M]	LC	TP	/									
6	Alcedinidae	White-throated Kingfisher	*Halcyon smyrnensis*	LC	TP		/		/		/	/	/		
7	Alcedinidae	Banded Kingfisher	*Lacedo pulchella*	LC	TP		/				/	/			
8	Dicaeidae	Crimson-breasted Flowerpecker	*Prionochilus percussus*	LC	TP		/	/			/			/	/
9	Dicaeidae	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	LC	TP			/			/			/	
10	Dicaeidae	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	LC	TP				/	/	/			/	/
11	Dicaeidae	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	LC	TP				/		/				
12	Dicaeidae	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	LC	TP						/				
13	Muscicapidae	Oriental Magpie-robin	*Copsychus saularis*	LC	P	/		/	/		/	/	/	/	/
14	Muscicapidae	White-rumped Shama	*Copsychus malabaricus*	LC	P		/	/	/		/				/
15	Muscicapidae	Chestnut-naped Forktail	*Enicurus ruficapillus*	NT	TP	/	/				/	/			
16	Muscicapidae	Large Blue Flycatcher	*Cyornis magnirostris* [M]	NT	TP	/									
17	Muscicapidae	Ferruginous Flycatcher	*Muscicapa ferruginea* [M]	LC	TP	/									
18	Muscicapidae	Asian Brown Flycatcher	*Muscicapa dauurica* [M]	LC	TP		/			/					/
19	Muscicapidae	Pale Blue Flycatcher	*Cyornis unicolor*	LC	TP							/			
20	Muscicapidae	Verditer Flycatcher	*Eumyias thalassinus*	LC	TP				/						
21	Muscicapidae	Rufous-chested Flycatcher	*Ficedula dumetoria*	LC	TP					/					

Table 4 (Con't): Checklist of avifaunal species recorded across the forest eco-parks during the present study

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	Forest Eco-Park (FEP)									
						A	B	C	D	E	F	G	H	I	J
22	Muscicapidae	Slaty-backed Forktail	*Enicurus schistaceus*	LC	TP									/	
23	Muscicapidae	White-tailed Flycatcher	*Cyornis concretus*	LC	TP									/	
24	Pycnonotidae	Scaly-breasted Bulbul	*Ixidia squamata*	NT	TP		/	/	/						
25	Pycnonotidae	Black-headed Bulbul	*Brachypodius atriceps*	LC	TP		/	/	/	/	/		/	/	/
26	Pycnonotidae	Stripe-throated Bulbul	*Pycnonotus finlaysoni*	LC	TP	/		/		/					/
27	Pycnonotidae	Grey-cheeked Bulbul	*Alophoixus tephrogenys*	VU	TP			/				/			
28	Pycnonotidae	Cream-vented Bulbul	*Pycnonotus simplex*	LC	TP	/	/	/	/	/	/	/			
29	Pycnonotidae	Yellow-vented Bulbul	*Pycnonotus goiavier*	LC		/	/	/	/	/	/				/
30	Pycnonotidae	Olive-winged Bulbul	*Pycnonotus plumosus*	LC	TP	/	/	/		/	/			/	
31	Pycnonotidae	Spectacled Bulbul	*Ixidia erythropthalmos*	LC	TP		/	/	/		/				/
32	Pycnonotidae	Hairy-backed Bulbul	*Tricholestes criniger*	LC	TP	/	/		/		/				
33	Pycnonotidae	Red-eyed Bulbul	*Pycnonotus brunneus*	LC	TP		/		/	/	/	/	/	/	/
34	Pycnonotidae	Black-crested Bulbul	*Rubigula flaviventris*	LC	TP		/			/				/	/
35	Pycnonotidae	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*	LC	TP		/								
36	Pycnonotidae	Grey-bellied Bulbul	*Ixidia cyaniventris*	NT	TP							/		/	
37	Pycnonotidae	Ochraceous Bulbul	*Alophoixus ochraceus*	LC	TP									/	
38	Megalaimidae	Black-eared Barbet	*Psilopogon duvaucelii*	LC	TP	/	/	/							
39	Megalaimidae	Red-crowned Barbet	*Psilopogon rafflesii*	NT	TP			/							
40	Megalaimidae	Gold-whiskered Barbet	*Psilopogon chrysopogon*	LC	TP	/	/	/		/					
41	Megalaimidae	Coppersmith Barbet	*Psilopogon haemacephalus*	LC	TP			/							
42	Megalaimidae	Red-throated Barbet	*Psilopogon mystacophanos*	NT	TP	/		/							
43	Megalaimidae	Sooty Barbet	*Caloramphus hayii*	NT	TP		/		/	/	/	/			
44	Megalaimidae	Black-browed Barbet	*Psilopogon oorti*	LC	TP				/						
45	Megalaimidae	Lineated Barbet	*Psilopogon lineatus*	LC	TP					/					
46	Nectariniidae	Brown-throated Sunbird	*Anthreptes malacensis*	LC	TP	/		/			/				
47	Nectariniidae	Crimson Sunbird	*Aethopyga siparaja*	LC	TP						/				
48	Nectariniidae	Ruby-cheeked Sunbird	*Chalcoparia singalensis*	LC	TP				/		/				/
49	Nectariniidae	Spectacled Spiderhunter	*Arachnothera flavigaster*	LC	TP	/		/					/		
50	Nectariniidae	Little Spiderhunter	*Arachnothera longirostra*	LC	TP	/		/		/	/				/
51	Nectariniidae	Grey-breasted Spiderhunter	*Arachnothera modesta*	LC	TP	/						/		/	
52	Nectariniidae	Purple-naped Spiderhunter	*Kurochkinegramma hypogrammica*	LC	TP		/						/	/	
53	Nectariniidae	Plain Sunbird	*Anthreptes simplex*	LC	TP									/	/
54	Timaliidae	Pin-striped Tit-Babbler	*Mixornis gularis*	LC	TP		/	/						/	
55	Timaliidae	Chestnut-winged Babbler	*Cyanoderma erythropterum*	LC	TP					/					
56	Timalidae	Grey-headed Babbler	*Stachyris poliocephala*	LC	TP										/
57	Cisticolidae	Dark-necked Tailorbird	*Orthotomus atrogularis*	LC	TP		/	/							
58	Cisticolidae	Common Tailorbird	*Orthotomus sutorius*	LC	TP			/		/	/				/

Table 4 (Con't): Checklist of avifaunal species recorded across the forest eco-parks during the present study

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	Forest Eco-Park (FEP)									
						A	B	C	D	E	F	G	H	I	J
59	Cisticolidae	Ashy Tailorbird	*Orthotomus ruficeps*	LC	TP						/				
60	Cisticolidae	Rufescent Prinia	*Prinia rufescens*	LC	TP	/									
61	Cisticolidae	Yellow-bellied Prinia	*Prinia flaviventris*	LC	TP										/
62	Hemiprocnidae	Whiskered Treeswift	*Hemiprocne comata*	LC	TP		/	/						/	
63	Hemiprocnidae	Grey-rumped Treeswift	*Hemiprocne longipennis*	LC	TP			/							
64	Psittacidae	Blue-crowned Hanging-parrot	*Loriculus galgulus*	LC	TP			/							
65	Laniidae	Brown Shrike	*Lanius cristatus* [M]	LC	TP	/	/	/							
66	Laniidae	Tiger Shrike	*Lanius tigrinus* [M]	LC	TP		/		/						
67	Hirundinidae	House Swallow	*Hirundo javanica*	LC	TP		/	/		/				/	/
68	Hirundinidae	Barn Swallow	*Hirundo rustica* [M]	LC	TP			/		/	/				
69	Irenidae	Asian Fairy-bluebird	*Irena puella*	LC	TP		/	/	/		/			/	
70	Cuculidae	Raffles's Malkoha	*Rhinortha chlorophaea*	LC	TP		/	/							
71	Cuculidae	Black-bellied Malkoha	*Phaenicophaeus diardi*	NT	TP	/	/			/	/				
72	Cuculidae	Red-billed Malkoha	*Zanclostomus javanicus*	LC	TP					/		/			
73	Cuculidae	Chestnut-breasted Malkoha	*Phaenicophaeus curvirostris*	LC	TP					/		/		/	/
74	Cuculidae	Chestnut-bellied Malkoha	*Phaenicophaeus sumatranus*	NT	TP				/						
75	Cuculidae	Indian Cuckoo	*Cuculus micropterus* [R, M]	LC	TP		/								
76	Cuculidae	Square-tailed Drongo Cuckoo	*Surniculus lugubris* [R, M]	LC	TP				/						
77	Chloropseidae	Lesser Green Leafbird	*Chloropsis cyanopogon*	NT	TP	/	/	/	/		/				
78	Chloropseidae	Blue-winged Leafbird	*Chloropsis moluccensis*	LC	TP	/	/		/			/			
79	Chloropseidae	Greater Green Leafbird	*Chloropsis sonnerati*	EN	TP		/				/	/			
80	Bucerotidae	Oriental Pied Hornbill	*Anthracoceros albirostris*	LC	TP			/							
81	Bucerotidae	Wreathed Hornbill	*Rhyticeros undulatus*	VU	TP			/							
82	Bucerotidae	Wrinkled Hornbill	*Rhabdotorrhinus corrugatus*	EN	TP	/									
83	Eurylaimidae	Black-and-yellow Broadbill	*Eurylaimus ochromalus*	NT	TP			/	/		/				
84	Eurylaimidae	Black-and-red Broadbill	*Cymbirhynchus macrorhynchos*	LC	TP					/					
85	Eurylaimidae	Banded Broadbill	*Eurylaimus javanicus*	LC	TP										/
86	Picidae	Crimson-winged Woodpecker	*Picus puniceus*	LC	TP	/		/							
87	Picidae	Common Flameback	*Dinopium javanense*	LC	TP	/									
88	Picidae	Buff-necked Woodpecker	*Meiglyptes tukki*	NT	TP		/					/			
89	Picidae	Banded Woodpecker	*Chrysophlegma miniaceum*	LC	TP		/								
90	Picidae	Maroon Woodpecker	*Blythipicus rubiginosus*	LC	TP										/
91	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus*	LC	TP		/	/				/			
92	Campephagidae	Pied Triller	*Lalage nigra*	LC	TP	/									
93	Campephagidae	Lesser Cuckooshrike	*Lalage fimbriata*	LC	TP				/						
94	Vangidae	Large Woodshrike	*Tephrodornis virgatus*	LC	TP	/	/	/			/	/			

Table 4 (Con't): Checklist of avifaunal species recorded across the forest eco-parks during the present study

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	Forest Eco-Park (FEP)									
						A	B	C	D	E	F	G	H	I	J
95	Vangidae	Black-winged Flycatcher-shrike	*Hemipus hirundinaceus*	LC	TP			/			/				
96	Sturnidae	Common Hill Myna	*Gracula religiosa*	LC	P	/						/			
97	Sturnidae	Javan Myna	*Acridotheres javanicus* [F]	VU		/					/		/		/
98	Sturnidae	Asian Glossy Starling	*Aplonis panayensis*	LC			/				/				/
99	Columbidae	Pink-necked Green-pigeon	*Treron vernans*	LC	P	/	/					/			
100	Columbidae	Spotted Dove	*Spilopelia chinensis*	LC		/									/
101	Columbidae	Mountain Imperial-pigeon	*Ducula badia*	LC	TP		/								
102	Columbidae	Emerald Dove	*Chalcophaps indica*	LC	P				/	/	/	/			
103	Columbidae	Zebra Dove	*Geopelia striata*	LC					/		/		/		
104	Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus*	LC	TP	/						/			
105	Dicruridae	Bronzed Drongo	*Dicrurus aeneus*	LC	TP				/						
106	Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	LC	P	/									/
107	Estrildidae	Pin-tailed Parrotfinch	*Erythrura prasina*	LC							/				
108	Estrildidae	White-headed Munia	*Lonchura maja*	LC	P						/				
109	Estrildidae	White-rumped Munia	*Lonchura striata*	LC	P						/				
110	Estrildidae	White-bellied Munia	*Lonchura leucogastra*	LC	P										/
111	Monarchidae	Oriental Paradise-Flycatcher	*Terpsiphone affinis*	LC			/								
112	Monarchidae	Black-naped Monarch	*Hypothymis azurea*	LC					/	/				/	/
113	Aegithinidae	Common Iora	*Aegithina tiphia*	LC	TP		/					/			
114	Aegithinidae	Green Iora	*Aegithina viridissima*	NT	TP		/					/		/	
115	Motacillidae	Paddyfield Pipit	*Anthus rufulus*	LC	TP		/				/				
116	Passeridae	Eurasian Tree Sparrow	*Passer montanus*	LC			/								
117	Phylloscopidae	Arctic Warbler	*Phylloscopus borealis* [M]	LC	TP		/			/					/
118	Phylloscopidae	Yellow-browed Warbler	*Phylloscopus inornatus* [M]	LC	TP										/
119	Calyptomenidae	Green Broadbill	*Calyptomena viridis*	NT	TP		/								
120	Sittidae	Velvet-fronted Nuthatch	*Sitta frontalis*	LC	TP		/					/			
121	Paridae	Sultan Tit	*Melanochlora sultanea*	LC	TP		/								
122	Falconidae	Black-thighed Falconet	*Microhierax fringillarius*	LC	TP		/							/	
123	Stenostiridae	Grey-headed Canary-flycatcher	*Culicicapa ceylonensis*	LC	TP				/			/			
124	Meropidae	Red-bearded Bee-eater	*Nyctyornis amictus*	LC	TP							/			
125	Meropidae	Blue-throated Bee-eater	*Merops viridis* [R, M]	LC	TP						/		/		
126	Strigidae	Buffy Fish-Owl	*Ketupa ketupu*	LC	TP						/				
127	Turnicidae	Barred Buttonquail	*Turnix suscitator*	LC	TP						/				
128	Corvidae	Large-billed Crow	*Corvus macrorhynchos*	LC						/					
129	Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus* [R, M]	LC	P								/		
130	Vireonidae	White-bellied Erpornis	*Erpornis zantholeuca*	LC	TP									/	

Table 4 (Con't): Checklist of avifaunal species recorded across the forest eco-parks during the present study

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	Forest Eco-Park (FEP)									
						A	B	C	D	E	F	G	H	I	J
131	Zosteropidae	Hume's White-eye	*Zosterops auriventer*	LC	TP									/	
132	Pellorneidae	Short-tailed Babbler	*Pellorneum malaccense*	NT	TP										/
					Total Number of Family	18	29	19	17	15	20	18	8	15	17
					Total Number of Species	35	51	39	30	27	43	28	10	26	31

Note: A – Lata Kekabu FEP; B – Kaki Bukit Larut FEP; C – Ulu Kenas FEP; D – Kledang Saiong FEP; E – Ulu Kinta FEP; F – Papan FEP; G – Ulu Licin FEP; H – Sungai Salu FEP; I – Lata Iskandar FEP; J – Kuala Woh FEP; LC – Least Concern; NT – Near Threatened; VU – Vulnerable; EN – Endangered; TP – Totally Protected; P – Protected; R, M – both resident and migrant; F – feral/ introduced species

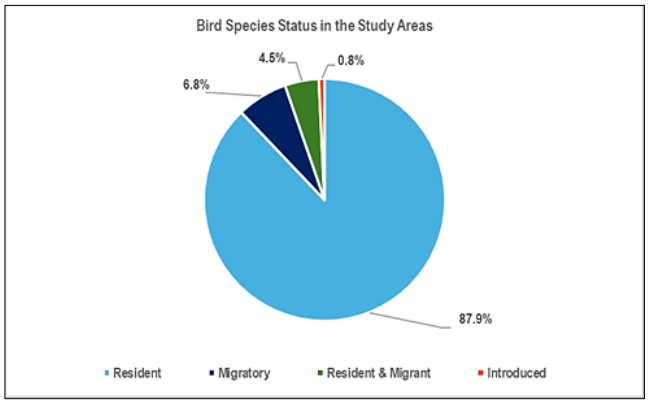

Figure 2: The bird species status in the study areas

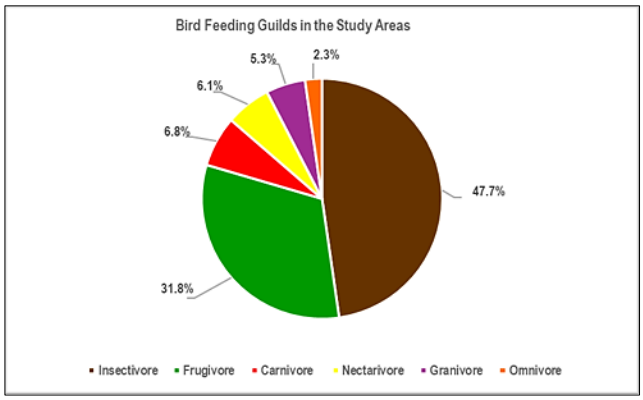

Figure 3: The bird feeding guilds in the study areas

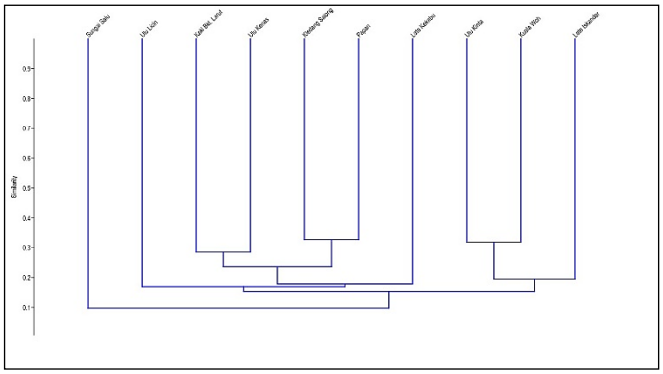

Figure 4: Dendrogram illustrating the similarity in bird species across 10 forest eco-parks in Perak

Figure 5: Black-headed Bulbul (*Brachypodius atriceps*) at Ulu Kenas FEP (Photo by Aina Amira, N. M.)

Figure 6: Black-crested Bulbul (*Rubigula flaviventris*) at Lata Iskandar FEP (Photo by Asyraff, M. A.)

Figure 7: Brown Shrike (*Lanius cristatus*) at Ulu Kenas FEP (Photo by Aina Amira, N. M.)

Figure 8: Oriental Magpie-robin (*Copsychus saularis*) at Kledang Saiong FEP (Photo by Aina Amira, N. M.)

4. CONCLUSION

Findings from this study highlight the importance of forest eco-parks as vital habitats for a diverse range of bird species in Perak, making them one of the region's key biodiversity hotspots. The dominance of Pycnonotidae, resident birds, and insectivorous species, emphasizes their critical role in ecosystem functioning via seed dispersal and insect regulation, as well as the importance of forest eco-parks in sustaining populations of functionally important birds that contribute to long-term forest resilience and conservation management. Based on this study, it is assumed that habitat structure, elevation, geographic location, food availability, and rainfall may be among the most influential factors shaping the richness of bird species across the forest eco-parks. The ecological uniqueness of each site underscores the importance of conserving multiple forest eco-parks to safeguard regional bird diversity. These eco-parks also qualify as Key Biodiversity Areas (KBAs), as they appear to support resident, migratory, and threatened species, while also contributing to ecological balance. However, this remains a preliminary assumption, and further studies are needed to establish the designation of these forest eco-parks as KBA in Malaysia.

Building on this excellent preliminary work, future research should explore long-term monitoring in the following areas: (1) to investigate the relationship between specific habitat types (e.g., forest edge, urban parks, wetlands) and bird species diversity and abundance; (2) to employ automated acoustic monitoring to survey bird species, particularly nocturnal or rare ones, providing a more comprehensive and less invasive census; (3) to explore the potential for collaborating with local birdwatching groups or local communities to integrate citizen science data (e.g., eBird and Malaysia Biodiversity Information System, MyBIS), thereby expanding the geographical and temporal scope of the research, as well as increased the coverage and frequency of data collection; (4) to study on how anthropogenic factors, such as urbanization and pollution, are affecting local bird populations and their migratory patterns would be a valuable contribution.

This baseline data provides practical guidance for stakeholders, such as: (1) forestry department can incorporate species and habitat information into development of effective management plans and also promote birdwatching activities as part of ecotourism activities in the forest eco-parks; (2) NGOs can prioritize conservation actions at important sites; (3) Local communities can take part in monitoring and habitat restoration.

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