

Comparative Studies of Avian Composition at Ayer Hitam Utara Forest Reserve, Muar, Johor

Tan Boon Keat¹, Nor Atiqah Norazlimi^{1*}, Mohd Lokman Ilham Norhakim²,
Abdul Muhaimin Abdul Halim¹

¹ Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia (Pagoh Campus), Hab Pendidikan Tinggi Pagoh,
KM1, Jalan Panchor, 84600 Muar, Johor,

² Kim Ichthyologist Centre, Kg Parit Samsu, Jalan Temenggong Ahmad, 84150 Parit Jawa, Muar, Johor, Malaysia

*Corresponding Author: atiqah@uthm.edu.my

DOI: <https://doi.org/10.30880/ekst.2024.04.02.076>

Article Info

Received: 28 December 2023

Accepted: 13 January 2024

Available online: 12 December 2024

Keywords

peat swamp forest, tropical lowland forest, bird composition, mist net, t-test, biodiversity indices

Abstract

The Ayer Hitam Utara Forest Reserve (AHUFR) represents the last peat swamp with diverse habitats in Johor, Malaysia. However, human-induced land conversion poses a threat to the ecological balance, affecting avian species distribution. This study aims to establish an avian species checklist and prioritize conservation areas in AHUFR by comparing different habitats. Sound recording, direct observation, and mist net methods were employed in the peat swamp (north) and lowland forest (south) areas. The sampling revealed 37 species, with 14 in the north and 28 in the south. 27 species were captured by sound recording, 9 species by observation, and 9 species by mist net. Notably, two Vulnerable species were identified: the Rhinoceros hornbill (*Buceros rhinoceros*) and Great argus (*Argusianus argus*). T-tests indicated no significant diversity differences between the two areas in 95% significant level, but lowland forests showed higher diversity and peat swamp forests exhibited higher evenness. In the conclusion, the study suggests a slightly higher priority for avian conservation in lowland forests over peat swamp forests in AHUFR.

1. Introduction

Peat swamp forest is a waterlogged forest formed in tropical regions. The waterlogged soil prevents organic matter from fully decomposing and forming a peat and acidic water body layer. The uniqueness of peat swamp forest contributed to the unique composition and endemism of flora and fauna. However, peat swamps are also sensitive ecosystems to environmental change in terms of humidity. The main threat to peat swamp forests is drought, in which peat swamps are extremely flammable in the dry season [1].

Birds play a crucial role in wetland ecosystems, serving as highly responsive bioindicators that reflect changes in habitat quality, productivity, and stability. With their strong environmental connections, birds are frequently used as surrogates to assess the impact of environmental changes. Peat swamp forests host a unique combination of tropical water birds and terrestrial species from tropical lowland forests. This habitat supports a diverse avifauna, including species such as the Bornean bristlehead (*Pityriasis gymnocephala*), Dusky munia (*Lonchura fuscans*), Bornean ground cuckoo (*Carpococcyx radiceus*), black hornbill (*Anthracoceros malayanus*), various bulbuls, kingfishers, and sunbirds [2].

The Ayer Hitam Utara Forest Reserve (AHUFR) in Johor, Malaysia, is the region's largest and final peat swamp, encompassing diverse habitats such as peat swamps and tropical lowland forests [3]. Despite its

ecological significance, human-induced land conversion in the surrounding areas poses a threat to the natural balance. The impact of this conversion on the distribution of avian species within AHUFR remains insufficiently explored, hindering comprehensive conservation efforts and effective management of the avian community in the reserve. Thus, this study aims to establish an avian species checklist and prioritize conservation areas in AHUFR by comparing different habitats.

2. Materials and Methods

2.1 Study areas

The Ayer Hitam Utara Forest Reserve (AHUFR) is situated in the Muar district of Johor, Peninsular Malaysia, precisely at latitude 2.057427 and longitude 102.806116 (Fig. 1). Encompassing a vast area of 3,797 hectares, AHUFR stands as the largest forest reserve in the region and represents the final bastion of peat swamp forests in Johor. Predominantly consisting of tropical lowland and peat swamp forests, AHUFR holds the unique distinction of being the sole peat swamp forest designated as a Forest State Park in Peninsular Malaysia.



Fig. 1 Map of AHUFR from Google Maps

Two sites were chosen for this study: Site 1 is situated to the north of the mining area between compartments 11 and 13, whereas Site 2 is located to the south of the mining area between compartments 12 and 14. As depicted in Fig. 2, Site 1 is in closer proximity to water resources and the peat swamp area, while Site 2 appears to resemble a lowland forest. Both sites are clearly marked on maps, with Site 1 represented in blue and Site 2 in red (Fig. 2).

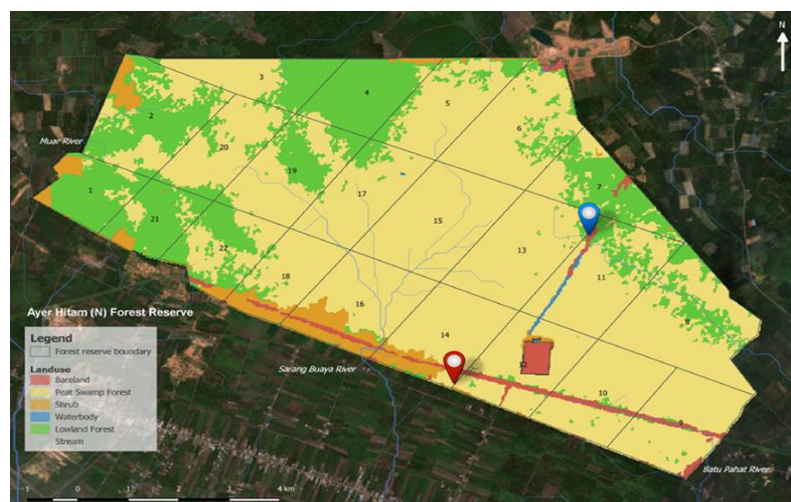


Fig. 2 Ayer Hitam Utara Forest Reserve by compartment [4]

2.2 Avian Checklist of AHUFR

To accomplish the primary objective of updating the avian species checklist in Ayer Hitam Utara Forest Reserve (AHUFR), a comprehensive methodology employing both active and passive methods was employed. Active methods involved point count observations along a 1 km transect line in two distinct habitats—peat swamp and lowland forest. Utilizing BirdNET, a bird sound recognition software, bird sounds were recorded and identified to species level. Data collection, comprising sight observations and sound recordings, occurred at fixed locations with a 50-meter radius for each 15-minute point count, spaced 200 meters apart along the transect line.

For the passive method, mist nets were strategically installed in chosen sites within both the North and South parts of AHUFR. These mist nets aimed to capture understory canopy birds, often small and elusive. Captured birds were meticulously identified to the species level using a specific bird field guide.

2.3 Prioritization of Avian Conservation Area in AHUFR

To meet this objective, a comparative analysis will leverage data from Section 3.2 to evaluate differences in avian composition between sites. An independent hypothesis test will ascertain the relationship between avian distribution and habitat type. Biodiversity indices (Simpson's, Shannon-Weiner, Pielou's) will offer insights into species richness, diversity, and evenness. The unequal t-test, addressing varying sample sizes and variances, will be applied at a 95% significance level ($\alpha=0.05$) for a two-tailed test. Avian composition similarity exceeding 95% supports the null hypothesis, indicating no difference in avian composition between sites and in peat swamp forests. These findings will illuminate the impact of habitat type on avian distribution in AHUFR. Following this analysis, a comprehensive ranking of avian conservation areas will be generated, integrating t-test results, biodiversity indices, and a comparison of species characteristics, behavior, and conservation status. For t-test and biodiversity indices, the analysis is conducted by using overall data of site 1 and site 2, and also data by each method to avoid bias and produce more detailed results.

3. Result and Discussion

3.1 Avian Checklist of AHUFR

Table 1 provides a comprehensive portrayal of avian species in AHUFR, utilizing sound recording, direct observation, and mist net techniques. The dataset encompasses 37 species, with 14 recorded on site 1 and 28 on site 2. Site-specific analysis reveals nine species on site 1, 23 on site 2, and five species common to both sites.

Among the 37 cataloged species, two are classified as Vulnerable, four as Near Threatened, and 31 as Least Concern based on IUCN conservation status. Site-specific breakdown indicates three Near Threatened species in site 1, and three Near Threatened along with two Vulnerable species in site 2.

For Vulnerable species, the Great argus (*Argusianus argus*) was recorded via sound recording, while the Rhinoceros hornbill (*Buceros rhinoceros*) was identified through both sound recording and direct observation. Among Near Threatened species, Black-and-yellow broadbill (*Eurylaimus ochromalus*), Chestnut-rumped babbler (*Stachyris maculate*), and Short-tailed babbler (*Pellorneum malaccense*) were documented through sound recording, while buff-necked woodpecker (*Meiglyptes tukki*) was captured using the mist net method. Additionally, three migrant species Black-and-yellow broadbill (*Eurylaimus ochromalus*), Chestnut-rumped babbler (*Stachyris maculate*), and Short-tailed babbler (*Pellorneum malaccense*) were documented through sound recording, while buff-necked woodpecker (*Meiglyptes tukki*) were captured exclusively by mist net during sampling.

Table 1 Checklist of Avian Species in Ayer Hitam Utara Forest Reserve, Johor

No	Common name	Local name	Species name	Conservation status	Distribution status	Sampling method	Occurrence	
							Site 1	Site 2
1	Arctic warbler	Cekup Daun Artik	<i>Phylloscopus borealis</i>	Least Concern	Migrant	Sound recording, mist net	x	✓
2	Asian palm swift	Layang-layang Asia	<i>Cypsiurus balasiensis</i>	Least concern	Native	Observation	✓	x
3	Black-and-yellow Broadbill	Takau Hitam Kuning	<i>Eurylaimus ochromalus</i>	Near Threatened	Native	Sound recording	✓	✓
4	Black-capped babbler	Rimba Kopiah Hitam	<i>Pellorneum capistratum</i>	Least Concern	Native	Sound recording	x	✓

5	Black-headed bulbul	Merbah Kepala Hitam	<i>Brachypodius atriceps</i>	Least Concern	Native	Sound recording	x	✓
6	Black-naped monarch	Sambar Uban Hitam	<i>Hypothymis azurea</i>	Least Concern	Native	Sound recording	x	✓
7	Blue-eared Barbet	Takur Telinga Biru	<i>Psilopogon duvacelii</i>	Least concern	Native	Sound recording, observation	✓	✓
8	Blue-eared Kingfisher	Pekaka Bintik-bintik	<i>Alcedo meninting</i>	Least concern	Native	Observation , mist net	✓	x
9	Bold-striped tit-babbler	Kekicau berjalur tebal	<i>Mixornis bornensis</i>	Least Concern	Native	Sound recording	x	✓
10	Brahminy kite	Helang Merah	<i>Haliastur indus</i>	Least Concern	Native	Observation	x	✓
11	Brown shrike	Tirjup Belukar	<i>Lanius cristatus</i>	Least Concern	Native	Sound recording	x	✓
12	Buff-necked woodpecker	Belatuk Tuki-tuki	<i>Meiglyptes tukki</i>	Near threatened	Native	Mist net	✓	x
13	Changeable hawk-eagle	Helang Hindek	<i>Nisaetus cirrhatus</i>	Least Concern	Native	Sound recording	x	✓
14	Chestnut-rumped Babbler	Kekicau Pinggul Perang	<i>Stachyris maculata</i>	Near Threatened	Native	Sound recording	✓	✓
15	Chestnut-winged babbler	Kekicau Sayap Perang	<i>Cyanoderma erythroptera</i>	Least Concern	Native	Sound recording, mist net	x	✓
16	Common Hill Myna	Tiong Emas	<i>Gracula religiosa</i>	Least concern	Native	Sound recording	✓	✓
17	Common iora	Burung Kunyit Kecil	<i>Aegithina tiphia</i>	Least concern	Native	Observation	✓	x
18	Crested Serpent-eagle	Burung Lang Kuik	<i>Spilornis cheela</i>	Least Concern	Native	Observation	x	✓
19	Dark-necked tailorbird	Perenjak Leher Hitam	<i>Orthotomus atrogularis</i>	Least Concern	Native	Sound recording	x	✓
20	Grey-headed Flycatcher	Sambar Kepala Kelabu	<i>Culicicapa ceylonensis</i>	Least concern	Native	Sound recording	✓	x
21	Great argus	Kuang Raya	<i>Argusianus argus</i>	Vulnerable	Native	Sound recording	x	✓
22	Great egret	Bangau Besar	<i>Ardea alba</i>	Least Concern	Native	Sound recording	x	✓
23	Greater Racket-tailed Drongo	Cecawi Anting-anting	<i>Dicrurus paradiseus</i>	Least concern	Native	Sound recording	✓	x
24	Tiger shrike	Tirjup Harimau	<i>Lanius tigrinus</i>	Least Concern	Migrant	Mist net	x	✓
25	Lesser coucal	Bubut Kecil	<i>Centropus bengalensis</i>	Least Concern	Native	Sound recording	x	✓
26	Pin-striped tit-babbler	Kekicau Berjalur	<i>Mixornis gularis</i>	Least Concern	Native	Sound recording	x	✓
27	Purple-naped sunbird	Kelicap Rimba	<i>Kurochkinagra hypogrammicum</i>	Least concern	Native	Mist net	✓	x

28	Olive-winged bulbul	Merbah Belukar	<i>Pycnonotus plumosus</i>	Least Concern	Native	Mist net	x	✓
29	Rhinoceros hornbill	Enggang Badak	<i>Buceros rhinoceros</i>	Vulnerable	Native	Sound recording, observation	x	✓
30	Rufous-tailed tailorbird	Perenjak Ekor Merah	<i>Orthotomus sericeus</i>	Least Concern	Native	Sound recording	x	✓
31	Short-tailed babbler	Kekicau Ekor Pendek	<i>Pellorneum malaccense</i>	Near Threatened	Native	Sound recording	x	✓
32	Spectacled Bulbul	Merbah Kecil	<i>Rubila erythrothal mos</i>	Least concern	Native	Sound recording	✓	x
33	White-breasted Waterhen	Wak-wak	<i>Amaurornis phoenicurus</i>	Least concern	Native	Sound recording	✓	x
34	White-rumped Shama	Murai Batu	<i>Copsychus malabaricus</i>	Least concern	Native	Sound recording, observation, mist net	✓	✓
35	White-throated kingfisher	Pekaka Dada Putih	<i>Halcyon smyrnenis</i>	Least Concern	Native	Sound recording	x	✓
36	Yellow-rumped flycatcher	Sambar Belakang Kuning	<i>Ficedula zanthopygia</i>	Least Concern	Migrant	Observation, mist net	x	✓
37	Yellow-vented bulbul	Merbah Kapur	<i>Pycnonotus goiavier</i>	Least Concern	Native	Sound recording	x	✓
Total							14	28

The study predominantly relied on sound recording, capturing 27 out of 37 species, with nine species in site 1 and 22 in site 2. Direct observation recorded nine species (three from site 1 and six from site 2), while the mist net captured nine species (four from site 1 and five from site 2). Notably, sound recording emerged as the most efficient method, particularly in challenging environments like peat swamp and tropical lowland forests, where direct observation proved less effective.

Identification using BirdNET introduced variability due to factors such as sound disturbance, distance of sources, and overlapping sounds. BirdNET precision ranged from 72 to 85%, while recall rates varied from 33 to 84% [5], emphasizing the sensitivity to recording settings and conditions.

Overall, data from site 1 were comparatively fewer than from site 2. Despite site 2's proximity to human settlements, the impact of human activities on avian composition appears low, with observations of nesting, particularly for the vulnerable Rhinoceros hornbill. The speculated nesting season for species like Blue-eared barbet and Rhinoceros hornbill in site 2 highlights its importance for conservation, indicating a higher priority than site 1 for avian species.

3.2 Prioritization of Avian Conservation Area in AHUFR

As the total number of samples from site 1 and site 2 are different, the unequal variance t-test is used. This test is used to identify the diversity of sites by analyzing the abundance and richness of species in the site. Table 2 below shows the summary of the t-test results for this study indicating that there is no significant difference in diversity between Site 1 and Site 2.

Table 2 Result of t-test

	Degree of freedom	Critical value (p-value)	T value
Overall	21	±2.080	-0.213
Sound recording	10	±2.228	-0.051
Observation	5	±2.571	0.320
Mist net	3	±3.182	-1

Table 3 Overview of biodiversity indices results from this study.

Biodiversity indices		Site	
		Site 1	Site 2
Simpson's index, D:	Overall	0.0882	0.0569
	Sound recording	0.0735	0.0453
	Observation	0.6222	0.2952
	Mist net	0	0.2778
Simpson's dominance index, 1/D:	Overall	11.3379	17.5747
	Sound recording	13.6054	22.0751
	Observation	1.6072	3.3875
	Mist net	∞	3.5997
Shannon-Weiner index, H:	Overall	2.3995	2.9741
	Sound recording	2.1193	2.8897
	Observation	0.639	1.3793
	Mist net	1.3863	1.3031
Pielou's Evenness Index, J:	Overall	0.9092	0.8925
	Sound recording	0.9645	0.9349
	Observation	0.5816	0.7698
	Mist net	1	0.8097

Based on Table 3 above, Simpson's index (D) and Shannon-Weiner index (H) reveal that the overall diversity of avian species in site 2 surpasses that of site 1. This trend is consistent across sound recording, where species diversity is higher in site 2, and observation, where site 2 exhibits significantly greater species diversity than site 1. The contrasting diversity pattern emerges in mist net data, with site 1 displaying higher species diversity than site 2. This unexpected result is attributed to adverse weather conditions during sampling in site 1, leading to reduced observation and sound recording durations compared to site 2. Mist nets are less useful in inclement weather, particularly when it's raining or when there are strong winds in more open environments [6]. The mist net data further diverges from sound recording and observation, displaying infinite diversity in Simpson's index for site 1, where even though fewer individuals were captured compared to site 2, each individual belonged to a different species, avoiding dominance observed in site 2. Despite having a lower species diversity than non-peat lowland forest, the peatland ecosystem has unique and distinctive avifauna [7].

In terms of Simpson's dominance index (1/D), site 1 exhibits higher overall dominance than site 2, consistent with sound recording and observation data. However, mist net data presents a different perspective, indicating extremely low dominance in site 1 compared to site 2.

Contrary to species diversity indices, Pielou's evenness index (J) portrays site 1 as having higher overall evenness than site 2. This is particularly evident in sound recording and mist net data, where site 1 shows complete evenness. In observation, site 2 demonstrates higher evenness, primarily due to the dominance of Asian palm swift, which constitutes 80% of total observations in site 1, causing a less even distribution compared to site 2.

The comprehensive analysis of different biodiversity indices underscores that species diversity is greater in the lowland forest of site 2 compared to the peat swamp forest of site 1 within AHUFR. The higher diversity in site 2 is attributed to a more diverse vegetation composition. However, mist net data in site 2 indicates the dominance of yellow-rumped flycatchers (*Ficedula zanthopygia*), highlighting that, despite higher species diversity, certain species may enjoy a competitive advantage in the environment. This species forages primarily at the crown level, but in a more open environment, it may take lookout perches as low as one meter above the ground [8], and this might be the reason why this species has been captured in large numbers by mist net with two-meter poles during sampling.

Regarding species evenness, site 1 exhibits higher evenness than site 2, suggesting that the complex resources and environment in the peat swamp area contribute to more complex species niches and reduced dominance. However, observation data, notably the prevalence of Asian palm swift (*Cypsiurus balasiensis*) in site 1, challenges this interpretation, revealing that specific species can dominate certain areas despite overall evenness. The observed higher abundance of Asian palm swift is attributed to its preference for open areas and water resources, accentuated by rainy weather conditions during sampling.

4. Conclusion

In summary, the study recorded a total of 37 avian species in both the peat swamp forest (site 1) and lowland forest (site 2) of AHUFR. Site 1 yielded 14 species, site 2 produced 28 species, with nine unique to site 1, 23

unique to site 2, and five common to both. Despite the absence of a significant difference in diversity between peat swamp (site 1) and lowland forest (site 2) according to the t-test, biodiversity indices revealed higher species diversity in site 2 and greater species evenness in site 1. Concerning conservation status, two Vulnerable species (Rhinceros hornbill and Great argus) were recorded in site 2, along with nesting activities of species such as Blue-eared barbet and Rhinceros hornbill. Consequently, the priority for avian conservation is slightly higher in site 2, emphasizing the need for concentrated and prioritized conservation efforts in this specific area of AHUFR.

Acknowledgement

We would like to extend our gratitude to Universiti Tun Hussein Onn Malaysia (UTHM) for providing the platform for this research.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design, data collection, methodology, analysis and interpretation of results:** Tan Boon Keat, Nor Atiqah Binti Norazlimi, Mohd Lokman Ilham Norhakim and Abdul Muhaimin bin Abdul Halim. All authors reviewed the results and approved the final version of the manuscript.*

References

- [1] Posa, M. R. C., Wijedasa, L. S., & Corlett, R. T. (2011, January 1). Biodiversity and conservation of Tropical Peat Swamp Forests. OUP Academic. Online Magazine Article.
- [2] Posa, M. R. C., & Marques, D. A. (2012). Peat swamp forest birds of the Tuanan research station, Central Kalimantan, Indonesia, with notes on habitat specialists.
- [3] Muhamad Jais, N. N. B., Linatoc, A. C., Muhamad Sa'ed, M. I. B., & Mohamad, S. (2022, December 31). Inventory of Non-Timber Species in Ayer Hitam Utara Forest Reserve, Johor.
- [4] Shamsuddin, S. A., Faidi, M. A., Husin, H. I. M., Ishak, M. F., Parlan, I., & Marjuni, H. (2021, December 1). The conservation of ground water levels in the peat swamp forest at Ayer Hitam North Forest Reserve, Muar in Johor, Malaysia. *Journal of Water Resource and Protection*.
- [5] Pérez-Granados, C. (2023, March 20). How to use birdnet. British Ornithologists' Union.
- [6] Karr, J. R. (1981). surveying birds with mist nets - researchgate. SURVEYING BIRDS WITH MIST NETS.
- [7] Fujita, M. S., Samejima, H., Haryadi, D. S., & Muhammad, A. (1970, January 1). Characteristics of bird community response to land use change in tropical peatland in Riau, Indonesia.
- [8] Bird Society of Singapore. (n.d.). Yellow-rumped Flycatcher.