Observations on Vertebrates at Padang Chong Forest Reserve, Perak

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Abstract. Observations on wildlife especially on arboreal and nocturnal species can generate important information especially in a forest reserve. Therefore, observations using binoculars (daytime) and torchlight (night) at Padang Chong Forest Reserve (PCFR) were carried out during five sessions in the months of June until November 2022. These activities were carried out at two sites namely P1 (500m from the forest edge) and P2 (500m up to 1000m from the forest edge). As a result, 65 species from 41 families were recorded. Of these, avifauna recorded 42 species from 23 families, mammals (nine species, seven families), amphibians (five species, five families), and reptiles (nine species, six families). Of these, there are 11 species had been classified as threatened species, where mammals with six threatened species followed by avifauna with four threatened species and herpetofauna with single threatened species. This study also shows that forest interior harbor the higher species richness of vertebrates with 91% (of the total species recorded) compare to forest edge that only consist of 11% (of the total species recorded) This information does not represent the whole wildlife community in PCFR. However, with this information, further monitoring can be carried out to better understand the wildlife communities in PCFR. Therefore, actions and strategies can be formulated to conserve this habitat for wildlife and future generations.

1. Introduction

Malaysia is one of twelve (12) mega-diverse countries in the world and listed as biodiversity hotspots in the tropical region of Southeast Asia [1, 2]. In Malaysia, the complex and rich tropical rainforest holds a large number of faunal diversity including vertebrates. Malaysia has an estimated 306 species of mammals, more than 742 species of birds, 567 species of reptiles, 242 species of amphibians, over 449 species of freshwater fish and more than 1,619 species of marine fish [2].

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Despite their richness in faunal diversity, tropical rainforest in Peninsular Malaysia are being destroyed and degraded at an alarming rate due to anthropogenic activities such as urbanization and conversion into agricultural fields [3]. Rapid urbanization and the accompanying increase road networks have also placed pressure on its biodiversity. Such networks require trade-offs in land use and lead to forest fragmentation. The emergence of forest fragmentation creates concern for conservationist as the process disrupts the structure and spatial continuity as it reduces original forested area, increases edge formation, and isolates remaining forest [2].

Edge formation in a forest area alters the abiotic factors (physical conditions, more direct sunlight, higher soil temperatures, differences in humidity, and increased wind exposure) as well as changes in the biological characteristics near the margin or edge of the patch, often called as an edge-interior effect [4]. Resulting in less stable habitats and alteration of species richness and composition in comparison to that of the interior habitats, therefore should be considered as two distinct habitats [5]. Edge formation provides habitat for species that prefer edge habitats, while species with particular habitat requirements will be pushed further into the interior habitat where the characteristics of forest remain unchanged. When these species being pushed into the now-smaller interior habitat, the competition for limited resources and niches will be increased.

Malaysia has introduced an initiative called Central Forest Spine (CFS) to create more expansive forested areas through ecological corridors that connect fragmented forests in Peninsular Malaysia. One of the ecological corridors recognized within the northern parts of Peninsular Malaysia are Padang Chong Forest Reserve (PCFR) - Sungai Kuak Forest Reserve (SKFR). PCFR represent Bintang Hijau forest complex and SKFR represent Main Range forest complex were identified as Primary Linkages 4 (CFSI-PL4), where the priority is to re-establish a connection between the Bintang Hijau forest complex and the Main Range forest complex [6].

The Bintang Hijau forest complex is almost entirely separated from the Main Range forest complex by the Kuala Kangsar-Gerik main road, a wide stretch of agriculture land (mostly rubber), and scattered human settlements including Gerik and Lenggong towns along the road [6]. In addition, there are scrubland, cleared land, and rubber plantations within this corridor. Along a narrow stretch of the Gerik-Pengkalan Hulu main road, the PCFR extends all the way to the main road. To the east of the main road, there is still (logged over) state land forest remaining between the main road and SKFR on the Main Range forest complex. Therefore, connecting and securing this CFSI-PL4 is essential to maintain forest connectivity across the northern section of the Main Range forest complex and the Bintang Hijau forest complex.

Unfortunately, there is no available baseline data and information in the scientific literature regarding vertebrate species in PCFR. Thus, this study aims to document the presence of vertebrate species within PCFR and compare the vertebrate species richness between the forest edge and forest interior. Therefore, with the insight on vertebrate species inquiry in PCFR, this study could supply baseline and essential information to the decision-makers, especially the state or local authorities in formulation of appropriate and effective management strategies for PCFR and also for this ecological corridor.

2. Materials and Methods

2.1. Study Site

Perak, which located in the north-western part of Peninsular Malaysia are considered as the second largest state in Peninsular Malaysia. The state is surrounded by Kedah and Thai state

(from the North), Kelantan and Pahang (from the East), and Selangor (from the South) [7]. The total land area of Perak covers approximately 2.11 million ha. Perak has a total forested area of 1.01 million ha (48.13% of the state land area). An area of 988,604 ha (97.6%) of the forested area in Perak has been gazetted as a Permanent Forest Reserve, which scattered among 77 forest reserve [8]. This survey focuses on one of the forest reserve in Perak, namely Padang Chong Forest Reserve (PCFR) which located in Pengkalan Hulu, Hulu Perak, Perak. This study also focuses specifically on compartment 12 as suggested by the Forestry Department of Hulu Perak due to their suitability habitat for the taxa that are focuses on in this survey.

2.1.1. Habitat Characteristics

PCFR is a secondary forest which is classified as a production forest type [11]. This forest reserve is a combination of lowland dipterocarp forest and hill dipterocarp forest, with also some part of sympodial growth bamboo that may thrive as a result of past logging activities or other disturbances. With an area of 1,134 ha, this forest reserve mainly consists of steep topography. PCFR have mostly close canopy closure on the interior part of the forest, while some parts with open canopy such as on the edge of the forest, near the edge of the forest and on the river flow pathway. In addition, the main activities surrounding PCFR are the cultivation of rubber trees, human settlements, and a stretch of the Gerik-Pengkalan Hulu main road.

2.2. Sampling Technique

Surveys were conducted during five sessions from the months of June until November 2022. Each session comprises five conservative days that are allotted for this observational survey. In this study, the forest was categorized into two, namely, P1 - 500m from the forest edge (N 05°41'03.4", E 101°01'11.0") and P2 – 1000m from the forest edge (N 05°41'19.1", E 101°00'58.0") (**Figure 1**). One line transect was established with 1000m distance from the forest edge and divided into two distance category, which 0m to 500m distance from the forest edge was considered as forest edge, while in 500m to 1000m considered as forest interior.

The study of vertebrates was conducted through direct observation methods by four to five observers which slowly walked along the transect line. All vertebrates sighting or calling was recorded and identified using various field guides accordingly [9, 10, 11, 12, 13]. All surveys were done during fair weather (no heavy winds and rain).

2.2.1. Mammals

Direct observation was carried out along the transect line by using binoculars 8 x 40 and canon DSLR cameras during the day and night, in order to record the diurnal and nocturnal active mammals. Footprints, scratch marks, feces droppings and salt lick from potential mammals have also been recorded and photographed if found in the study area. All mammal's species sighting was recorded in Zoology datasheet and species identification was done by referring to mammal's field guide [9].

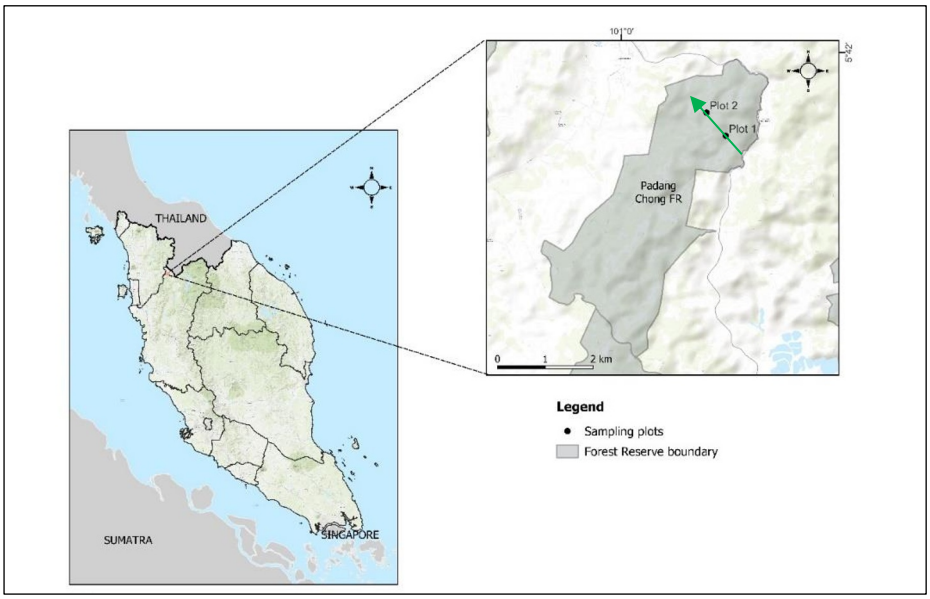

Figure 1. Locations of Line Transect at point 500m (Plot 1) and Line Transect at point 1000m (Plot 2).

2.2.2. Avifauna

Survey of avifauna were carried out twice a day, from 7.30 a.m. to 11.30 a.m. and from 4.30 p.m. to 7.00 p.m. This observation was carried out along the transect line by using binoculars 8 x 40 and picture were taken using canon DSLR camera for further reference and identification purposes. Avifauna sighting were recorded in Zoology datasheet and species identification was done by referring to bird's field guides [10, 11].

2.2.3. Herpetofauna

Active observation technique was conducted along the transect line, under the rock, on the tree, and near water bodies. Two days of active search was done on each survey session, with time was set for two to three hour during the day and night respectively. This to maximize the probability of recording both diurnal and nocturnal herpetofauna species. Morning session was done for two hours from 9.00 a.m. to 11.00 a.m., while night session was done for three hours from 8.00 p.m. to 11.00 p.m. with headlamps was used to aid visibility in the dark. All species sighted were photographed using a Canon DSLR camera and recorded in Zoology datasheet for further reference and identification purposes. Identification of herpetofauna species was done by referring to herpetofauna field guides [12, 13].

2.3. Vertebrate Checklist

A preliminary checklist of the vertebrate's species was prepared together with their conservation status globally and protection status nationally that will be based on IUCN Red List of Threatened Species and Wildlife Conservation Act (2010) respectively. This preliminary checklist was prepared from the findings of the inventory that has been carried out throughout the survey sessions.

3. Results and Discussion

Overall, 65 species from 41 families of vertebrates were recorded and documented in these surveys **(Table 1-3)**. Among these, avifauna recorded the highest species observed with 42 species from 23 families followed by herpetofauna with 14 species from 11 families and mammals with nine species from seven families. Cercopithecidae and Hylobatidae recorded as the most dominant mammal's families in PCFR with each contribute 22% (two species) of total mammal's species observed. In contrast, mammal's families of Cynocephalidae, Felidae, Lorisidae, Mustelidae and Suidae were represented by a single species (11%) respectively. Of these, Cynocephalidae represented by Sunda Flying Lemur (*Galeopterus variegatus*), Felidae consists of Leopard Cat (*Prionailurus bengalensis*) and Lorisidae comprises of Greater Slow Loris (*Nycticebus coucang*) are sighted during the night time as they are nocturnal active species. In addition, Mustelidae represented by Oriental Small-Clawed Otter (*Aonyx cinerea*) are observed in the small river flow near the forest edge.

Among the avifauna families, Columbidae and Pycnonotidae are the most dominant families with four species (10%) each, followed by Cisticolidae, Megalaimidae and Picidae that contribute three species (7%) each, while families of Bucerotidae, Dicaeidae, Dicruridae, Estrildidae, Meropidae, Muscicapidae and Phasianidae recorded with two species (5%) each **(Figure 2)**. In contrast, another 11 families of avifauna were represented by only a single species (2%) respectively. Of these, only one species of Phasianidae which is Great Argus (*Argusianus argus*) are not sighted or observed throughout the surveys, but found traces such as fallen feathers on the forest floor and also its calling.

Among 14 species of herpetofauna, five species from five families belong to amphibians. All five amphibian families were represented by a single species (20%) respectively. In the other hand, another nine species from six families of herpetofauna are belong to reptiles. In term of reptile families, the most dominant in PCFR are Colubridae, Geoemydidae and Scincidae with two species (22%) each. In contrast families of Agamidae, Elapidae and Gekkonidae were represented by only a single species (11%) respectively.

Table 1. Checklist of mammals recorded during surveys at Padang Chong Forest Reserve, Perak.

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	P1	P2
1	Cercopithecidae	Long-Tailed Macaque	*Macaca fascicularis*	EN	P		x
		Dusky leaf monkey	*Trachypithecus obscurus*	EN	P		x
2	Cynocephalidae	Sunda Flying Lemur	*Galeopterus variegatus*	LC	TP		x
3	Felidae	Leopard Cat	*Prionailurus bengalensis*	LC	TP		x
4	Hylobatidae	Agile Gibbon	*Hylobates agilis*	EN	TP		x
		Siamang	*Symphalangus syndactylus*	EN	TP		x
5	Lorisidae	Greater Slow Loris	*Nycticebus coucang*	EN	TP		x
6	Mustelidae	Oriental Small-Clawed Otter	*Aonyx cinereus*	VU	TP	X	
7	Suidae	Wild Pig	*Sus scrofa*	LC	P		x
Total	**7**		**9**				

IUCN= International Union for Conservation of Nature; LC= Least Concern; VU= Vulnerable; EN= Endangered
WCA 2010= Wildlife Conservation Act 2010; P=Protected; TP; Totally Protected

Table 2. Checklist of avifauna recorded during surveys at Padang Chong Forest Reserve, Perak.

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	P1	P2
1	Accipitridae	Crested Serpent-Eagle	*Spilornis cheela*	LC	TP		x
2	Alcedinidae	White-throated Kingfisher	*Halcyon smyrnensis*	LC	TP		x
3	Bucerotidae	Black Hornbill	*Anthracoceros malayanus*	VU	TP		x
		Bushy-crested Hornbill	*Anorrhinus galeritus*	NT	TP		x
4	Campephagidae	Fiery Minivet	*Pericrocotus igneus*	NT	TP		x
5	Chloropseidae	Greater Green Leafbird	*Chloropsis sonnerati*	EN	TP		x
6	Cisticolidae	Common Tailorbird	*Orthotomus sutorius*	LC	TP		x
		Dark-necked Tailorbird	*Orthotomus atrogularis*	LC	TP		x
		Yellow-bellied Prinia	*Prinia flaviventris*	LC	TP		x
7	Columbidae	Spotted Dove	*Spilopelia chinensis*	LC			x
		Emerald Dove	*Chalcophaps indica*	LC	P		x
		Zebra Dove	*Geopelia striata*	LC			x
		Green Imperial-Pigeon	*Ducula aenea*	NT	TP		x
8	Cuculidae	Chestnut-bellied Malkoha	*Phaenicophaeus sumatranus*	NT	TP		x
9	Dicaeidae	Crimson-breasted Flowerpecker	*Prionochilus percussus*	LC	TP		x
		Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	LC	TP		x
10	Dicruridae	Bronzed Drongo	*Dicrurus aeneus*	LC	TP		x
		Greater Racquet-tailed Drongo	*Dicrurus paradiseus*	LC	TP		x
11	Estrildidae	Pin-tailed Parrotfinch	*Erythrura prasina*	LC			x
		Scaly-breasted Munia	*Lonchura punctulata*	LC	P		x
12	Eurylaimidae	Black-and-yellow Broadbill	*Eurylaimus ochromalus*	NT	TP		x
13	Irenidae	Asian Fairy-bluebird	*Irena puella*	LC	TP		x
14	Laniidae	Tiger Shrike	*Lanius tigrinus*	LC	TP		x
15	Megalaimidae	Brown Barbet	*Caloramphus fuliginosus*	LC	TP		x

		Golden-throated Barbet	*Psilopogon franklinii*	LC	TP		x
		Gold-whiskered Barbet	*Psilopogon chrysopogon*	LC	TP		x
16	Meropidae	Red-bearded Bee-eater	*Nyctyornis amictus*	LC	TP		x
		Blue-throated Bee-eater	*Merops viridis*	LC	TP		x
17	Motacillidae	Paddyfield Pipit	*Anthus rufulus*	LC	TP		x
18	Muscicapidae	Yellow-rumped Flycatcher	*Ficedula zanthopygia*	LC	TP		x
		Mugimaki Flycatcher	*Ficedula mugimaki*	LC	TP		x
19	Nectariniidae	Plain Sunbird	*Anthreptes simplex*	LC	TP		x
20	Phasianidae	Red Junglefowl	*Gallus gallus*	LC	P	x	x
		Great Argus	*Argusianus argus*	VU	TP		x
21	Picidae	Crimson-winged Woodpecker	*Picus puniceus*	LC	TP		x
		Buff-necked Woodpecker	*Meiglyptes tukki*	NT	TP	x	
		Great Slaty Woodpecker	*Mulleripicus pulverulentus*	VU	TP		x
22	Pycnonotidae	Grey-bellied Bulbul	*Ixidia cyaniventris*	NT	TP		x
		Stripe-throated Bulbul	*Pycnonotus finlaysoni*	LC	TP		x
		Olive-winged Bulbul	*Pycnonotus plumosus*	LC	TP		x
		Buff-vented Bulbul	*Iole olivacea*	NT	TP		x
23	Timaliidae	Fluffy-backed Tit-Babbler	*Macronus ptilosus*	NT	TP		x
Total	**23**		**42**				

IUCN= International Union for Conservation of Nature; LC= Least Concern; NT= Near Threatened; VU= Vulnerable; EN= Endangered
WCA 2010= Wildlife Conservation Act 2010; P=Protected; TP; Totally Protected

Table 3. Checklist of herpetofauna recorded during surveys at Padang Chong Forest Reserve, Perak.

No.	Family	Common Name	Scientific Name	IUCN	WCA 2010	P1	P2
1	Bufonidae	Dwarf Toad	*Ingerophrynus parvus*	LC			x
2	Dicroglossidae	Asian Grass Frog	*Fejervarya limnocharis*	LC			x
3	Megophryidae	Spotted Litter Frog	*Leptobrachium hendricksoni*	LC			x
4	Microhylidae	Dark-sided Chorus Frog	*Microhyla heymonsi*	LC			x
5	Rhacophoridae	Four-lined Tree Frog	*Polypedates leucomystax*	LC			x
6	Agamidae	Fringed Flying Dragon	*Draco fimbriatus*	LC			x
7	Colubridae	Asian Vine Snake	*Ahaetulla prasina*	LC	P		x
		Yellow-striped ratsnake	*Coelognathus flavolineatus*	LC			x
8	Elapidae	Blue coral snake	*Calliophis bivirgata*	LC		x	
9	Gekkonidae	Peters's bow-fingered gecko	*Cyrtodactylus consobrinus*	LC	P	x	
10	Geoemydidae	Asian leaf turtles	*Cyclemys dentata*	NT	P	x	
		Malayan flat-shelled turtle	*Notochelys platynota*	VU	P	x	
11	Scincidae	East Indian brown mabuya	*Eutropis multifasciata*	LC			x
		Banded Lipinia	*Lipinia vittigera*	LC			x
Total	**11**		**14**				

IUCN= International Union for Conservation of Nature; NE= Not Evaluated; LC= Least Concern; NT= Near Threatened; VU= Vulnerable
WCA 2010= Wildlife Conservation Act 2010; P=Protected

According to distance category, forest interior harbor the highest species richness of vertebrates with 59 species (91% of the total species recorded) compare to forest edge that only consist of 7 species (11% of the total species recorded) **(Figure 2)**. Nevertheless, there are vertebrate's species that are only sighted in forest edge but are not observed in forest interior throughout the surveys, such as mammal: Oriental Small-Clawed Otter (*Aonyx cinerea*), avifauna: Buff-necked Woodpecker (*Meiglyptes tukki*) and herpetofauna: Blue coral snake (*Calliophis bivirgata*), Peters's bow-fingered gecko (*Cyrtodactylus consobrinus*), Asian leaf turtles (*Cyclemys dentata*) and Malayan flat-shelled turtle (*Notochelys platynota*). Furthermore, there are only single species that can be found on both (forest edge and forest interior) which are Red Junglefowl (*Gallus gallus*). This show that forest edge can be considered to be a distinct habitat which support a distinct community as it is inhabited by a characteristic set of species that differ from the forest interior [4]. In some cases, species richness and abundance increase in forest edge due to the increased food availability and the fact that forest edge is suitable for some species such as generalist species but unsuitable for others such as specialist species [4, 14, 15]. Edge formation cause specialist species that have special habitat requirements to be pushed further into the interior habitat where the characteristics of forest remain unchanged and create the 'vacancies' on the forest edge [16]. Thus, this 'vacancies' or habitat availability may be filled or invaded by species that have a wider tolerance range and the edge may also introduce species that would not formally and normally be found in the interior habitat [14]. However, this can't be applied to all forest edge because forest edge with continued disturbances may not have such increasing in species richness and abundance [17]. In fact, will experience a decrease in richness and abundance of species.

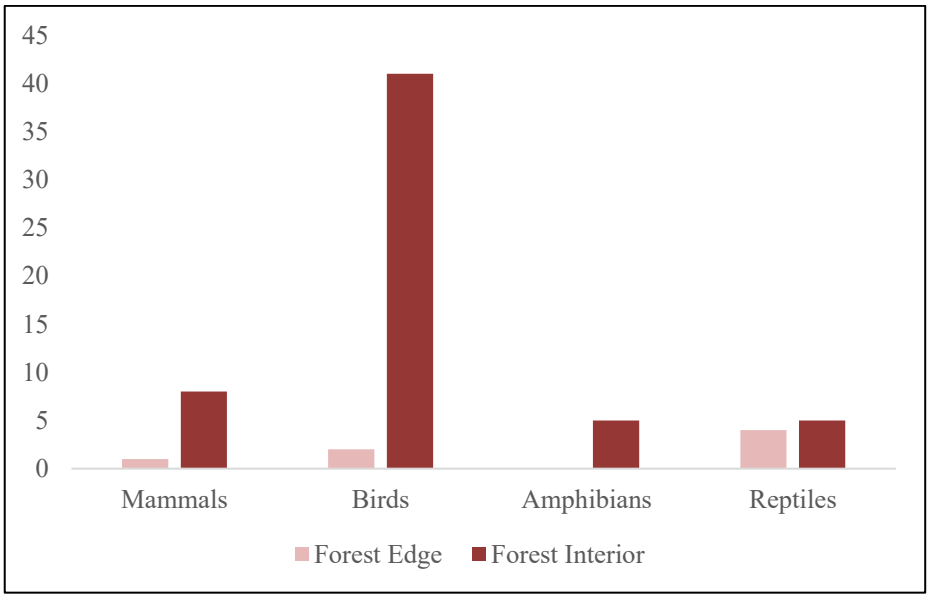

Figure 2. Number of vertebrate species in forest edge and forest interior

Low in vertebrate species richness in the forest edge compared to the forest interior from this study may be related to the continued disturbances toward the forest edge as it is next to the Gerik-Pengkalan Hulu main road. This related to forest edge near the road often reduces sign, movements, and abundance of species due to the increased traffic movement, vehicular noise, vibrations, and light pollution [18]. In fact, noise pollution was postulated as the

primary disturbance factor that can possibly cause stress, hearing loss, and altered behavior, particularly during the breeding season when communication may be masked [19]. In addition, primates with large-bodied and/or highly frugivorous show a decrease in species richness toward the forest edge as compared to the forest interior. This likely due to the absence of the large and mature fruiting trees on which they rely in the forest edge. This also much are associated with lower tree density, less tree species, smaller tree diameter, less canopy closure, and lack of emergent trees in forest edge versus to that of forest interior [15]. This study also shows that there are no amphibians sighted in forest edge during this surveys. This may due to the fact that amphibians require the cool moist conditions of forest floor microhabitats, but increasing sunlight penetration on the forest floor in the forest edge may provide drier and warmer forest floor microhabitats that cause amphibians tend to avoid the forest edge [20, 21]. Beside, rich in reptile's species may due to their tolerance for higher temperatures and by behavioural means, where most reptiles regulate their body temperature via basking under the sun and move into shades when their body temperature drops or ambient temperature starts increasing more than they can tolerate [22]. Study also found that amphibians show stronger impact toward edge effect compare to reptiles, as edge effect decrease the abundance of amphibian's species higher than reptile's species [23].

4. Conclusion

In conclusion, the study herein is the first insight into the comprehensive checklist of vertebrate's species richness in PCFR. This study records a total of nine species of mammals, 42 species of avifauna, and 14 herpetofauna species at PCFR, which 11 of these are classified as threatened species. This suggests that the PCFR is an essential habitat for various vertebrate's species, including the threatened and protected species. In addition, the findings also indicate that the forest interior are different markedly from the forest edge in terms of vertebrate's species richness and taxonomically, where suggested to be treated as distinct habitat which support a distinct set of species. Overall, the forest interior possesses higher species richness compare to the forest edges. If the PCFR will continue being fragmented, there will be an increase of forest edge related habitats and decrease of forest interior related habitat, which will cause structural and floristic composition changes due to increased edge effects and the forest will face a great threat of local extinction especially the specialist vertebrate's species. Appropriate regulation and enforcement by relevant stakeholders at the federal and state level are needed to secure and maintained this forest reserve. These efforts are vital for protecting and ensuring the sustainability of the vertebrate populations. The study recommends long-term research to include the abundance, diversity, and composition of vertebrate's species in the future. Also, long-term study on micro-environmental factors such as light availability, air and soil temperature, humidity, and nutrients along the edge-interior gradient in the forest in order to determine their influence on vertebrate's species richness, composition, and structure.

Acknowledgement

We would like to express our heartfelt appreciation to the Perak Forestry Department and Hulu Perak District Office for their permission and assistance throughout the studies. We would also like to express out sincerest gratitude to the Forest Research Institute Malaysia (FRIM) and the Zoology Branch team members for their dedication throughout this study. The assessment was permitted via a wildlife research permit granted by the Department of Wildlife and National Park (B-00297-15-22y).

References

1. J. William-Dee, F.A.A. Khan, Q. Rosli, M.A. Morni, I. Azhar, L.S. Lim, R.C.T. Tingga, M.R.A. Rahman, Tropical life sciences research, **30**, 131 (2019)
2. Ministry of Energy and Natural Resource, *Sixth National Report of Malaysia to the Convention on Biological Diversity*, Available at: https://www.cbd.int/doc/nr/nr-06/my-nr-06-en.pdf (2019)
3. Z. Muhammad, S. Yaacob, Journal of the Department of History, **29** (2020)
4. R.J. Maynard, N.C. Aall, D. Saenz, P.S. Hamilton, M.A. Kwiatkowski, Tropical Conservation Science, **9**, 264 (2016)
5. Z. Rosli, M. Zakaria, M.N. Rajpar, Journal of Animal & Plant Sciences, **28** (2018)
6. Department of Town and Country Planning Peninsular Malaysia, *Final report CFS I: Master Plan for Ecological Linkages*, Malaysia: Regional Planning Division (2009)
7. N. Rahmanian, S.H.B. Ali, M. Homayoonfard, N.J. Ali, M. Rehan, Y. Sadef, A.S. Nizami, Journal of Chemistry, 2015, 1 (2015)
8. Ministry of Housing and Local Government, *Pelan Induk Rangkaian Ekologi Central Forest Spine (PIRECFS) Perak*, Malaysia: Department of Town and Country Planning Peninsular Malaysia (2022).
9. C. Francis, Bloomsbury Publishing (2019)
10. C. Robson, Bloomsbury Publishing (2014)
11. K.S. Lim, D.L. Yong, K.C. Lim, John Beaufoy Publishing Limited (2020)
12. I. Das, Bloomsbury Publishing (2015)
13. A. Norhayati, Penerbit UKM, Bangi, Malaysia (2017)
14. R.A. Cerboncini, J.J. Roper, F.C. Passos, Oryx, **50**, 460 (2016)
15. L.M. Bolt, A.L. Schreier, K.A. Voss, E.A. Sheehan, N.L. Barrickman, N.P. Pryor, M.C. Barton, Primates, **59**, 301 (2018)
16. L. Rowley, R. Edwards, P. Kelly, *Edges-their effect on vegetation and wildlife*, in *Their Role in Wildlife Management and Conservation*, Department of Conservation and Environment, Victoria, 84 (1993)
17. T. Magura, G.L. Lövei, Diversity, **12**, 320 (2020)
18. E.E. Poor, V.I. Jati, M.A. Imron, M.J. Kelly, PloS One, **14** (2019).
19. M. Goosem, Wildlife Research, **28**, 351 (2001)
20. V. Arroyo-Rodríguez, R.A. Saldana-Vazquez, L. Fahrig, B.A. Santos, Ecological research, **32**, 81 (2017)
21. A.J. Nowakowski, J.I. Watling, S.M. Whitfield, B.D. Todd, D.J. Kurz, M.A. Donnelly, Conservation biology **31**, 96 (2017)
22. A.J. Veselka, A. Aponte-Gutiérrez, O.A. Medina-Báez, J.I. Watling, Biotropica, **55**, 540 (2023)
23. M. Pfeifer, V. Lefebvre, C.A. Peres, C. Banks-Leite, O.R. Wearn, C.J. Marsh, S.H.M. Butchart, V. Arroyo-Rodríguez, J. Barlow, A. Cerezo, L. Cisneros, N. D'Cruze, D. Faria, A. Hadley, S.M. Harris, B.T. Klingbeil, U. Kormann, L. Lens, G.F. Medina-Rangel, J.C. Morante-Filho, P. Olivier, S.L. Peters, A. Pidgeon, D.B. Ribeiro, C. Scherber, L. Schneider-Maunoury, M. Struebig, N. Urbina-Cardona, J.I. Watling, M.R. Willig, E.M. Wood, R.M. Ewers, Nature, **551**, 187 (2017)