

Small vertebrates in CFS ecological corridor (D-PL1: Lojing - Sungai Brok - Sungai Betis Forest Reserves) Kelantan

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Abstract. Small vertebrate surveys were carried out in the Sungai Brok and Sungai Betis Forest Reserves. The Central Forest Spine (CFS) initiative has recognised these forest reserves as part of Kelantan's important ecological corridors, known as D-PL1. The surveys were conducted from July to September 2019. This study aims to identify and update the checklist of small vertebrates in the selected forest reserves. One hectare plot was established in each forest reserve for this study. Traps were used to capture and document these vertebrates, including 100 collapsible cage traps, three harp traps, 10 mist nets, and 25 pitfall traps deployed at each sampling site. In addition, the surveys also carried out active searches and direct observations. Overall, this study recorded 83 species from 38 families of small vertebrates. With the total, small mammals comprise of 13 spp. from six families, birds (53 spp. from 24 families), and herpetofauna (17 spp. from eight families) were recorded during this study. Ten small mammal species are recorded as additional species for D-PL1. Birds and herpetofauna recorded 38 and eight additional species to the existing checklist of D-PL1, respectively. Based on the IUCN Red List of Threatened Species (Version 3.1), this study recorded three threatened species namely Great Argus (*Argusianus argus*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), and Grey-cheeked Bulbul (*Alophoixus tephrogenys*) in D-PL1. This information is likely to support stakeholders in formulating a management strategy for the forest mosaics in the corridor, which will continue to serve as an essential habitat for small vertebrates.

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1. Introduction

Malaysia is a megadiverse country that inhabits at least 307 species of mammals, 785 birds, 567 amphibians, and 242 reptiles [3]. They can be found in different kinds of habitats including primary and secondary forest reserves, mangrove forests, peat swamp forests, and forest plantations. Small vertebrates are animals that have backbones and weigh less than five kilograms as an adult, such as small mammals, birds and herpetofauna (amphibians and reptiles) [1,2]. They play significant ecological roles as seed dispersers, pollinators, and insect population regulators [4,5,6].

However, forest fragmentation or habitat loss has posed a significant threat to Malaysia's biodiversity, especially small vertebrate populations [3]. Hence, the Central Forest Spine (CFS) initiative was established to safeguard biodiversity by re-establishing connectivity between fragmented forests in Peninsular Malaysia [7]. The establishment of ecological corridors will facilitate wildlife movements, gene flow, and the spread of seeds and pollen in order to reduce the risk of species extinction [8]. A total of 39 ecological corridors, comprising 20 Primary Linkages (PL) and 19 Secondary Linkages (SL) have been identified across eight states, including Kelantan.

There are six ecological corridors in Kelantan, including D-PL1: Lojing-Sungai Brok-Sungai Betis Forest Reserves [7]. Forest reserves in the ecological corridor linkage have been separated by agricultural areas and highway [7]. To date, Lojing Forest Reserve (LFR) has recorded 12 small mammal species from six families, 61 bird species from 29 families, and 20 amphibian species from seven families [9,10,11]. Sungai Brok Forest Reserve (SBRFR) has reported one small mammal species from one family and one amphibian species from one family [12,13]. Sungai Betis Forest Reserve (SBEFR) has recorded two small mammal species from two families and two amphibian species from two families [13,14,15,16]. Yet, there is still a lack of information on small vertebrates in the forest reserves, especially for SBRFR and SBEFR.

Therefore, the purpose of this study is to document and update the checklist of small vertebrates in the selected forest reserves. The information on small vertebrates is essential in developing conservation plan for the forest reserves in D-PL1.

2. Methodology

2.1 Study Sites

This study was carried out at Sungai Brok Forest Reserves (04°40'26.5" N, 101°38'34.7" E) and Sungai Betis Forest Reserve (04°44'41.8" N, 101°39'23.5" E) (Figure 1). Both forest reserves consist of secondary lowland forests. In Sungai Brok FR, the study plot has hilly areas and a closed canopy cover with tall trees. Apart from that, the study plot was also located near a river with rock crevices. On the other hand, Sungai Betis FR has hilly areas with dense understorey vegetation. Most of the areas in the study plot have closed canopy cover with several gaps and openings. During the surveys, logging activities or land clearing were still taking place in the areas adjacent to the forest reserves.

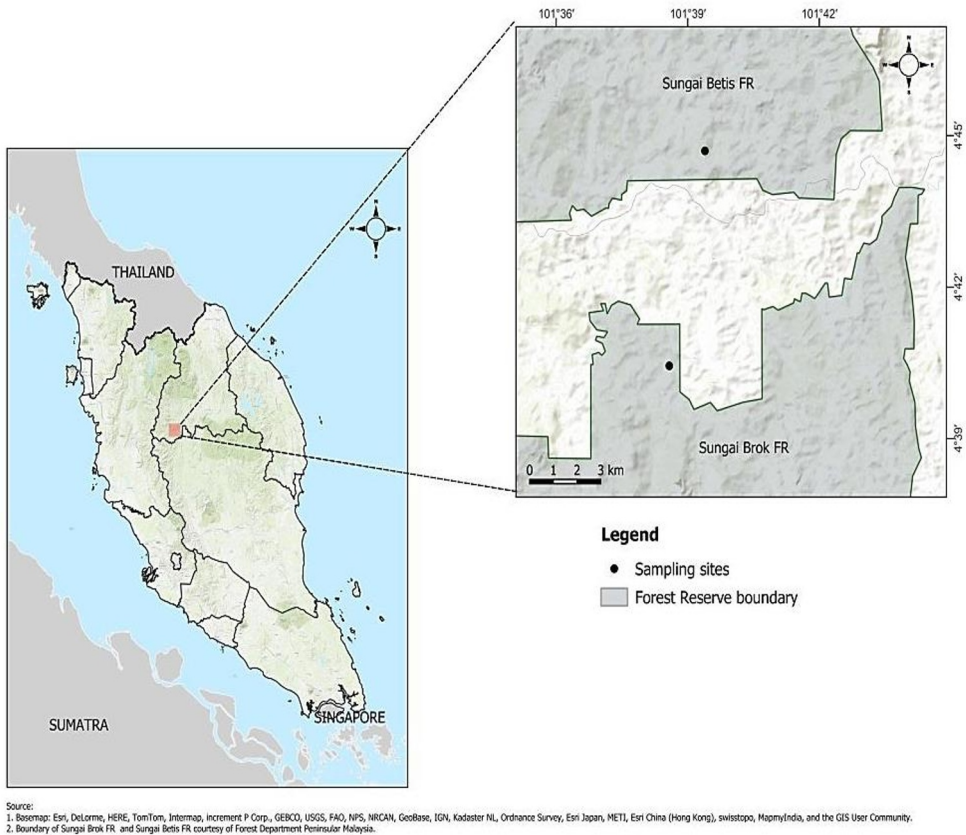


Fig. 1. The location of the study sites.

2.2 Field Methods

The surveys were conducted from July to September 2019. A 1-ha plot (100 m x 100 m) was established in each forest reserve, and each plot was sampled twice. Ten transect lines of 100 m length with 10 m separations were prepared for each plot. For each plot, a total of 100 collapsible cage traps baited with oil palm fruit were deployed to capture non-volant small mammals. Three harp traps were used to catch insectivorous bats, while ten mist nets were used to catch frugivorous bats and birds. Twenty-five pitfall traps were used in each plot to capture herpetofauna. The traps were left open for five consecutive nights and checked twice daily, as early as 0630 and 2230.

Active searches were also carried out for two consecutive nights (minimum of two hours per night) during each sampling session. Direct observations were also conducted during the surveys. All captured individual morphological measurements were recorded in this study. The species identifications were based on descriptions in Kingston et al. [17] and Francis [18] for mammals, Robson [19] for birds, and Norhayati et al. [20], Das [21], and Norhayati [22] for herpetofauna.

The information on small vertebrates from previous and present studies was gathered to identify additional and threatened species at the forest reserves. The checklist of small vertebrates recorded during this study was produced.

3. Results and Discussion

Surveys at the two forest reserves have recorded a total of 83 species from 38 families of small vertebrates. These comprised 13 small mammal species from six families (Table 1), 53 bird species from 24 families (Table 2), and 17 herpetofauna species from eight families (Table 3).

According to the findings, SBEFR had the higher number of small mammal species compared to SBRFR, with 10 and nine species, respectively. This might be associated with dense understorey vegetation in the study plot, which usually provides favorable conditions for the occurrence of small mammals [23]. The family Vespertilionidae is the most diverse group of small mammals recorded during the surveys, with four species. This is due to the fact that it is the largest, most diverse, and most widespread family of bats, occurring on every continent except Antarctica [17,18].

Besides that, SBRFR recorded higher number of bird species than SBEFR, with 38 and 35 species, respectively. This might be due to the availability of various food sources from the fruiting trees, the abundance of insects, and aquatic animals from the nearby river. Birds often prefer to utilize various habitats and rely on the quality and productivity of those habitats in term of food supply, shelter, and breeding sites in order to maintain viable populations [24,25]. The most dominant group of birds recorded in this study is family Pycnonotidae with a total of eight species. The presence of fruiting trees, such as fig trees, might have contributed to this finding, as Pycnonotidae prefer to feed on fruits. [19].

As for the herpetofauna, SBRFR reported the highest number, with 14 species, while SBEFR recorded three species. This finding might be related to the presence of freshwater habitat nearby the study plot. The nearby river provides suitable habitat for herpetofauna that depends on wetland environments and adjacent terrestrial habitats to carry out their life cycles, such as breeding and foraging for survival [26, 27]. The families Dicroglossidae and Ranidae are the most dominant groups of herpetofauna recorded in this study, both with four species. Dicroglossidae and Ranidae are terrestrial and aquatic species that can be found in various habitats [28,29].

Based on the compilation of previous and present studies of small vertebrates, a total of 154 species from 54 families of small vertebrates were recorded at the forest reserves in D-PL1 [9,10,11,12,13,14,15,16]. Of these, there are 24 small mammal species from eight families, 99 bird species from 35 families and 31 herpetofauna species from 11 families. This study has successfully recorded 10 additional small mammal species, 38 additional bird species, and eight additional herpetofauna species for D-PL1.

Moreover, D-PL1 also recorded a total of three threatened bird species based on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (Version 3.1). The threatened species are Great Argus (*Argusianus argus*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), and Grey-checked Bulbul (*Alophoixus tephrogenys*) [30].

Table 1. Checklist of small mammals recorded during this study.

No.	Family	Common Name	Scientific Name	IUCN Status	SBR FR	SBE FR
1.	Erinaceidae	Moonrat	<i>Echinosorex gymnura</i>	LC		/
2.	Muridae	Pencil-Tailed Tree Mouse	<i>Chiropodomys gliroides</i> *	LC		/
3.	Muridae	Long-Tailed Giant Rat	<i>Leopoldamys sabanus</i> *	LC	/	/
4.	Pteropodidae	Malayan Spotted-winged Fruit Bat	<i>Balionycteris seimundi</i> *	LC	/	/

5.	Pteropodidae	Lesser Dog-faced Fruit Bat	<i>Cynopterus brachyotis</i>	LC	/	/
6.	Pteropodidae	Forest Dusky Fruit Bat	<i>Penthetor lucasi</i> *	LC	/	
7.	Hipposideridae	Diadem Roundleaf Bat	<i>Hipposideros diadema</i>	LC	/	/
8.	Rhinolophidae	Intermediate Horseshoe Bat	<i>Rhinolophus affinis</i> *	LC	/	
9.	Rhinolophidae	Trefoil Horseshoe Bat	<i>Rhinolophus trifolius</i> *	NT		/
10.	Vespertilionidae	Hardwicke's Woolly Bat	<i>Kerivoula hardwickii</i> *	LC	/	/
11.	Vespertilionidae	Least Woolly Bat	<i>Kerivoula minuta</i> *	NT	/	
12.	Vespertilionidae	Papillose Woolly Bat	<i>Kerivoula papillosa</i> *	LC	/	/
13.	Vespertilionidae	Clear-Winged Woolly Bat	<i>Kerivoula pellucida</i> *	NT		/
				Total No. of Species	9	10
				Total No. of Family	5	6

Note: (*) - additional species; NT - Near Threatened; LC - Least Concern

Table 2. Checklist of birds recorded during this study.

No.	Family	Common Name	Scientific Name	IUCN Status	SBR FR	SBE FR
1.	Accipitridae	Crested Serpent-Eagle	<i>Spilornis cheela</i>	LC	/	/
2.	Alcedinidae	Malay Blue-banded Kingfisher	<i>Alcedo peninsulae</i> *	NT		/
3.	Alcedinidae	Oriental Dwarf-kingfisher	<i>Ceyx erithaca</i> *	LC	/	
4.	Alcedinidae	Banded Kingfisher	<i>Lacedo pulchella</i> *	LC	/	
5.	Alcedinidae	Rufous-collared Kingfisher	<i>Actenoides concretus</i> *	NT	/	
6.	Calyptomenidae	Green Broadbill	<i>Calyptomena viridis</i> *	NT	/	/
7.	Chloropseidae	Blue-winged Leafbird	<i>Chloropsis cochinchinensis</i> *	LC		/
8.	Cisticolidae	Rufous-tailed Tailorbird	<i>Orthotomus sericeus</i> *	LC	/	
9.	Columbidae	Emerald Dove	<i>Chalcophaps indica</i>	LC	/	/
10.	Dicaeidae	Crimson-breasted Flowerpecker	<i>Prionochilus percussus</i> *	LC	/	/
11.	Dicruridae	Bronzed Drongo	<i>Dicrurus aeneus</i>	LC		/
12.	Estrildidae	Pin-tailed Parrotfinch	<i>Erythrura prasina</i> *	LC	/	
13.	Estrildidae	White-headed Munia	<i>Lonchura maja</i> *	LC	/	
14.	Eurylaimidae	Dusky Broadbill	<i>Corydon sumatranus</i> *	LC		/
15.	Hirundinidae	Barn Swallow	<i>Hirundo rustica</i> *	LC		/
16.	Megalaimidae	Gold-whiskered Barbet	<i>Psilopogon chrysopogon</i>	LC		/
17.	Monarchidae	Black-naped Monarch	<i>Hypothymis azurea</i> *	LC	/	/
18.	Monarchidae	Asian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	LC		/
19.	Muscicapidae	Oriental Magpie-Robin	<i>Copsychus saularis</i>	LC	/	
20.	Muscicapidae	White-rumped Shama	<i>Kittacincla malabarica</i> *	LC		/

21.	Muscicapidae	Grey-chested Jungle-Flycatcher	<i>Cyornis umbratilis</i> *	NT	/	/
22.	Nectariniidae	Ruby-cheeked Sunbird	<i>Chalcoparia singalensis</i> *	LC		/
23.	Nectariniidae	Plain Sunbird	<i>Anthreptes simplex</i> *	LC	/	
24.	Nectariniidae	Little Spiderhunter	<i>Arachnothera longirostra</i>	LC	/	/
25.	Nectariniidae	Purple-naped Spiderhunter	<i>Kurochkinogramma hypogrammica</i>	LC		/
26.	Nectariniidae	Grey-breasted Spiderhunter	<i>Arachnothera modesta</i> *	LC	/	/
27.	Oriolidae	Dark-throated Oriole	<i>Oriolus xanthonotus</i> *	NT	/	
28.	Pellorneidae	Scaly-crowned Babbler	<i>Malacopteron cinereum</i> *	LC	/	/
29.	Pellorneidae	Rufous-crowned Babbler	<i>Malacopteron magnum</i> *	NT	/	
30.	Pellorneidae	Black-capped Babbler	<i>Pellorneum nigrocapitatum</i> *	LC		/
31.	Pellorneidae	Short-tailed Babbler	<i>Trichastoma malaccense</i> *	NT	/	/
32.	Pellorneidae	White-chested Babbler	<i>Pellorneum rostratum</i> *	NT	/	/
33.	Phasianidae	Red Junglefowl	<i>Gallus gallus</i>	LC	/	/
34.	Phasianidae	Great Argus	<i>Argusianus argus</i> *	VU		/
35.	Picidae	Rufous Piculet	<i>Sasia abnormis</i>	LC	/	/
36.	Picidae	Checker-throated Woodpecker	<i>Chrysophlegma humii</i> *	NT	/	
37.	Picidae	Buff-necked Woodpecker	<i>Meiglyptes tukki</i> *	NT	/	/
38.	Picidae	Maroon Woodpecker	<i>Blythipicus rubiginosus</i>	LC	/	
39.	Picidae	Great Slaty Woodpecker	<i>Mulleripicus pulverulentus</i> *	VU		/
40.	Pycnonotidae	Black-headed Bulbul	<i>Brachypodius atriceps</i> *	LC		/
41.	Pycnonotidae	Grey-bellied Bulbul	<i>Ixidia cyaniventris</i> *	NT	/	/
42.	Pycnonotidae	Cream-vented Bulbul	<i>Pycnonotus simplex</i>	LC	/	/
43.	Pycnonotidae	Spectacled Bulbul	<i>Ixidia erythrophthalmos</i> *	LC	/	/
44.	Pycnonotidae	Hairy-backed Bulbul	<i>Tricholestes criniger</i> *	LC	/	/
45.	Pycnonotidae	Ochraceous Bulbul	<i>Alophoixus ochraceus</i>	LC	/	/
46.	Pycnonotidae	Grey-cheeked Bulbul	<i>Alophoixus tephrogenys</i>	VU	/	
47.	Pycnonotidae	Yellow-bellied Bulbul	<i>Alophoixus phaeocephalus</i> *	LC	/	
48.	Sturnidae	Common Hill Myna	<i>Gracula religiosa</i> *	LC	/	
49.	Timaliidae	Chestnut-rumped Babbler	<i>Stachyris maculata</i> *	NT	/	
50.	Timaliidae	Grey-throated Babbler	<i>Stachyris nigriceps</i>	LC	/	
51.	Timaliidae	Grey-headed Babbler	<i>Stachyris poliocephala</i> *	LC	/	/
52.	Trogonidae	Scarlet-rumped Trogon	<i>Harpactes duvaucelii</i> *	NT		/
53.	Vangidae	Rufous-winged Philentoma	<i>Philentoma pyrhoptera</i> *	LC	/	
				Total No. of Species	38	35
				Total No. of Family	18	19

Note: (*) - additional species; VU - Vulnerable; NT - Near Threatened; LC - Least Concern

Table 3. Checklist of herpetofauna recorded during this study.

No.	Family	Common Name	Scientific Name	IUCN Status	SBR FR	SBE FR
1.	Bufonidae	Latiff's Torrent-Dwelling Toad	<i>Ansonia latiffi</i>	NT		/
2.	Bufonidae	Lesser Toad	<i>Ingerophrynus parvus</i>	LC	/	
3.	Bufonidae	Java Toad	<i>Phrynoidis asper</i>	LC	/	
4.	Dicroglossidae	Asian Grass Frog	<i>Fejervarya limnocharis</i>	LC	/	
5.	Dicroglossidae	Blyth's Wart Frog	<i>Limnonectes blythii</i>	LC	/	
6.	Dicroglossidae	Hill Forest Frog	<i>Limnonectes hascheanus</i> *	LC	/	
7.	Dicroglossidae	Rhinoceros Frog	<i>Limnonectes plicatellus</i>	LC	/	
8.	Ranidae	White-lipped frog	<i>Chalcorana labialis</i>	LC	/	
9.	Ranidae	Poisonous rock frog	<i>Odorrana hosii</i> *	LC	/	
10.	Ranidae	Western Sunda Spotted Stream Frog	<i>Pulchrana sundabarat</i> *	LC	/	
11.	Ranidae	Variable-backed Frog	<i>Pulchrana signata</i>	LC	/	
12.	Rhacophoridae	Norhayati's Gliding Frog	<i>Rhacophorus norhayatiae</i>	LC		/
13.	Agamidae	Great Anglehead Lizard	<i>Gonocephalus grandis</i> *	LC	/	
14.	Colubridae	Yellow-striped Rat Snake	<i>Coelognathus flavolineatus</i> *	LC	/	
15.	Colubridae	Striped Bronzeback	<i>Dendrelaphis caudolineatus</i> *	LC		/
16.	Gekkonidae	Taylor's Bow-fingered Gecko	<i>Cyrtodactylus quadrivirgatus</i> *	LC	/	
17.	Scincidae	Common Mabuya	<i>Eutropis multifasciata</i> *	LC	/	
Total No. of Species					14	3
Total No. of Family					7	3

Note: (*) - additional species; NT - Near Threatened; LC - Least Concern

4. Conclusion

In conclusion, CFS ecological corridor D-PL1 is an essential habitat for numerous species of small vertebrates. Dense understorey vegetation, availability of food sources, and freshwater habitat might be among the factors that influence the occurrence of small vertebrates in forest reserves. The presence of additional species of small vertebrates in the surveys indicates that more species have not yet been discovered and documented in the corridor. Therefore, continuous monitoring that covers more areas of the forest reserves is needed in order to better understand the population dynamics of small vertebrates in the ecological corridor. Thus, this information is vital in supporting stakeholders in formulating management plans, especially for the forest mosaics in D-PL1 in order to provide secure habitat and pathways for the small vertebrates.

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