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J-SuNR

Journal of Sustainable Natural Resources

Journal homepage: http://publisher.uthm.edu.my/ojs/index.php/jsunr

e-ISSN : 2716-7143

Small Mammals of Tekai Tembeling Forest Reserve (TTFR), Jerantut, Pahang, Peninsular Malaysia

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DOI: https://doi.org/10.30880/jsunr.2021.02.02.002

Received 22 November 2021; Accepted 16 December 2021; Available online 31 December 2021

Abstract: Despite the increasing numbers of hydro-dam worldwide, only a handful of studies evaluated their impacts on biodiversity especially terrestrial small mammals. This survey aimed to provide an updated checklist and diversity status of small mammals inhabiting the Tekai-Tembeling Forest Reserve (TTFR), an area that has been extensively logged for the next phase of construction of dam. To elucidate further the species assemblages and diversity of small mammals within TTFR, a comparison was made to a nearby forest, Ulu Jelai Forest Reserve (UJFR), which was also has been logged for the development of Telom Dam. 10 days survey conducted in March 2018 by using cage-trapping and mist-netting techniques, successfully recorded a total of 27 species (Shannon Index (H') = 3.11) in TTFR and 23 species (H'=2.62) in UJFR. Most of these species in TTFR were bats (56 individuals representing 22 species), rodents (three species representing four individuals) and squirrels (two species representing three individuals). Insectivorous bat species, Narrow-winged Pipistrelle (*Pipistrellus cf. stenopterus*), are the most abundance in TTFR mainly because insectivorous bats behavior that forage understory in a lowland forest and some of these bats is known to forage in groups. Results from this study indicated that richness and diversity of small mammal's species assemblages appear to decline in TTFR at which this can be associated to less sampling approaches due to the seasonal impact (rainy season) and habitat disturbance or habitat changes resulted from extensive logging activity. A good mitigation measures should be conducted immediately to prevent elimination species at the study area.

Keywords: Chiroptera; logging effects; Rodentia; small mammal's diversity; Tekai-Tembeling Forest Reserve

1. Introduction

The conversion of forested area to other man-made construction or developing area does indeed have significant impact on the wildlife and its environment. This conversion causes loss of natural habitat and food supplies and consequently affects the survivability of species and population [1]. In Malaysia, the demand for electricity increases every year, however, restrictions on the number of hydroelectric dams that become an additional source of electricity will result in unsuccessful energy production in which can lead to an increase energy rates and a burden on consumers. To fulfill the electric demand, development of hydroelectric plant is required to satisfy the electric demand, however,

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building a hydroelectric dam involves an inundation of a massive acreage of land. Basically, on the upstream, hydroelectric dam was built at which it is rich with forested land. Forests need to be demolished to inundate the dam and this will have a detrimental impact on wildlife. Forest clearing through logging activity may result in habitat degradation, population isolation, and decreasing trends of species richness, abundance, and movement, which consequently resulting in loss of biodiversity.

Fragmentation of habitats in landscapes dominated by humans is seen as a major threat to the survival of biodiversity. One of the primary threats to biodiversity is human-induced habitat fragmentation [2] [3], which is on the rise worldwide [4] [5] [6]. A fragmented landscape is characterized by patches of natural habitat surrounded by a matrix of human-modified land cover [7] resulting from logging and forestry industry activities that have resulted in many trees being cut and cleared. As a result of this activity, with each passing year, the number of our tropical rainforests diminishes. In any development involving modification of large areas such as hydroelectric project or conversion of forest land especially if it involves logging activities, the most interesting issues for the ecologists to be questioned are how the population and wildlife communities change due to habitat loss [8]. In addition, changes in land use are thought to have a high impact on the survival of small terrestrial mammals compared to large and medium-sized mammals in terms of the ability to escape or adapting the harsh changing environment [9]. However, these changes should have some limit or tolerance and otherwise they will not survive [10].

To develop an efficient management and conservation strategy, wildlife conservation efforts or mitigation plans must be planned and implemented in a timely manner to improve the survival of species within the impact zone as well as adjacent habitat [11]. Since there is a wide gap in information regarding the distribution, abundance, and conservation status of terrestrial small mammals in logged-over forest, it is important to tackle this lack of knowledge. Thus, to obtain a clear picture of the impact of logging activities on diversity of small mammals, this study aims to provide a baseline information on abundance of terrestrial volant and non-volant small mammal's species in logged-over forest of TTFR and their conservation status. Deforestation often results in dramatic changes in terms of relative abundance of small mammals in the community, and that shift may have a significant influence on the populations of small mammals as consumers. For those reasons, it is important to understand the changes in small mammal communities resulting from forest harvest activity. The resulting impact is very useful in enabling the development of immediate mitigation plans and conservation efforts. Since part of the TTFR has been proposed for the development of the hydroelectric scheme, listing the rare and protected species found in the study area, conservation efforts can easily be made before, during and after the development of the hydroelectric dam.

2. Material and Methods

2.1 Study Area

Permission to enter Tekai-Tembeling Forest Reserve (TTFR), Jerantut, Pahang was approved by Forestry Department of Pahang and permission to conduct research on wildlife was approved by the Department of Wildlife and National Parks, Malaysia. A 10-days survey was conducted in early of March 2018 nearby to Tekai River of TTFR (N 4506112, E 466619) within a south-eastern tributary of Sungai Tembeling, in Mukim Hulu Tembeling, District of Jerantut, Pahang Darul Makmur (Fig. 1).

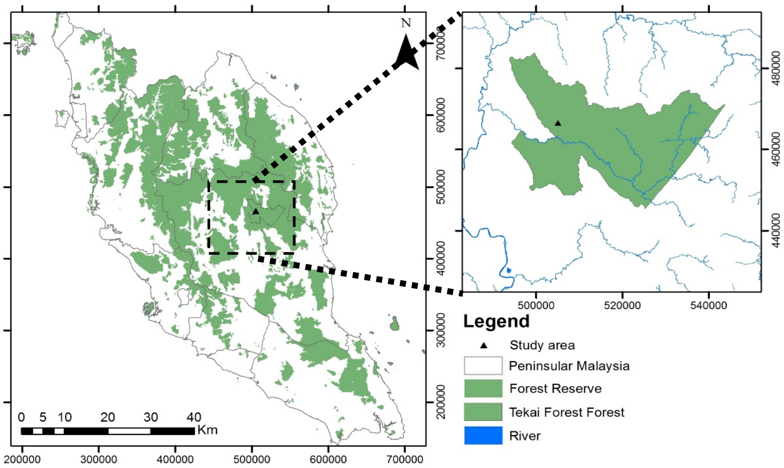

Fig. 1 - The location of sampling area within Tekai Tembeling Forest Reserve (TTFR), Jerantut, Pahang (Source: TNBR, 2018)

TTFR is a mixed dipterocarp forest with a coverage area of 87,885 hectares and lies approximately six kilometers below the southernmost boundary of Taman Negara, with the nearest town is Jerantut. TTFR was logged-over two to five years ago and consists of mainly logged-over hill dipterocarp forest [12]. Our study area is partly hilly and rugged with narrow tracts of lowlands of 50 to 200 m above mean sea level (MSL). The proposed dam area covers mainly slopes of <25° (96%), with only 0.95% above 35°. The submerged areas will include the broad, NW-SE trending valleys of the present-day Termus River and Senuak River as well as narrower valleys of the Tekai River and its upper headwater tributaries of Kerum River and Song River.

In this study, comparison on the species richness of bats and rodents were made with data from Ulu Jelai Forest Reserve (UJFR). UJFR was chosen for comparison based on the proximity and the relevant of data (e.g. habitat type, trapping effort) to our study site in order to elucidate further the diversity of small mammals in TTFR

UJFR located in the forest district of Lipis, Pahang, is one of the forest fragments within the groups of forest complexes of Peninsular Malaysia. The forest area was categorized as an area with sustainable use of natural resources which also located neighboring to Taman Negara National Park (TNNP). Survey area (N 423319, E 495581) was done nearby to Telom River located in the high-altitude area of the Cameron Highlands district. The altitude ranges from 1200 m to 1500 m above sea level. Brinchang, the closest town in the Cameron Highlands is at an altitude of 1450 m above sea level. UJFR physically consists of forest land that has been logged over (productive forest), thus, presence of shrubs and regenerated forest at the area.

2.2 Non-volant Small Mammal Trapping

A total of 100 wire mesh live-traps, measuring 30 x 15 x 15 cm were used in the study areas. The baits used were bananas, roasted coconut meat, or oil palm seeds. Cage traps were deployed along established trails and set at five meters from one another along an existing forest transect and checked twice each day; once in the morning (10:00h) and once in the evening (16:00h), and re-baited when necessary. All the cages were left open for eight continuous days and nights. Captured animals were identified following description in [13] with their standard measurements recorded and released at the capture points. Selected specimens were prepared as museum vouchers.

2.3 Bat-netting

Based on field observation and the condition of forest habitat of the study areas, it is anticipated that bat species that generally dominate lowland and hill dipterocarp forest species are present. Field trapping for bats were conducted by using trapping such as mist-nets and harp-traps. An average 22 mist-nets and five harp-traps were used to capture both frugivorous and insectivorous bats, respectively. Each mist-net was 2.5 × 9 × 4 m in dimension, with a 36 mm Diamond mesh size and a 3-pouch construction were erected at potential flight pathways of bats. In the meanwhile, harp-traps with overall dimensions of 4 x 1.8 m and trapping area 2.4 x 1.8 m were set crossing narrow pathways and along Tekai River. Both mist-nets and harp-traps were checked twice, in the evening between (18:00h - 21:00h) and in the morning between (06:00h - 09:00h). Mist-nets and harp-traps were set up at different locations within the sampling areas during the period of study to maximize the effort to cover the areas. Bats captured were examined for species identification based on [14] and [15].

2.4 Statistical Analysis

In order to characterize small mammal species distribution patterns at the two sites, we used non-parametric analysis, the Rank-abundance Curve (RAC) and Species Accumulation Curve (SAC) [16]. Species were arranged in sequence from the most to the least abundant along the x-axis, while log abundance was plotted on the vertical or y-axis. Several diversity indices and model verification were performed by PAST software version 2.17c (Hammer, Harper, and Ryan 2001), which will give the Chi-square and p-value. Model with the lowest p-value will indicate the best model type. Shannon Index is a measure of diversity at a site and is influenced by the number of species present and species uniformity. Chao-1 index gives an estimated species richness if sampling is prolonged. Considering the unequal effort applied to each site, individual-based rarefaction curves were generated to calculate the expected number of species as a function of sampling effort. Curves were generated based on species richness and number of individuals recorded for each species by using Ecosim software version 7.7 [17]. To compare species compositions between both sites, we use Jaccard Similarity Indexes (JSI) using MVSP (Multivariate Statistical Package) version 3.13b to determine the degree of similarity in species composition in both sites.

3. Results

3.1 Species Composition and Similarity

A total of 63 individuals of volant and non-volant small mammals from Order Chiroptera, Rodentia and Scandentia were caught during the sampling period at Tekai-Tembeling Forest Reserve (TTFR). From the nine nights of trapping, bats recorded a significantly higher number of individuals and species captured in TTFR (Table 1). These

five species were frugivorous bats (Pteropodidae family), 25 species insectivorous bats (Family Hipposideridae, Rhinolophidae, Molossidae and Vespertilionidae), eight of the Muridae family (Muridae family) and two of the Sciuridae family. In comparison to Ulu Jelai Forest Reserve (UJFR), there are 98 individuals representing 23 species and six families of terrestrial small mammals recorded. In terms of diversity, the most diverse family recorded at TTFR belongs to Vespertilionidae and Muridae at UJFR with both having the same number of species which is seven species.

Table 1 - Species and relative abundance of bats species (Volant) sampled at TTFR and UJFR, Pahang

No	Taxa	IUCN	WCA	TTFR	UJFR
	Vespertilionidae: Insect Bats				
1	*Glischropus tylopus*	LC	LC	1 (1.79)	0
2	*Hesperoptenus tomesi*	VU	LC	1 (1.79)	0
3	*Kerivoula intermedia*	NT	VU	2 (3.57)	4 (4.94)
4	*Kerivoula minuta*	NT	LC	1 (1.79)	9 (11.11)
5	*Kerivoula pellucida*	NT	LC	2 (3.57)	0
6	*Kerivoula whiteheadi*	LC	LC	0	1 (1.23)
7	*Murina peninsularis*		LC	0	1 (1.23)
8	*Murina suilla*	LC	LC	1 (1.79)	0
9	*Phoniscus atrox*	NT	LC	0	1 (1.23)
10	*Pipistrellus cf stenopterus*	LC	LC	6 (10.71)	0
	Hipposideridae: Roundleaf Bats				
11	*Hipposideros cervinus*	LC	LC	5 (8.93)	7 (8.64)
12	*Hipposideros atrox*	LC	LC	1 (1.79)	0
13	*Hipposideros bicolor*	LC	LC	4 (7.14)	8 (9.88)
14	*Hipposideros diaderma*	LC	LC	2 (3.57)	0
15	*Hipposideros galeritus*	LC	LC	0	1 (1.23)
16	*Hipposideros larvatus*	LC	LC	0	1(1.23)
17	*Hipposideros ridleyi*	VU	LC	3 (5.36)	0
	Pteropodidae: Fruit Bats				
18	*Balionycteris maculata*	LC	LC	5 (8.93)	1 (1.23)
19	*Cynopterus brachyotis*	LC	LC	3 (5.36)	5 (6.17)
20	*Cynopterus horsfieldii*	LC	LC	2 (3.57)	2 (2.47)
21	*Macroglossus subrinus*	LC	LC	1 (1.79)	12 (14.81)
22	*Megaerops ecaudatus*	LC	LC	0	3 (3.70)
	Rhinolophidae: Horseshoe Bats				
23	*Rhinolophus affinis*	LC	NP	0	24 (29.63)
24	*Rhinolophus acuminatus*	LC	NP	3 (5.36)	0
25	*Rhinolophus cf sedulus*	NT	NP	3 (5.36)	0
26	*Rhinolophus lepidus*	LC	NP	0	1 (1.23)
27	*Rhinolophus luctus*	LC	NP	3 (5.36)	0
28	*Rhinolophus trifoliatus*	NT	NP	1 (1.79)	0
	Molossidae: Free-tailed Bats				
29	*Chaerephon johorensis*	VU	NP	1 (1.79)	0
30	*Mops mops*	NT	NP	5 (8.93)	0
	Total Individuals			56	81

Total Species	22	16
Total Family	5	4

Site: TTFR = Tekai Tembeling Forest Reserve, KFR = Kemasul Forest Reserve; Wildlife Conservation Act (WCA) (2010): NP = Not Protected; IUCN: NT = Near threatened, LC = Least concerned, VU = Vulnerable.

There are 17 species that were exclusively recorded in TTFR and do not appear in UJFR (Table 2), such as Annandale's Rat (*Rattus annandalei*), Prevost's squirrel (*Callosciurus prevostii*), Low's Squirrel (*Sundasciurus lowii*), Common Thick-thumbed Bat (*Glischropus tylopus*), Large False Serotine Bat (*Hesperoptenus tomesi*), Clear-winged Woolly Bat (*Kerivoula pellucida*), Brown Tube-nosed Bat (*Murina suilla*), Narrow-winged Pipistrelle (*Pipistrellus cf stenopterus*), Lesser Bicolored Leaf-nosed Bat (*Hipposideros atrox*), Diadem Leaf-nosed Bat (*Hipposideros diaderma*), Ridley's Leaf-nosed Bat (*Hipposideros ridleyi*), Acuminate Horseshoe Bat (*Rhinolophus acuminatus*), Lesser Woolly Horseshoe Bat (*Rhinolophus cf sedulous*), Woolly Horseshoe Bat (*Rhinolophus luctus*), Trefoil Horseshoe Bat (*Rhinolophus trifoliatus*), Northern Free-tailed Bat (*Chaerephon johorensis*) and Malayan Free-tailed Bat (*Mops mops*).

Table 2 - Species and relative abundance of Rodentia and Scadentia (non-volant) sampled at TTFR and UJFR, Pahang

No	Taxa	IUCN	WCA	TTFR	UJFR
	Muridae: Rats, Mice				
1	*Leopoldamys sabanus*	LC	LC	0	5 (29.41)
2	*Maxomys rajah*	VU A2c	LC	0	3 (17.65)
3	*Maxomys surifer*	LC	LC	0	3 (17.65)
4	*Maxomys whiteheadi*	VU	LC	2 (28.57)	1 (5.88)
5	*Niviventer cremoriventer*	LC	LC	0	1 (5.88)
6	*Rattus annandalei*	LC	LC	1 (14.29)	0
7	*Rattus rattus*	LC	LC	0	3 (17.65)
8	*Rattus tiomanicus*	LC	LC	1 (14.29)	1 (5.88)
	Sciuridae: Squirrels				
11	*Callosciurus prevostii*	LC	TP	1 (14.29)	0
12	*Sundasciurus lowii*	LC	NA	2 (28.57)	0
	Total Individuals			7	17
	Total Species			5	7
	Total Family			2	2

Site: TTFR = Tekai Tembeling Forest Reserve, KFR = Kemasul Forest Reserve; Wildlife Conservation Act (WCA) (2010): TP = Totally Protected, P = Protected; IUCN: NT = Near threatened, LC = Least concerned, VU = Vulnerable

The Jaccard coefficient showed a 25% similarity in species composition between the TTFR and the UJFR. A total of 10 species were relatively common in both study areas such as the Whitehead's Spiny Rat (*Maxomys whiteheadi*), Malayan Field Rat (*Rattus tiomanicus*), Small Woolly Bat (*Kerivoula intermedia*), Least Woolly Bat (*Kerivoula minuta*), Fawn Leaf-nosed Bat (*Hiposideros cervinus*), Bicolored Roundleaf Bat (*Hipposideros bicolor*), Spotted-winged Fruit Bat (*Balionycteris maculata*), Lesser Short-nosed Fruit Bat (*Cynopterus brachyotis*), Horsfield's Fruit Bat (*Cynopterus horsfieldii*) and Long-tongued Fruit Bat (*Macroglossus subrinus*).

The results also showed that the most abundant species recorded from TTFR were the Narrow-winged Pipistrelle (*Pipistrellus cf stenopterus*) (n=6, 10.71% of total individuals recorded) and Intermediate Horseshoe Bat (*Rhinolophus affinis*) (n=24, 29.63%) from UJFR. In conclusion, although number of individuals caught at UJFR is higher than at TTFR with 98 and 63 individuals, respectively, the results showed that species richness of small mammals was higher in the TTFR (27 species) compared with the UJFR, which recorded only 23 species.

3.2 Diversity Pattern

Based on the diversity indices (Table 3) analysed using the PAST software version 2.17c, TTFR obtained the highest value of Simpson index (1-D=0.95), Shannon index (H'=3.11 ± 0.26), Evenness index (e^H/S= 0.83), Brillouin index (HB=2.6), Menhinick (3.40), Margalef (6.28), Equitability (Pielou, J= 0.94) and Fisher alpha (17.9) indices of diversity compared to the UJFR. However, dominance was the highest at UJFR (D=0.11) compared to the TTFR (D=0.05). Chao-1 index estimated that species richness in the TTFR could reach up to 34 (Table 1) and 45 species in the UJFR.

Table 3 - Small mammal diversity indices calculated using PAST software for TTFR and UJFR, Pahang

Diversity Indices	TTFR	UJFR
Taxa_S	27	23
Individuals	63	98
Dominance_D	0.05	0.11
Simpson_1-D	0.95	0.89
Shannon_H	3.11	2.62
Brillouin	2.60	2.32
Menhinick	3.40	2.32
Margalef	6.28	4.80
Berger-Parker	0.10	0.24
Chao-1	34.86	45.50

Rank abundance curves (RAC) (Fig. 2) shows two distinct relative abundance patterns at each site. Small mammals' relative abundance in the TTFR and UJFR as shown in Fig. 3(a) and 3(b) exhibited a log-normal model, ($\chi2$ =0.48 p=0.49) and a geometric model, ($\chi2$ =14.22, p=0.22), respectively. Rarefaction curves as in Fig. 4 show somewhat similar pattern in both sites but species richness was higher in the TTFR than in the UJFR (27 vs. 23 (Table 1). The rarefaction curve at the TTFR and UJFR does not reaching an asymptomatic level indicating low sampling efficiency for both sites. Interpolation point at 55th individual (which is the least number of individually captured in TTFR), showed a slightly higher average species in TTFR (25.49 ± 1.09), compared to the UJFR (19.35 ± 1.71). The overlapping confidence intervals of TTFR and UJFR in the rarefaction curves indicate that the average species richness between the two assemblages are insignificantly different in species richness of two sites at individual of 63 and 98, respectively. This indicate that the minimum sampling effort unable to distinguish the species richness for both sites. Thus, more surveys and samplings need to be conducted to obtain asymptomatic curves.

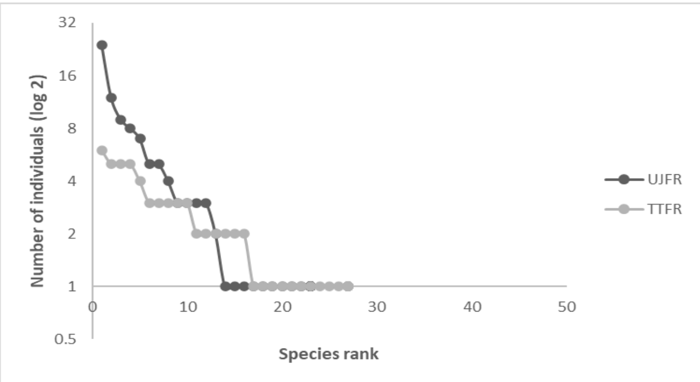

Fig. 2 - Rank abundance curve (RAC) for small mammals at both locations, TTFR and UJFR, Pahang

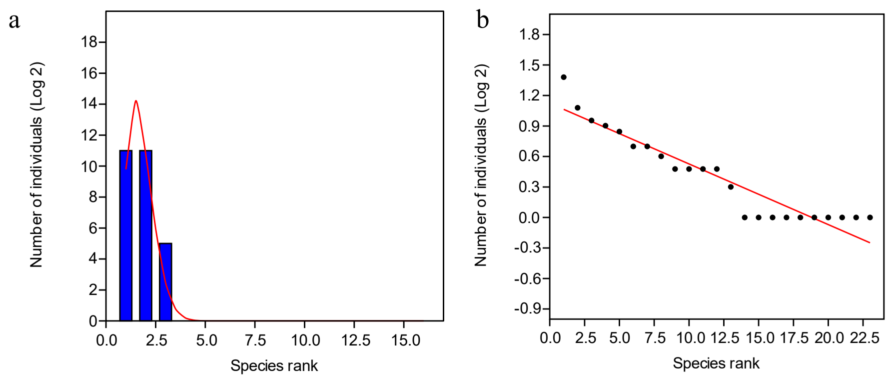

Fig. 3 - Pattern of distribution (a) TTFR and (b) UJFR, Pahang.

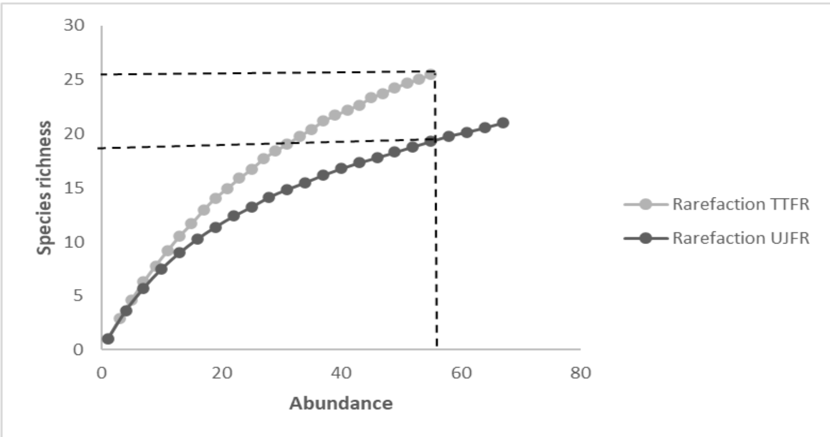

Fig.4 - Rarefaction curves for small mammals in TTFR and UJFR, Pahang

4. Discussion

The most notable findings in this research are that the relative abundance of insectivorous bats is greater than the frugivorous bats caught in this research (81.5% of the total bat captured). A total of 38 species of volant small mammals, consisting mainly of bats and 12 species of non-volant small mammals, consisting of rodents, have been identified in this study. Of all these, 27 species of insectivorous bats were recorded in this study and these species were mainly recorded in TTFR (16 species) and UJFR (11 species). This can be largely attributed by the behavior of insectivorous bats which feed in a lowland forest, and some of these bats is known to forage in group [18]. Species from the family Vespertilionidae (Kerivoulinae and Murininae), Hipposideridae and Rhinolophidae are the most common insectivorous families in the interior of the forest, with high flight maneuverability and good echolocators that enable them to effectively avoid mist nets [19]. Our results suggested that the family Vespertilionidae is the most diverse at TTFR while Muridae is the most diverse at UJFR with both recorded seven species. The most abundant, however, were the Hipposideridae family at TTFR (15 individuals) and the Rhinolophidae family at UJFR (25 individuals).

Regenerating forest like TTFR is considered having high disturbance with habitat changes and forest fragmentation. These factors were predicted to have a high impact particularly on Vespertilionidae, Hipposideridae and the Rhinolophidae families, as many of them are usually highly adapted for foraging in the clutter of the interior forest ('narrow space') [20] [18]. As a result, these species may be more vulnerable to forest degradation, and may be more likely to avoid disturbed and open habitats [15]. Because of this reliance on forests, deforestation and other forest disturbance events possibly influenced these species [21] [22]. The actively logging activity at the study area causes the canopy cover to diminish, which consequently increases the number of open space species to be caught such as *B. maculata* and *M. mops* [23] [24]. This is because these species forage at high canopy cover and there is nothing that would hinder their movement. Meanwhile, forest dwellers species such as *K. intermedia* and *K. pellucida* might be highly affected by forest disturbance as they are dependent on forest for foraging and often found in the understory of tall secondary forest [25]. Among all the volant small mammal species captured at TTFR, six species were listed as Near Threatened (NT) by the IUCN Red List which are *K. intermedia, K. pellucida, K. minuta, R. cf. sedulous, R. trifoliatus* and *M. mops*. These species are threatened from habitat loss due to logging, agriculture, plantations, and forest fires [3]. The bats are among the small mammal species documented which are significant, and this highlights the importance of karst areas in Malaysia for the conservation of bats. Most of the captured volant species is cave-dwelling, which includes Vespertilionidae, Hipposideridae and Pteropodidae family. This finding is supposed to be aligned with those of [25], because these species are the colonies that were found mainly roosting in caves. Based on personal field observations, the Kota Gelanggi Caves Complex was the closest cave that could be the roosting sites of the bats found from the study area.

On the other hand, the family Muridae has shown a significant low abundance in TTFR as compared to UJFR. Small mammals, particularly non-volant small mammals can be classified as forest and open land specialists and habitat generalists, with each responding differently to changes in landscape complexity [26]. The abundance of *L. sabanus* is higher in UJFR relative to the least-impaired habitat in TTFR. Analysis of habitat utilisation by *L. sabanus*, based on spool-and-line-tracks of [9], revealed *L. sabanus* has a strong ability to move between various forest matrices, such as logged and unlogged forests. A higher abundance of *L. sabanus* in UJFR proves that the species can forage for its resources in varieties of habitats and may encourage a healthy reproduction.

Although UJFR had more captures (98 individuals) than TTFR in this study, TTFR showed the highest species diversity as it has the steepest curve than the other study area. However, the total sampling effort was still inadequate to document the total diversity of small mammals in TTFR and UJFR as the cumulative curve was still exponential. Conversely, the highest species richness recorded in TTFR is apparent, as TTFR encompasses a significantly larger area than UJFR and many uncommon bat species (such as *H. tomesi, H. Ridleyi* and *C. johorensis*) were recorded in TTFR but not in UJFR. Areas increase diversity as a larger plot is likely to have more habitats and functions to support a greater diversity of species. Besides, many species require a wide range for adequate prey or seed forage [27]. Although TTFR was the richest in the total number of species, there was a decreased discrepancy between the species richness values estimated by the rarefaction and the Chao-1 estimators. These results indicate that TTFR is potentially the richest study site, followed by UJFR. According to [28], different ecological limits for clades appear to be the main determinants of diversification and therefore species richness.

There are many factors that may explain the low number of species documented from the area of study. Trapping methods, habitat changes and climate change are those that affect the diversity of small mammals and other wildlife species [15]. In addition, the other possibility of a low number of individuals caught was mainly due to bait that was not alluring to the species as many fruit trees were already present in the forest and the limited sampling effort could also contribute to the current finding. Although most of the individuals recorded in this study were either cage traps, harp traps or mist nets, a direct observation technique was also another effective approach that can be used to record the presence of small mammal species, especially diurnal squirrels, and nocturnal mammals such as Colugo [29]. In addition to the use of various sampling techniques, an increase in the sampling frequency and an extension of the sampling period may also increase the total number of species recorded. Although a low diversity of terrestrial small mammals at TTFR can be associated with a less aggressive sampling approach (either in terms of the number of methods used or sampling frequency/period), habitat disturbance caused by logging activity also has a significant impact on the TTFR mammals' diversity.

5. Conclusion

This survey generated the first list of small mammals found in Tekai-Tembeling Forest Reserve (TTFR), within the Jerantut area. Further surveys need to be carried out with an increase in sampling effort to determine the fauna diversity in TTFR more accurately. Although the species diversity of small mammals recorded during this study considered low, however, this is possibly not a correct representation of species diversity in the study area. Trapping methods and climate changes, where and when trapping was conducted are the factors affecting the diversity of small mammals and other fauna species. Extreme weather such as heavy rainfall and extreme dry season and drought probably explain to the low number of individuals caught. In another word, some species may be left undetected due to seasonal variations. Thus, it is advisable to conduct the sampling extensively. The sampling can be significantly improved by applying diverse techniques and extended sampling period for each method [29]. There is very limited information currently available regarding status on certain species of small mammals (especially volant small mammals) in Wildlife Conservation Act 2010's and IUCN Red List needs to be identified because it is apparent that many species that need protection have yet to be addressed and that these mammals may face possible local extinction if nothing is done to control the current rate of deforestation.

Acknowledgement

We would like to thank the Environmental Unit from Tenaga Nasional Berhad Research (TNBR) Sdn. Bhd, for funding this study, and the Department of Wildlife and National Parks (DWNP) from HYDRO-CFS team and UTS (Unit Tangkapan Seladang) team for the logistics and field assistance. This research was fully funded by Research Grant ST-2017-00.

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