Composition and Diversity of Tree Species with DBH of 5 cm and above at Pulau Banding, Gerik, Perak, Malaysia

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Abstract. A total of 92 individual trees with DBH of 5 cm and above comprising 21 families, 28 genera and 35 species were measured, identified and recorded. This study aimed to enumerate the tree species composition and estimate the diversity index of trees with DBH of 5 cm and above at Pulau Banding, Perak. An ecological plot size of 70 m x 70 m or 0.49 ha was established and divided into three subplots. The data collection was collected to determine the number of species, number of individuals and DBH within the plots. The Shannon Diversity Index was estimated at H' = 2.98 (H'_{max} = 3.53) while the Simpson's Index (D) was 0.10 and Species Evenness (E) was 0.85. *Murraya paniculata* (Rutaceae) was the most important species with an IV*i* (Important Value Index) of 24.7%, while Dipterocarpaceae was the dominant family for the study area with an IV*i* of 45.36%. The total aboveground biomass of all trees with a DBH of 5 cm and above in a 0.49 ha plot in Pulau Banding was estimated at 66.2 t/ha. Hence this study is providing preliminary data on tree species composition at Pulau Banding, Perak for conserving the remaining valued timber trees that are still in the regeneration phase.

1 Introduction

Tree species diversity varies due to differences in terms of habitat, disturbance and biogeography [1]. The difference in ecosystems and mechanisms become a limitation to the researchers to study tree species composition and floristic patterns [2]. Island ecosystems such as Pulau Banding, Perak is suspected to have different tree species composition compared to mainland ecosystem based on geographical isolation [3].

Biomass is a significant factor in the distribution of soil nutrients, carbon cycles, fuel accumulation, and habitat conditions in terrestrial ecosystems. According to [4], aboveground biomass (AGB) is the best indicator of forest productivity, sequestration, and carbon storage. Two critical parameters in plant community ecosystems that are normally

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estimated are biodiversity indices and aboveground biomass [5]. Ultimately, a main parameter of ecology that focuses worldwide is the biodiversity-biomass relationship over the recent decade [6]. The amount of forest biomass must be measured to maintain the forest's ability to absorb and store carbon in the ecosystem, as well as to estimate the amount of carbon lost or released during deforestation. However, the changes in land use, particularly tropical deforestation have led to the global reduction of AGB [7]. Moreover, the AGB is a crucial component of the global carbon cycle and an essential ecological variable.

More specifically, this study aimed to measure the DBH of each tree and identified species names to calculate the species diversity indices. The non-destructive method was chosen [8] in estimating biomass to determine the productivity of trees in this area. Hence, no study on tree composition has been conducted in Pulau Banding, Perak except a similar study with this study was carried out in Royal Belum as a part of Temengor Forest Reserve [9]. Although information on the conservation and endemic status of tree species in Peninsular Malaysia was already documented [10], additional floristic information covering the Pulau Banding, Perak a neighbourhood of Temengor Forest Reserve would be useful in forest management and conservation of biodiversity of the Pulau Banding, Perak by various stakeholders.

2 Methodology

2.1 Study area and tree enumeration

Pulau Banding is located in Gerik, Perak, Malaysia (Figure 1). It lies between 5°34'24.8"N 101°20'33.1"E has a total coverage of 290,000 hectares, and is close to Bang Lang National Park and Hala-Bala Wildlife Sanctuary in Thailand [11]. It is located on the east side of the East-West Highway, which connects Gerik, Perak, and Jeli, Kelantan. The forest is divided into two areas, the Upper Belum area, which stretches to the Malaysia-Thailand border and the Lower Belum area covered by the Temengor Lake.

The AGB of trees with a diameter of more than 5 cm DBH was studied using the plotting technique at Pulau Banding, Perak. The random sampling method was used in this study, which was introduced by [12]. A randomly selected sample is supposed to provide a reasonable representative of the entire population. The samplings were conducted by plot (70 m x 70 m) at the study site. Species identification was referred to the books [10] and [13] to identify tree specimens in this study.

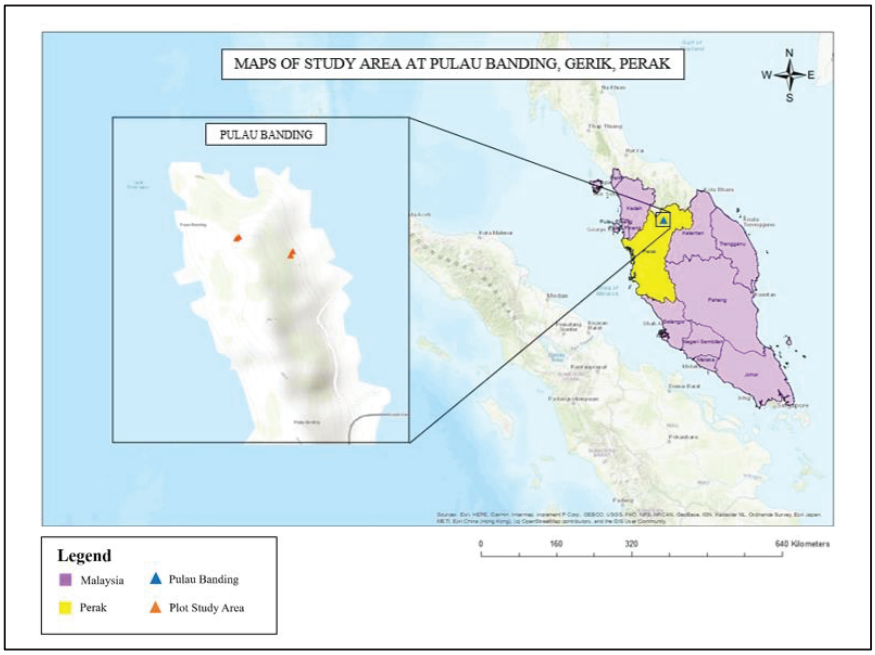

Fig. 1. The map of the study area at Pulau Banding, Gerik, Perak

2.2 Ecological parameters

All identified trees were arranged up to species level. Ecological parameters measured in this study were basal area, aboveground biomass and biological diversity indices. The estimation of all ecological parameters was analysed using the formula by [14] as Equations (3.1 – 3.6):

a) Basal area (BA)
$= 0.7857 \times D^2$ (1)
where D = DBH (cm)

b) Aboveground biomass (AGB)
$= W_s + W_b + W_l$, *(kg)* (2)

c) Importance Value Index (IVi) and summing parameters, where relative frequency (RF), relative density (Rd) and relative dominance (RD) [15].
$= IVi = R_F + R_d + R_D$ (3)

d) Shannon-Wiener's Index (H') [16] is used to determine tree species diversity.
$H' = \sum_{i=1}^{s} \text{pi} \ln pi$ (4)
Where:
s = number of species
pi = the proportion of individuals or the abundance of its species expressed as a proportion of total abundance
ln = log base n

e) Pielou's Evenness Index [17] is to calculate Species Evenness (E).
$EH = H' / H'max = H' / log\ S$ (5)
Where:
S = Total number of species in the sample
H' = Shannon-Weiner diversity index

f) Simpson's Index (D) [18]
$(D = 1/\sum_{i=1}^{s} pi^2)$ (6)

3 Results and Discussion

3.1 Tree species composition and diameter breast height (DBH)

A total of 92 individual trees with DBH of 5 cm and above were censused in a 0.49 ha plot at Pulau Banding, Perak. It comprises 35 species, 28 genera and 21 families (Table 1). Nine families are recorded with one species, one genus and one family, respectively. Two dominant families are Dipterocarpaceae and Rutaceae which Dipterocarpaceae family has two genera, two species and a total number of individuals is 16 while the Rutaceae family has a total number of individuals 16 with one species and one genus.

According to Figure 2, the total 92 individual trees with DBH class ranges between 5 cm and more than 45 cm formed a reverse J-curve graph. DBH values for all individual trees were classified into five classes: I: 2.0–15 cm, II: 16–25 cm, III: 26–35 cm, IV: 36–45 cm, and V: more than 46 cm. It is clearly shown the number of individuals with Class I (5-15 cm) is higher than the other four Class (II-V). This indicates the study area is in the regeneration phase where 68 individual trees are recorded with DBH Class 1 (5-15 cm). The findings recorded that the individual with the highest DBH in the study plot was the Shorea laevis (Dipterocarpaceae) with a DBH of 96.5 cm.Equations should be centred and numbered with the number on the right-hand side.

Table 1. Floristic composition was recorded in 0.49 ha plot size at Pulau Banding, Perak.

No.	Family	Genus	Species	*n*
1	Dipterocarpaceae	2	6	16
2	Rutaceae	1	1	16
3	Euphorbiaceae	2	2	13
4	Burseraceae	1	1	9
5	Moraceae	2	2	7
6	Malvaceae	2	3	4
7	Rubiaceae	3	4	4
8	Scorodocarpaceae	1	1	4
9	Anacardiaceae	2	2	3
10	Annonaceae	1	2	3
11	Ochnaceae	1	1	2
12	Rhizophoraceae	1	1	2
13	Asteraceae	1	1	1
14	Calophyllaceae	1	1	1
15	Chrysobalanaceae	1	1	1
16	Clusiaceae	1	1	1
17	Fabaceae	1	1	1
18	Lecythidacea	1	1	1
19	Leguminosae	1	1	1
20	Olacaceae	1	1	1
21	Thymelaeaceae	1	1	1
	Total	**28**	**35**	**92**

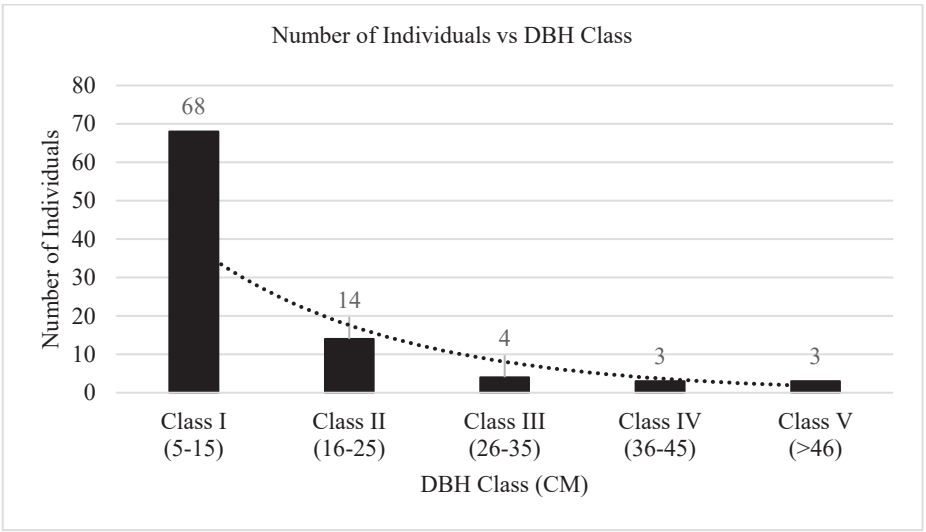

Fig. 2. The number of individuals based on the DBH classes in a 0.49 ha plot with more than 5 cm DBH at Pulau Banding, Perak

3.2 Importance Value Index (IV*i*)

Based on Table 2, the Dipterocarpaceae family is the family with the highest importance value of 45.6%. This is followed by the Rutaceae family which is the second most important family and the Euphorbiaceae family is the third most important in this plot with importance values of 34.49% and 26.63% respectively. According to [19], families with a family interest value (FIVi) exceeding 40% per 100% are considered absolute dominant families. In this plot, it is found that the Dipterocarpaceae is the dominant family.

According to [19], a species Importance Value Index (SIV*i*) above 10% is considered the dominant species in a community. Therefore, in this study, four species that can be considered absolute dominant are *Murraya paniculata*, *Croton argyratus*, *Shorea laevis*, *Canarium littorale*, and *Shorea bentongensis*. The results of the analysis found that the relatively important Species Importance Value Index (SIV*i*) in the study plot are *Murraya paniculata*, followed by *Croton argyratus*, and *Shorea laevis* with a species importance index of 24.7%, 17.3%and 15.7%, respectively.

Table 2. The Family Importance Value Index (FIV*i*) and Species Importance Value Index (SIV*i*) at Pulau Banding, Perak.

Family	***n***	**IV$_i$ (%)**	**Species**	***n***	**IV$_i$ (%)**
Dipterocarpaceae	16	45.36	*Murraya paniculata*	16	24.7
Rutaceae	16	34.49	*Croton argyratus*	12	17.3
Euphorbiaceae	13	26.63	*Shorea laevis*	3	15.7
Burseraceae	9	20.07	*Canarium littorale*	9	14.6
Moraceae	7	14.28	*Shorea bentongensis*	9	13.6
Malvaceae	4	11.68	*Artocarpus anisophyllus*	6	8.5
Rubiaceae	4	8.21	*Scorocbcarpus borneensis*	4	5.6
Scorodocarpaceae	4	8.08	*Microcos tomentosa*	2	5.1
Anacardiaceae	3	6.83	*Aquailaria malaccensis*	1	4.2
Annonaceae	3	6.12	*Bouea macrophylla*	2	3.6

3.3 Species Diversity

The value of all diversity indices used to estimate the species diversity is tabulated in Table 3. The Shannon-Wiener's Index (H') usually range between 1.5 to 3.5, although in certain extraordinary cases, it can exceed 4.5 and above [20]. In this study, a 0.49 ha plot obtained a value of 2.98 for the Shannon-Wiener Diversity Index (H'). The value of H' is 2.98 which indicates the species diversity within the 0.49 ha plot is considered intermediate because it almost reaches 3.5. As a comparison, the species diversity was slightly lower than the study conducted at the Pulau Redang inland forest recorded for a 0.1 plot with 3.5 (H'_{max}= 4.0) with evenness (E) of 0.89 [21].

However, in this study the species diversity represents *Murraya paniculata* (Rutaceae) but most studies show Dipterocarpaceae represent the species diversity although *Shorea laevis* had the highest biomass value. In contrast, the species diversity represents *Dipterocarpus costulatus* at Pulau Redang inland forest [21].

Table 3. Overall species diversity indices estimated in this study

Diversity Indices	This Study
Shannon-Wiener's Index (H')	2.98
Shannon-Wiener's Maximum Index (H'_{max})	3.53
Species Evenness Index (E_H)	0.85
Simpson's Index (D)	0.1

3.4 Aboveground Biomass (AGB)

As a result, from the DBH data analysis, the total aboveground biomass (AGB) estimated at Pulau Banding, Perak was 66.2 t/ha. Table 4 shows the highest AGB was contributed by Dipterocarpaceae (55.3% = 36.61 t/ha) and followed by Malvaceae (12.2%=8.09 t/ha) (Table 4). At the species level, *Shorea laevis* highly influenced the total biomass estimated at 33.00 t/ha. This is related to the DBH recorded of *Shorea laevis* is 96.5 cm which may consider as a factor that DBH may influence the aboveground biomass content [22].

Based on Table 4, the species that contributed the highest biomass in the study plot was *Shorea laevis* with an estimated biomass of 33.00 t/ha. *Murraya paniculata* contributed the second-highest biomass at 5.42 t/ha, followed by *Microcos tomentosa* species which contributed the third-highest biomass value with an estimated 5.30 t/ha.

Table 4. The value of aboveground biomass of the ten highest families and species each at Pulau Banding, Gerik, Perak.

Family	Biomass (t/ha)	Species	Biomass (t/ha)
Dipterocarpaceae	36.61	*Shorea laevis*	33.00
Malvaceae	8.09	*Murraya paniculata*	5.42
Rutaceae	5.42	*Microcos tomentosa*	5.30
Burseraceae	4.51	*Canarium littorale*	4.51
Olacaceae	2.60	*Ochanostachys amentaceae*	2.60
Euphorbiaceae	1.90	*Shorea bentongensis*	2.51
Anacardiaceae	1.80	*Microcos antidesmifolia*	2.42
Rubiaceae	1.64	*Croton argyratus*	1.84
Rhizophoraceae	0.94	*Bouea macrophylla*	1.70
Moraceae	0.83	*Carallia suffruticosa*	0.94

4 Conclusions

Based on the tree species composition and species diversity calculation of all censused data showed that Pulau Banding, Perak had the higher diversity of tree species. Although the study area was relatively small compared to other similar studies, it proved that Pulau Banding, Perak contains a higher floristic composition than was estimated. As Pulau Banding, Perak within the compartment of Royal Belum State Park, Perak and near to Tropical Rainforest Research Centre (UMK-Trace) this is vitally important to sustain and conserve the trees from being logged for any development. These data would be of interest to other researchers to conduct the monitoring study on the growth development of the trees in the particular study area. This result can be used as basic information for other ecological studies of the whole Pulau Banding, Perak, that involve a larger scope of the area.

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References

1. T.C. Whitmore, An Introduction to Tropical Rain Forests (University Press, New York, 1998)
2. F.C. Nettesheim, M.L. Garbin, M.G. Pereira, D.S.D.D. Araujo, C.E.D.V. Grellea, Flora **248**, 61–69 (2018)
3. E. Pesiu, M.T. Abdullah, J, Salim, M.R. Salam, *J. Sustain. Sci. Manag.* (**1**): 48-50 (2016)
4. H. Bi, J. Turner, M.J. Lambert *Trees* **18**(4): 467-479 (2004)
5. Q.F. Guo, *Basic Appl Ecol.* **8** 199–208 (2007)
6. X. Wu, X.P. Wang, Z.Y. Tang, Z.H. Shen, C.Y. Zheng, X.L. Xia, Ecography **38**, 602–613 (2015)
7. W.C. Adinugroho, L.B. Prasetyo, C. Kusmana, H. Krisnawati, IOP Conf. Series: Earth and Environmental Science. **1109** (2022)
8. N. Montès, T. Gauquelin, W. Badri, V. Bertaudière, El H. Zaoui, For. Ecol. Manag. **130** (1-3): 37-46 (2000)
9. M.S. Nizam, Z.A. Norwahidah, D. Rohaiza, Komposisi, kepelbagaian spesies dan biojisim atas tanah komuniti pokok di Taman Negeri Diraja Belum (Kuala Lumpur: Forestry Department of Peninsular Malaysia, 2011)
10. F.S.P. Ng, C.M. Low, N.S., Mat Asri, Endemic Trees of the Malay Peninsula. Research Pamphlet No. 106 (Kepong: Forest Research Institute, 1990)
11. F.K. Kedri, Z. Hamzah, N.S. Sukri, S.H. Yaacob, N.K.S. Abd Majid, N. Mokhtar, S.F. Amir, *Int. J. Eng. Technol.* **7**, 292-296 (2018)
12. H. Taherdoost, *Int. J. Acad. Res.* **5**(2), 18-27 (2016)
13. I.M. Turner, *Gardens Bulletin of Singapore* **47**, (1 & 2) 1-757 (1995)
14. R. Kato, Y. Tadaki, H. Ogawa, *Malayan Nat. J* **30**(2), 211-224 (1978)
15. J.E. Brower, J.H. Zar, C.N. Ende, Field and Laboratory Methods for General Ecology (4th Ed. Boston: McGraw Hill, 1997)
16. C. Shannon, *Bell Syst. Tech. J.* **27,** 379–423 (1948)
17. E.C. Pielou, *J. Theor. Biol.* **13**, 131–144 (1966)
18. E.H. Simpson, *Nature* **163**, 688 (1949)
19. J.T. Curtis, R.P. Macintosh, *Ecology* **32**, 476-496 (1951)
20. A.E. Magurran, Ecological diversity and its measurement (Princeton University Press, 1988)

21. M. Khairil, M. Nashriyah, N. Norhayati, Shahril Amin, Nur Fatihah, *Walailak J Sci. Technol.* **10**(1), 77-90 (2013)
22. H. Bao, P.P. Krishna, T. Hailemariam. *For. Ecol. Manag.* **376**, 276-83 (2016)