PAPER • OPEN ACCESS

The remaining black jewels ecosystem in southern Peninsular Malaysia: Floristic composition of peat swamp forest in Muar, Johor

To cite this article: M H Hyrul Izwan *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1053** 012011

View the article online for updates and enhancements.

The remaining black jewels ecosystem in southern Peninsular Malaysia: Floristic composition of peat swamp forest in Muar, Johor

M H Hyrul Izwan*, P Ismail, S Siti Aisah and H Tariq Mubarak

Forest Research Institute Malaysia (FRIM), Kepong, 52109, Selangor, Malaysia

* Corresponding author: hyrulizwan@frim.gov.my

Abstract. The Ayer Hitam North Forest Reserve (AHNFR) is located in the Muar district of Johor, Malaysia. The total area of AHNFR is stated as 3,797 hectares (ha), and this forest is unique as it has both inland forest and peat swamp forest. Peat swamp forest established on organic soils while the inland forest grows on mineral soils. AHNFR best described as the last remaining 'black jewel' ecosystem in the state of Johor as other peat swamp forests has perished. Five transect lines were established within the peat swamp forest areas. Each transect line has five plots where each plot is 0.04 ha in size. All trees with more than 10 cm in diameter at breast height were enumerated to determine the community structure and diversity of trees. 447 individuals tree were enumerated and result indicated that a total of 31 families with 70 species were found in the area assessed. The total tree density for peat swamp forest in AHNFR was estimated at 447 tree ha^{-1}. The top five species with highest density were *Syzygium cerinum* (33 tree ha^{-1}), *Syzygium inophyllum* (31 tree ha^{-1}), *Palaquium hexandrum* (29 tree ha^{-1}), *Stemonurus secundiflorus* (24 tree ha^{-1}) and *Koompassia malaccensis* (21 tree ha^{-1}). Total tree basal area at peat swamp forest area of AHNFR was 24.48 m^{2}ha^{-1}. Species with highest basal area was *K. malaccensis* (3.46 m^{2}ha^{-1}) while the least was *Lithocarpus curtisii* (0.01 m^{2}ha^{-1}).

Keywords: Peat swamp forest vegetation; species composition; community structure; Johor peat swamp forest.

1. Introduction

Peat swamp forests (PSF) is one of the wetlands type found in Malaysia which others being mangrove swamp forests, brackish water swamp forests, fresh water swamp forests, riparian forests and coastal or beach forests [1]. PSF is a unique ecosystem where forested wetland found in low lying plain in environment where naturally high water tables and seasonal waterlogged condition prevails [2]. This forest ecosystem developed on peat which is an oligotrophic soil [2]. Peat is also known as organic matter as it was made of dead leaves and other plant materials accumulations that partially decomposed under waterlogged conditions due to the oxygen-deficient conditions. Peat containing 90% water and remaining 10% organic matter which enables peatlands having unique ability to store large amount of water [3]. Thus, PSF forms the largest wetland forest type in Malaysia in term of area, which total covered approximately 1.5 million hectares (ha). Of this area, less than 20% are in Peninsular Malaysia, 72% are in Sarawak and the remaining are in Sabah [4].

Tree species diversity in PSF is low compared to the dryland forest type in Peninsular Malaysia because PSF are very special type of forest and have a restrictive flora composition [5]. The PSF support tree species with small to medium-sized crowns and a generally open and irregular canopy with emergent trees of above 30 m height are scattered throughout the areas [2]. There are three main layers of canopy in the PSF which are emergent layer with trees more than 40 m high (e.g. *Koompassia malaccensis*, *Anisoptera marginata*, *Shorea uliginosa* and etc.); main canopy layer with trees 20 to 40

m high (e.g. *Blumeodendron tokbrai*, *Xylopia fusca*, *Gonystylus bancanus* and etc.); and substorey layers with trees less than 20 m high (various species including *Calamus* sp., *Licuala* sp., and *Zalacca conferta*. Water-logged areas commonly inhabited by stemless palm such as *Pandanus* and *Z. conferta* [2]. Extensive inventory of PSF have been conducted mostly in Sarawak, Pahang and Selangor. Not much information on stand structure and species composition has been made available regarding the PSF in Muar, Johor. Therefore, objectives of this study was to assess and describe the species composition for PSF in Ayer Hitam North Forest Reserve (AHNFR), Muar, Johor.

2. Materials and methods

2.1 Study area
AHNFR is located in Muar district, north western part of Johor. AHNFR has been gazetted as Permanent Forest Reserve under the provision of National Forestry Act 1984 on 28th February 1940 (Gazette No. 272) and its total areas stated as 3,797 hectares (ha). Apart from that, AHNFR is the only PSF recognised as Forest State Park in Peninsular Malaysia. PSF of AHNFR best described as the last 'black jewel' forest remaining in the state of Johor as other PSF areas has perished. AHNFR consist of two (2) forest types, which are PSF and inland forest. However, this study only focused on PSF areas.

2.2 Inventory method and design
The tree survey was conducted in August 2016. Five (5) lines transect has been established randomly at PSF areas of AHNFR. Each line transect has five (5) sample plots with size 20 m X 20 m. The distance between 2 sample plots are 30 m apart. The total length of each line transect was 250 m and total area has been sampled was 1 ha. All trees with diameter at breast height (dbh) ≥ 10 cm were measured and recorded. The parameter taken within the sample plot are species, dbh (cm) and height (m).

2.3 Data analysis
All trees enumerated in the sample plots were summarized for overall taxonomic composition and quantitative data were analysed to determine abundance. These include determination of basal area, as well as calculating the density and frequency of occurrence of each species. Tree basal area (BA) was calculated using the equation as follows: BA = $[\pi \times (d^2)/40000]$ (unit: m^2), where d is the dbh and π=3.142.

Shannon Diversity Index (or Shannon-Weiner diversity index) denotes as *H'*, is a way to measure the diversity of species in a community. A community with only one species would have an *H'* value of zero (0). If the species are evenly distributed, *H'* value would be high. So the *H* value allows us to know not only the number of species but how the abundance of the species is distributed among all the species in the community [6].

$$H' = -\sum pi * \ln(pi) \, , \tag{1}$$

where:

pi = The proportion of the entire community made up of species *i*
ln = Natural log

Importance Value Index (IVI) is used to determine the overall importance of each species in the forest structure. The IVI was calculated by summing up the values of relative density (RD), relative dominance (based on basal area) (RDm), and relative frequency (RF) of each species [IVI = RD + RDm + RF)/3]. Equation to calculate RD, RDm, RF, Density, Frequency and Dominance for IVI are as in Table 1. The species having the highest IVI value is the most dominant species in the community [7].

Table 1. Equation to calculate Important Value Index (IVI) of a species.

Index	Equation	
Relative Density (RD)	$= \left(\dfrac{\text{density of a species}}{\text{total density of all species}} \right) \times 100$	(2)
Relative Frequency (RF)	$= \left(\dfrac{\text{frequency of a species}}{\text{total frequency of all species}} \right) \times 100$	(3)
Relative Dominance (RDm)	$= \left(\dfrac{\text{dominance of a species}}{\text{total dominance of all species}} \right) \times 100$	(4)
Density	$= \dfrac{\text{number of a species}}{\text{total area sampled}}$	(5)
Frequency	$= \dfrac{\text{area of plots in which a species occurs}}{\text{total area sampled}}$	(6)
Dominance	$= \dfrac{\text{total basal area of a species}}{\text{total area sampled}}$	(7)

3. Results and discussion

A total of 447 trees of 10 cm dbh and above were enumerated in the study areas. The result indicated that a total of 70 species of trees belongs to 53 genera and 31 families were found in the area surveyed. The Annonaceae was the largest families represented by 7 species. This was followed by the Burseraceae (6 species), Euphorbiaceae and Myrtaceae (5 species each), Lauraceae (4 species), Calophyllaceae, Myristicaceae and Sapindaceae (3 species each), Anacardiaceae, Clusiaceae, Dipterocarpaceae, Ebenaceae, Elaeocarpaceae, Fabaceae, Moraceae, Phyllanthaceae, Rubiaceae, Rutaceae and Sapotaceae (2 species each) and the remainder have one species each. A comparison of finding from this study with previous study has been summarized in the Table 2.

Table 2. Comparison of findings on PSF species composition / diversity studies in Peninsular.

Site	Findings / Results	Source
Compartment 156, Pekan Forest Reserve, Pahang	68 tree species from 26 families (above 10cm dbh ; 1 ha plot)	[8]
Compartment 200, Pekan Forest Reserve, Pahang	100 tree species from 37 families (above 10cm dbh ; 1 ha plot)	[8]
Post-felling inventory at Pekan Forest Reserve, Pahang (2,156 ha)	67 tree species occurring at surveyed area.	[8]
Kuala Langat VJR, Selangor	54 tree species from 27 families (above 5cm dbh)	[2]
North Selangor PSFs	107 tree species from 27 families (above 5cm dbh)	[2]
Ayer Hitam North PSF, Johor	70 tree species from 31 families (above 10 cm dbh)	This study

The study area shows a high species diversity whereby the Shannon Diversity Index (H') indicates a value of 3.69. The H' value from this study is comparable to the H' value obtained from previous study mainly from PSF in Pahang. A comparison of finding from this study with previous study has been simplified in the Table 3 below:

Table 3. Comparison of Shannon Diversity Index (H') findings in PSF within Peninsular Malaysia from previous studies.

Site	Findings / Results (H')	Source
PSF in Kuala Langat, Selangor	2.79	[9]
PSF in Sungai Bebar, Pahang	4.23	[10]
Compartment 156, Pekan Forest Reserve, Pahang	3.61	[8]
Compartment 200, Pekan Forest Reserve, Pahang	4.12	[8]
Ayer Hitam North PSF, Johor	3.69	This study

Parameters for abundance such as density and basal area are important to describe forest structure [8]. The species density gives an idea about the strength of a species in the community. The total tree density in AHNFR was estimated at 447 tree ha^{-1}. The top five species with highest density were *Syzygium cerinum* (33 tree ha^{-1}), *Syzygium inophyllum* (31 tree ha^{-1}), *Palaquium hexandrum* (29 tree ha^{-1}), *Stemonurus secundiflorus* (24 tree ha^{-1}) and *K. malaccensis* (21 tree ha^{-1}). The basal area is an important parameter for understanding the dominance of trees in an ecosystem [11]. Total tree basal area of AHNFR was estimated at 24.48 m^{2}ha^{-1}. Species with highest basal area was *K. malaccensis* (3.46 m^{2}ha^{-1}) while the least was *Lithocarpus curtisii* (0.01 m^{2}ha^{-1}).

The dominance of a species in a community is expressed through Important Value Index (IVI) that incorporate the values of relative density (RD), relative dominance (RB), and relative frequency (RF) of each species for measuring the productivity and diversity of each species [12]. The species with higher IVI is the leading dominant species in the area of study. From the analysis, IVI for the study area ranged from 23.62 % (*K. malaccensis*) to 0.60 % (*L. curtisii*). Data from Table 4 describe that *S. cerinum* has the highest density (33 tree ha^{-1}) but has small dbh, thus ranked at 4th place in the IVI. When compared to *K. malaccensis* which only has 21 tree ha^{-1}, this species ranked 1st in the IVI because most of its stands were big in size.

Table 4. Abundance parameters for 10 important species that are ranked based on Importance Value Index (IVI) in AHNFR.

Species	Density (tree ha^{-1})	Basal area (m^{2}ha^{-1})	IVI (%)
Koompassia malaccensis	21	3.46	23.62
Syzygium inophyllum	31	1.71	20.42
Palaquium hexandrum	29	1.69	18.18
Syzygium cerinum	33	0.88	15.43
Cratoxylum arborescens	14	2.24	14.67
Myristica lowiana	13	1.69	13.24
Stemonurus secundiflorus	24	0.56	13.14
Shorea platycarpa	15	1.17	11.89
Santiria laevigata	17	0.62	10.79
Polyalthia glauca	19	0.51	9.43

Stand structure of AHNFR was studied based on the distribution of tree diameter classes. The distribution of tree diameter classes contributes to the structural pattern and characteristics of rainforest [8]. In this study, the forest stand structure clearly display the inverse J shape where stem frequencies decrease with the increase in dbh (Figure 1). This suggest that this forest has normal distribution pattern of rainforest, with a high density of trees at the lower diameter classes and gradually declines with bigger diameter classes. This generally indicates that the stands are developing and regeneration is present. Natural regeneration is dependent on the availability of the mother trees, fruiting pattern and favourable conditions [13].
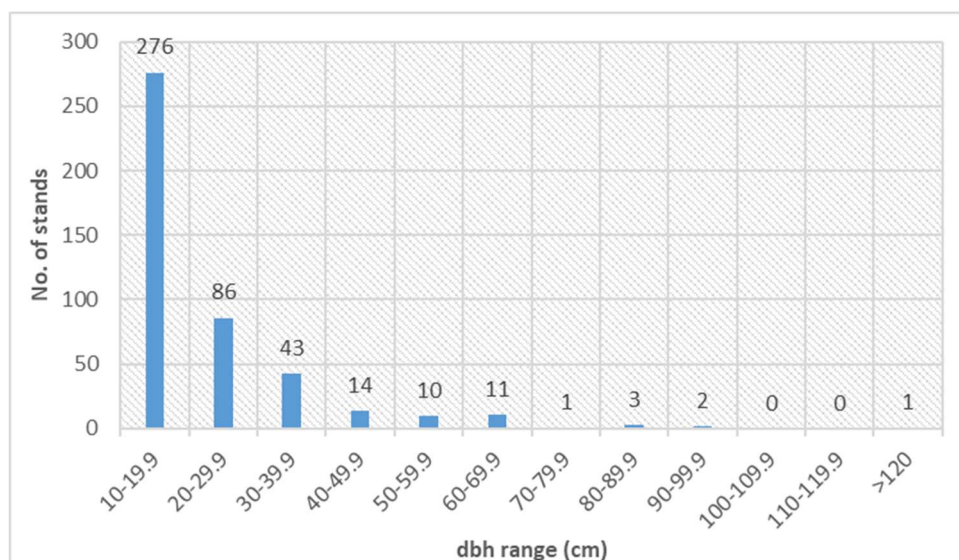
Figure 1. Diameter at breast height (dbh) classes distribution of trees at PSF of AHNFR

4. Conclusion

PSF of AHNFR is the only remaining PSF in the southern part of Peninsular Malaysia which is still rich in tree species even though it is under threatened by its surrounding activities. The small diameter class of trees were found in a large number of tree stems and was decreased in total with the increasingly diameter class shown that this forest is in the ecology equilibrium of a natural forest.

The data collected from this study will serve as baseline data for AHNFR and will benefit the forest manager in formulating the management plan for this forest in the future. However, more detailed studies on the flora of AHNFR is needed. The more detailed information on the floristic diversity would be useful for AHNFR to be promoted as ecotourism, education and research site.

Due to the uniqueness and richness of ecosystem and floristic diversity of AHNFR, capacity building and awareness campaign of the significant contribution of the PSF in Johor is deemed required to ensure that it is well managed and sustainably conserved for future generation.

5. References

[1]   Latiff A 2005 An Overview of the Significant Findings of the Biodiversity Expedition to the Peat Swamp Forest of Sungai Bebar, Pahang. *Biodiversity Expedition Sungai Bebar, Pahang, Summary Findings (PSF Technical Series No.4)* Latiff A, Khali Aziz H, Norhayati A, Mohd Nizam M S, An Nee T and Savinder K G ed (Selangor: Peat Swamp Forest Project, UNDP/GEF Funded Project) pp 3-7
[2]   Appanah S, Ismail H, Samsudin M and Sadali S 1999 Flora Survey in North Selangor Peat Swamp Forest. *Sustainable Management of Peat Swamp Forest in Peninsular Malaysia, Vol. 1: Resources* T Y Chin and M Palle ed (Kuala Lumpur: Forestry Department Peninsular Malaysia) pp 199-238
[3]   Global Environment Centre 2019 *Peatland Forest Ranger Module* (Selangor: Global Environment Centre) p 41
[4]   Ismail P, Tariq Mubarak H and Hyrul Izwan M H 2021 *An Overview of Wetlands in Malaysia. FRIM Research Pamphlet No. 153* (Selangor: Forest Research Institute Malaysia) pp 56
[5]   Whitmore T C 1975 *Tropical Rain Forest of the Far East* (Oxford: Clarendon Press)
[6]   Shannon C E and Weaver W 1949 *The Mathematical Theory of Communication.* (Urbana, IL: University of Illinois Press.)
[7]   Noraimy R, Norizh K and Mohd Hasmadi I 2014 Examining the rate of vegetation diversity under abandoned skid trails in Peninsular Malaysia forest. *J Agric Crop Res* **2**(8) 165-172
[8]   Ismail P, Nizam M S, Faridah Hanum I, Khali Aziz H, Shamsudin I, Samsudin M and Latiff A 2009 Community structure, diversity and biomass of trees in two forest subtypes of Pekan Forest Reserve, Pahang, Malaysia. *The Malaysian Forester* **72**(1) 117-133

[9]   Juliana W A, Norazlin S and Norhayati A 2004 Komposisi Spesies Hutan Paya Gambut di Hutan
          Simpan Kuala Langat Selatan, Selangor *Prosiding Simposium Biologi Kebangsaan ke-7* Asmat A,
          Farah Diba A B, Abdul Munir A M, Hasidah M S, Norela S and Marina Z ed (Selangor: University
          Kebangsaan Malaysia)

[10]   Nizam M S, Juliana W A, Raffae A, Rohani S and Sani M 2005 Community Structure of Tree
          Species at the Sungai Bebar Peat Swamp Forest, Pekan, Pahang *Biodiversity Expedition Sungai
          Bebar, Pahang, Summary Findings (PSF Technical Series No.4)* Latiff A, Khali Aziz H,
          Norhayati A, Mohd Nizam M S, An Nee T and Savinder K G ed (Selangor: Peat Swamp Forest
          Project, UNDP/GEF Funded Project) pp 70 - 72

[11]   Srinivasa R D, Prayaga M P and Venkaiah M 2013 Phytosociological observations on tree species
          diversity of tropical forest of Srikakulam District, Andhra Pradesh, India. *Ind. Jour. Pl. Sci.* **2**(4)
          89-108

[12]   Saurav M and Das A P 2014 Diversity and composition of tree stands in tropical forests of the
          Darjiling part of Eastern Himalaya. *International Journal of Current Research* **6**(12) 10446-10451

[13]   Mohd Nazip S 2012 Tree species diversity and forest stand structure of Pahang National Park,
          Malaysia *Biodiversity Enrichment in a Diverse World* IntechOpen pp 473-492

Acknowledgments