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Assessment of plant species diversity and abundance using line-transect method at Pantai Sabak, Kelantan

Nazahatul Anis Amaludin[1,*], Nur Aina Ab Majid[1], Nor Nadia Mohd Zulkafli[1], Nur Anis Zarifa Zamri[1], Siti Azieza Ahmad Zu[1], Muhammad Firdaus Abdul Karim[1], Radhiah Zakaria[2] and Shamsul Khamis[3]

[1] Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, 17600, Jeli, Kelantan, Malaysia.
[2] Faculty of Public Health, Universitas Muhammadiyah Aceh, Banda Aceh, 23123, Indonesia.
[3] Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600, UKM Bangi, Selangor, Malaysia.

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*Corresponding author:
Dr. Nazahatul Anis binti Amaludin
Faculty of Earth Science,
Universiti Malaysia Kelantan,
Jeli Campus, 17600, Jeli,
Kelantan, Malaysia.
Email: nazanis@umk.edu.my

Abstract

Coastal areas are environmentally sensitive areas filled with various local inhabitants focusing on the tree species ecosystem continuing to develop according to its environment. Pantai Sabak is one of the well-known eroded beaches in Kelantan due to the natural phenomenon, tidal wave erosion. This study aimed to identify the species availability and determine the species abundance, density, frequency, and diversity found in Pantai Sabak, Kelantan. Certain native species and common tree species at the coastline area are still available, such as *Nypa fruticans* and *Ipomoea pes-caprae*. Shocking results are achieved whereby the shoreline area has been degraded by the tidal wave and shoving away some species such as *Cocos nucifera*. Due to the situation, the coastal area has reached the mangrove area resulted in the species along the transect line is mangrove species namely *Excoecaria agallocha*. Another species achieved were shrubs and it showed Pantai Sabak has been severely damaged. A total of 1,350 individuals of 30 species from 30 genera belong to 22 families were recorded along two kilometres transect line. By using the diversity index which is Shannon-Wiener Diversity Index (H') value is 2.99, Shannon-Wiener Maximum Index (H'_{max}) is 3.40 while Shannon Evenness (E_H) is 0.88. These results showed the area of the study is still diverse in species hence dominated by shrubs such *Lantana camara*. Hence, this study only focuses on the species diversity ecosystem, not the causes of the occurrence that occurred.

1. INTRODUCTION

The length of the coastline area in Malaysia was recorded as 4,800 km long including Sabah and Sarawak (Ismail 2014). The coastal forest is located on the East Coast of the Peninsular of Malaysia, mostly in Pahang (around Kuantan), the entire Terengganu coastline with a distance of 255 km and Kelantan (Liang *et al.,* 2017).

East coast experiencing a higher rate of coastal erosion compared to the west coast (Bird and Teh, 1990). Pantai Sabak experienced severe coastal erosion and has become a social and economic calamity to the community (Hamirdin and Azmi 2004). It has covered more than 22 hectares as dumpsite since 1987 and is an abandoned area for now.

The abundance of plant species is the qualitative variable that refers to an arbitrarily estimated range in numerical values which express plenty or scarcity of a species (Bonham, 2013). The designs in conveyance and wealth of plant species customarily have been clarified essentially by variety in natural variables and unsettling influence history (Whittaker, 1975). There are several types of common plant species which grows in the coastline area namely *Casuarina equisetifolia, Ipomoea pes-caprae, Pandanus odoratissimus* and *Terminalia catappa* (Mueller-Dombois and Fosberg, 2013). According to Braun-Blanquet (1932), an abundance of tree species have been classified into five classes whereby very sparse, sparse, not numerous, numerous and very numerous (Bonham, 2013). The number of species that exist in the particular area indicates the richness and productiveness of the beaches. This study aimed to identify the species availability and determine the species abundance, density, frequency, and diversity found in Pantai Sabak, Kelantan. Pantai Sabak can be potentially developed as a tourism area, migratory bird spots and for local community activities. There is no study conducted on species diversity and abundance on the plant to determine the plant species diversity in Pantai Sabak, Kelantan.

1.1. The study area

The study was conducted in Pantai Sabak, Kelantan ranging between latitude 6°10'42.4"N and

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longitude 102°19'19.7"E (Figure 1). This area is located in the South China Sea and near to the airport in Pengkalan Chepa, Kelantan. It is an 11 km distance from Kota Bharu city.

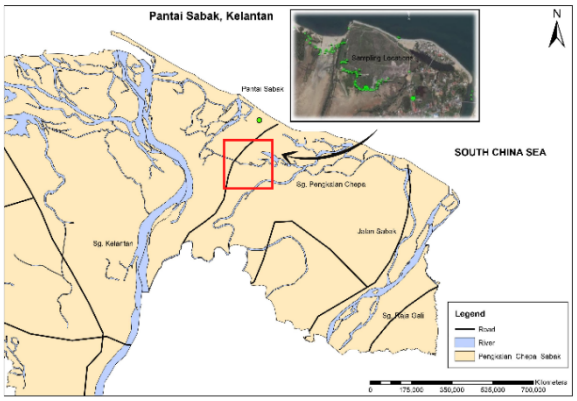

Figure 1: Sampling sites and location of the study site at Pantai Sabak, Kelantan.

2. MATERIALS AND METHODS

2.1. Line transect sampling

The line transect sampling method was used to record and collect the sample of the plant species along the coastal area. It has been set up 2 kilometres long and were divided into 20 parts with 100 metres each and approximately 5 metres the inland from the coastal of the beach. It is to measure the density estimate by quantifying the number of individuals of each species, and species richness along the line transect that occupied with plants species. All the tree species within the line transect has been marked and tabulated in the datasheet. Next, the plant sample taken were identified by collecting the fresh samples from the line transect by the assistant of botanists. Leaves, fruits, roots and flowers were taken as samples for the preparation of the specimen voucher.

2.2. Data analysis

The calculation of abundance, density, frequency and Shannon-Wiener's Index was calculated using the following formula as shown below:

$$\text{Abundance} = \frac{\text{Total number of individuals}}{\text{Number of sampling unit occurrence}}$$

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Number of sampling unit sampled}}$$

$$\text{Frequency} = \frac{\text{Number of sampling unit occurrence}}{\text{Total number of sampling unit sampled}} \times 100$$

Shannon-Wiener's Diversity Index =

$$H' = -\sum_{i=1}^{s} \; pi \; x \; ln(pi) \qquad (1)$$

Where:

H' = The value of Shannon Wiener's Diversity Index

P_i = The proportion of the i^{th} species

Log = Natural logarithm of p_i

S = The number of species in the community

The maximum diversity (H'_{max}) of a sample is found when all species are equally abundant. H_{max} = ln S, where S is the total number of species

$$H'_{max} = \ln S \qquad (2)$$

Species Evenness (E_H) can be computed from the Shannon-Wiener and species richness values. The formula of evenness is:

$$E_H = H'/H'_{max} \qquad (3)$$

Where it is calculated to determine the similarity of abundance within different individuals. If there is a common value in all species, the evenness is one, while when the abundance is different where some individuals are rare, the evenness value is increased.

3. RESULT AND DISCUSSION

3.1. Composition of plant species at Pantai Sabak

Plant species composition at Pantai Sabak, Kelantan were successfully collected according to their families, genus and species name within two kilometres of the study site. At Pantai Sabak, 22 families are representing 30 genera that belong to 30 species. All the plant species recorded including all kinds of trees which are shrubs, wooden trees and climbers. The species distribution possessed the ecology around the area and the local community habitat. This study is likely covered the community ecology of plants and their habitat.

Measuring species abundance allows for the understanding of how species are distributed within an ecosystem (Verberk, 2011). According to Saw (2010), on some of the East Coast islands, on the side facing the east exposed to the north-east monsoon, wind pruned vegetation is common where the annual strong winds shear off the vegetation at the beach fronts.

Based on the previous studies by (Wyatt-Smith and Panthon, 1963), the examples of plants species such as *Scaevola taccada* (Goodeniaceae) and *Terminalia catappa* (Combretaceae) while between the tree belt and the high tide mark, there is usually a narrow herbaceous community of *Canavalia cathartica* and *Vigna marina* (Leguminosae), *Cyperus stoloniferus* and *Remirea maritime* (Cyperaceae), *Euphorbia atoto* (Euphorbiaceae), *Ipomoea pes-caprae* subsp. *brasiliensis*, *Ischaemum muticum* and *Spinifex littoreus* (Gramineae) with *Vitex trifolia* subsp. *littoralis* as a common creeping shrub and scrambler existed along the coastal area in Malaysia. In addition, Saw (2010) stated that along the receding and gravel beaches, notably on the West Coast of Peninsular Malaysia, the littoral or strand forest consists of a narrow, often single belt of trees; *Hibiscus tiliaceus* (Malvaceae) is quite common species that could be found. This study showed that some of the species were tallied with the previous study of which shrub

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species recorded in Pantai Sabak shown 17 families belongs to 28 species and 24 genera (Zamri *et al.,* 2021).

The list of 30 species in Figure 2 presents the number of individuals found in Pantai Sabak, Kelantan. *Excoecaria agallocha* is the highest individual collected while *Flagellaria indica* is the lowest individual collected within the two kilometres transect line. The species existence to some extent helps to prevent the threats, erosion and wave from the oceans to protect the mainland and other ecosystems.

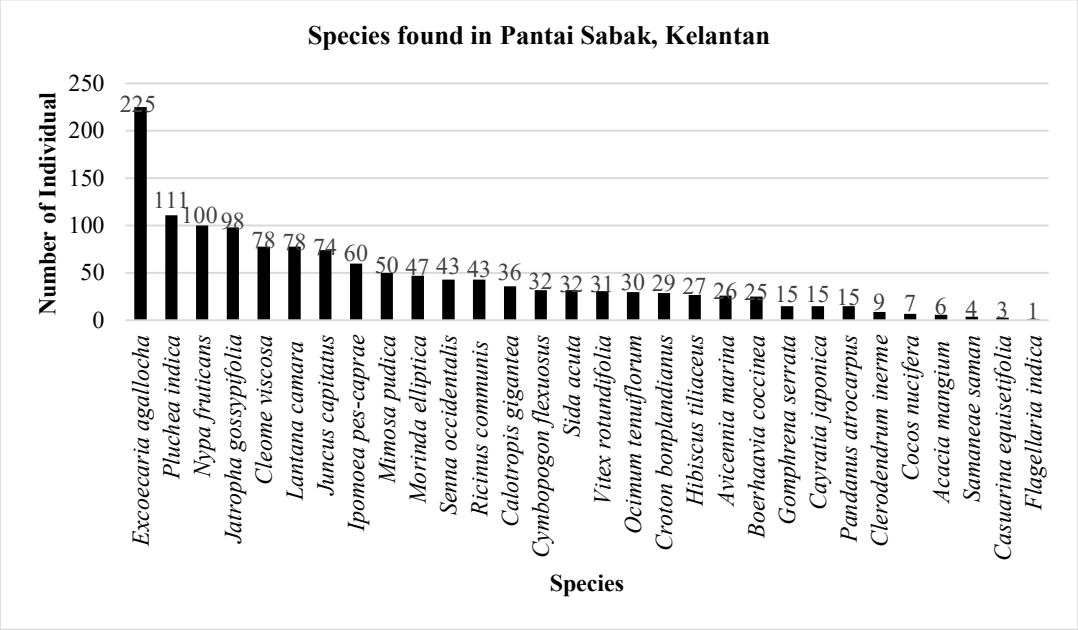

Figure 2: The bar chart of family and number of individuals from the highest to the lowest number collected from the study area.

3.2 Abundance

There was a past study of the abundance and diversity of the tree species at Pantai Sabak and this study is the preliminary study conducted there. The primary data was gathered through the abundance plant species by using the DAFOR scale by Dagar, Mongia and Bandhyopadhyay (1991) as in Table 1.

Table 1: Scale of abundance species categories.

>25	D	Dominant
15-25	Va	Very abundance
10-15	A	Abundance
6-10	F	Frequent
3-6	O	Occasional
1-3	R	Rare
<1	Vr	Very rare

An abundance of tree species that exceeds 25 is verified as Dominant (D). Abundance is in simplest terms usually measured by identifying and counting every individual of every species in a given sector. It is common for the distribution of species to be skewed so that a few species take up the bulk of individuals collected (Verberk, 2011). Throughout this study, the percentage of the ten leading tree species is dominated by *Jatropha gossypifolia* which is inhibited by as much as 49 individuals per sampling unit occurrence (Table 2). These species were found at only two points along the coastal area hence the individual collected in both sectors were fully loaded.

Moreover, based on Table 2, *Juncus capitatus*, *Nypa fruticans* and *Pluchea indica* abundance values are 37.0, 33.3 and 22.2 individuals per sampling unit occurrence, respectively. Those four leading species showed the dominant species covered in the study area. The other six species were tabulated which included *Excoecaria agallocha*, *Mimosa pudica*, *Cymbopogon citratus*, *Ipomoea pes-caprae* and *Ocimum tenuiflorum* communal with 18.8, 16.7, 16.0, 15.0 and 15.0 individuals per sampling unit occurrence, respectively. The situation that occurred showed that those species fall to the scale of very abundance (Va). Table 2 shown only *Croton bonplandianus* was the lowest abundance with 14.5 individuals per sampling unit occurrence. By using DAFOR scale, the value that lower than 15 indicate the species are abundance (A) compared to the other nine species that counted as very abundance (Va).

Table 2: Ten highest plant species abundance at Pantai Sabak, Kelantan.

No.	Species	Abundance
1.	*Jatropha gossypifolia*	49.0
2.	*Juncus capitatus*	37.0
3.	*Nypa fruticans*	33.3
4.	*Pluchea indica*	22.2
5.	*Excoecaria agallocha*	18.8

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6.	*Mimosa pudica*	16.7
7.	*Cymbopogon citratus*	16.0
8.	*Ipomoea pes-caprae*	15.0
9.	*Ocimum tenuiflorum*	15.0
10.	*Croton bonplandianus*	14.5

3.3 Density

Plant species density is the common attribute that has been taken into account to determine the dominant species occurring at a particular place. The availability of the density of the trees keeps declining day by day around the world. According to Faezah *et al.* (2013) density is one of the vital characteristics and parameters that lead to analyse of the woodland structure.

Based on Table 3, the maximum percentage calculated for the species density in this study is the *Excoecaria agallocha* species from the Euphorbiaceae family which is 11.25 individuals per sampling unit sample. It is followed by *Pluchea indica*, *Nypa fruticans*, *Jatropha gossypifolia*, *Cleome viscosa*, *Lantana camara*, *Juncus capitatus*, *Ipomoea pes-caprae*, *Mimosa pudica*, *Morinda elliptica* with 5.55, 5.0, 4.9, 3.9, 3.9, 3.7, 3.0, 2.5 and 2.35 individuals per sampling unit sampled, respectively. It can be counted as all of these species are widespread in most of the area.

Table 3: Ten highest plant species density at Pantai Sabak, Kelantan.

No.	Species	Density
1.	*Excoecaria agallocha*	11.25
2.	*Pluchea indica*	5.55
3.	*Nypa fruticans*	5.00
4.	*Jatropha gossypifolia*	4.90
5.	*Cleome viscosa*	3.90
6.	*Lantana camara*	3.90
7.	*Juncus capitatus*	3.70
8.	*Ipomoea pes-caprae*	3.00
9.	*Mimosa pudica*	2.50
10.	*Morinda elliptica*	2.35

3.4 Frequency

According to Raunkier (1934) the frequency percentage have been designated in grouping with classes in Table 4 as follows:

Table 4: Classes of frequency species in a community.

Classes	Frequency
A	1 – 20%
B	21 – 40%
C	41 – 60%
D	61 – 80%
E	81 – 100%

The frequency parameters figured being dedicated as the size distribution of trees that lead to the distinctive of the pattern constitutional of the coastal area (Nizam et al., 2006). *Excoecaria agallocha* (Euphorbiaceae) express the highest percentage of trees which is 60% pursued by the *Calotropis gigantea* that achieved 50% and *Morinda elliptica* and *Vitex rotundifolia* shared the same percentage which is 35%. Then, *Cleome viscosa*, *Lantana camara* and *Senna occidentalis* are mutual to each other in which 30% while *Pluchea indica* and *Boerhaavia coccinea* communal with 25% each. One of the common tree species in the coastal area (*Ipomoea pes-caprae*) resulting 20% per all the study sites. The frequency result (Table 5) tabulated indicates the prevalence of trees in the study area.

Table 5: Ten highest plant species frequency at Pantai Sabak, Kelantan.

No.	Species	Frequency
1.	*Excoecaria agallocha*	60
2.	*Calotropis gigantea*	50
3.	*Morinda elliptica*	35
4.	*Vitex rotundifolia*	35
5.	*Cleome viscosa*	30
6.	*Lantana camara*	30
7.	*Senna occidentalis*	30
8.	*Pluchea indica*	25
9.	*Boerhaavia coccinea*	25
10.	*Ipomoea pes-caprae*	20

3.5 Diversity Index

To issues of statistical sampling, the rather arbitrary nature of delineating an ecological community, and the difficulty of positively identifying all of the species presents, species diversity has two separate components namely the number of species present (species richness), and their relative abundances (termed dominance or evenness) (Magurran, 2004). In the context of this study, the plant species diversity at the study area was achieved by using the Shannon-Wiener's Diversity Index (H') and Species Evenness (E_H). The results value is shown in Table 6.

The value H' for the 0.2 ha area is 2.99 while the H'_{max} value is 3.40. The H' value in this study almost half higher than Zamri et al., (2021), of which the H' for the 0.05 ha area is 1.67 while the H'_{max} value is 3.34. The values of the indices calculated are in the standard ecological studies. According to Magurran (2004), H' value is generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. A high value of H' would be representative of a diverse and equally distributed community and lower values represent a less diverse community. A value of 0 would represent a community with just one species. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness (Magurran, 2004). In addition, if the H' value approaching the H_{max}

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value, it can be proven as the study area are diverse with trees species.

Shannon Wiener's Diversity index is affected by both the number of species and their equitability or evenness. A greater number of species and a more even distribution both increase diversity as measured by H'. The actual diversity value can be compared to the maximum possible diversity by using a measure called evenness. By definition, E_H is ranged between 0 and 1.0. As with H', evenness assumes that all species are represented within the sample. Considering the Species Evenness (E_H) value is 0.93 where is approaching 1, the community of the species at the study area are evenly distributed.

Table 6: The Diversity Index for plant species at the Pantai Sabak, Kelantan.

Species Diversity Index	Value
Shannon Weiner's Index (H')	2.99
H_{max}	3.40
Species Evenness (E_H)	0.88

4. CONCLUSION

Based on the present study findings and the numerical figures results, the application of Shannon-Wiener's Diversity Index and formula of abundance, density and frequency used were the most reliable in this study. The species occurrence, abundance and density at the Pantai Sabak were rich and evenly distributed and the objectives of this study have been successfully achieved where Pantai Sabak was proven diverse with a variety of plant species.

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