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Diversity of Flora in A Pulpwood Plantation of Sumatran Elephant *Elephas maximus sumatranus* Habitat in Air Sugihan Wetlands, Ogan Komering Ilir, South Sumatra

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Abstract
Knowledge about flora biodiversity is an important component to determine the best strategy for policy makers in making decisions. A study on flora diversity with assesment on Sumatran Elephant habitats has been conducted in PT. Bumi Andalas Permai (PT. BAP). This area is a home range for Sumatran Elephant habitat in Sumatra. This research is to obtain basic information before carrying out other activities that might influence the composition of vegetation in the future. Determining the sampling location uses a purposive method, collecting data using observation plots which are expected to represent each existing vegetation type. Based on research conducted, there is only one species of plant at tree level, one species at pole level, and two species at sapling level, and 32 species at seedling level. Species diversity at the tree, pole and sapling level in study site. The species diversity in PT. BAP is included in low level category, under criteria H'=0, H'=0 and H'=0.69 respectively. Meanwhile, for the seedling/undergrowth level, H'= 3.05. There are very few species of plants at the level of trees, poles and stakes because the land is an open area in the form of bushes, thickets, swamps and rice fields on the side of an artificial canal.

Keywords: Sumatran Elephant barrier, flora, Industrial Plantation Forest, purposive sampling, Sumatra.

Introduction

Studies on the diversity of flora (vegetation) can describe the stability of an ecosystem that supports wild animal life both as a habitat, a place to shelter and breed, and a source of food (Yuslinawari *et al.* 2021). Survey of the 'quality', status or condition of stands of vegetation are currently commonplace and are regularly a basic component of planning processes and ecological studies (Parkes *et al.* 2003). Vegetation in a region is the result of interactions between environmental factors such as soil, water, climate and genetics (Tlidi *et al.* 2019). Vegetation generally consists of many plant species with various shapes and structures and population numbers (Soerianegara & Indrawan 2005).

Flora diversity is an important aspect of global biodiversity that plays a vital role in maintaining ecosystem balance and providing various ecosystem services for humans (Quijas *et al.* 2010). Plant diversity includes not only a diversity of species, but also abundant genetic variations and morphological differences, which enrich the natural landscape and offer great potential for new discoveries in the fields of science and technological applications (Safei & Tsani 2016). Indonesia has unique position in biogeographic regions, and the country ussually divided into seven main regions, namely Sumatra, Java and Bali, Kalimantan, Lesser Sunda, Sulawesi, Maluku and Papua (Andrew1992). In the botanic scope, the distribution of flora in Indonesia is part of the Malesiana region (Kusmana & Hikmat 2015).

Located in mainland Sumatra, South Sumatra has divided into five types of ecosystems, including

riparian ecosystems, mangrove ecosystems, peat ecosystems, low-land ecosystems and mountainous ecosystems (Whitten *et al.* 2000; Pragustiandi *et al.* 2020). Sugihan wetlands or Air Sugihan or is a subdistrict in South Sumatra that covering is about 2.593 km², mostly dominated by wetlands, ranging from freshwater swamp to the mangrove zone, and home for Sumatran Elephant *Elephas maximus sumatranus* (Setiawan *et al.* 2019). There are few Pulpwood Plantations, including the PT. Bumi Andalas Permai (PT BAP) in Air Sugihan wetlands were the concession is elephant ranging habitats (Susilowati *et al.* 2016). Study on flora diversity with assesment on Sumatran Elephant habitats in needed to give best understanding to habitat management. In this paper, we report our study diversity of flora in PT BAP as a Sumatran Elephant habitat in Sumatra.

Methods

The site of study diversity of flora in a pulpwood plantation of Sumatran Elephant *Elephas maximus sumatranus* habitat in Air Sugihan Wetlands is PT. Bumi Andalas Permai (PT BAP). This consession is located in Ogan Komering Ilir, South Sumatra Province (Fig. 1).

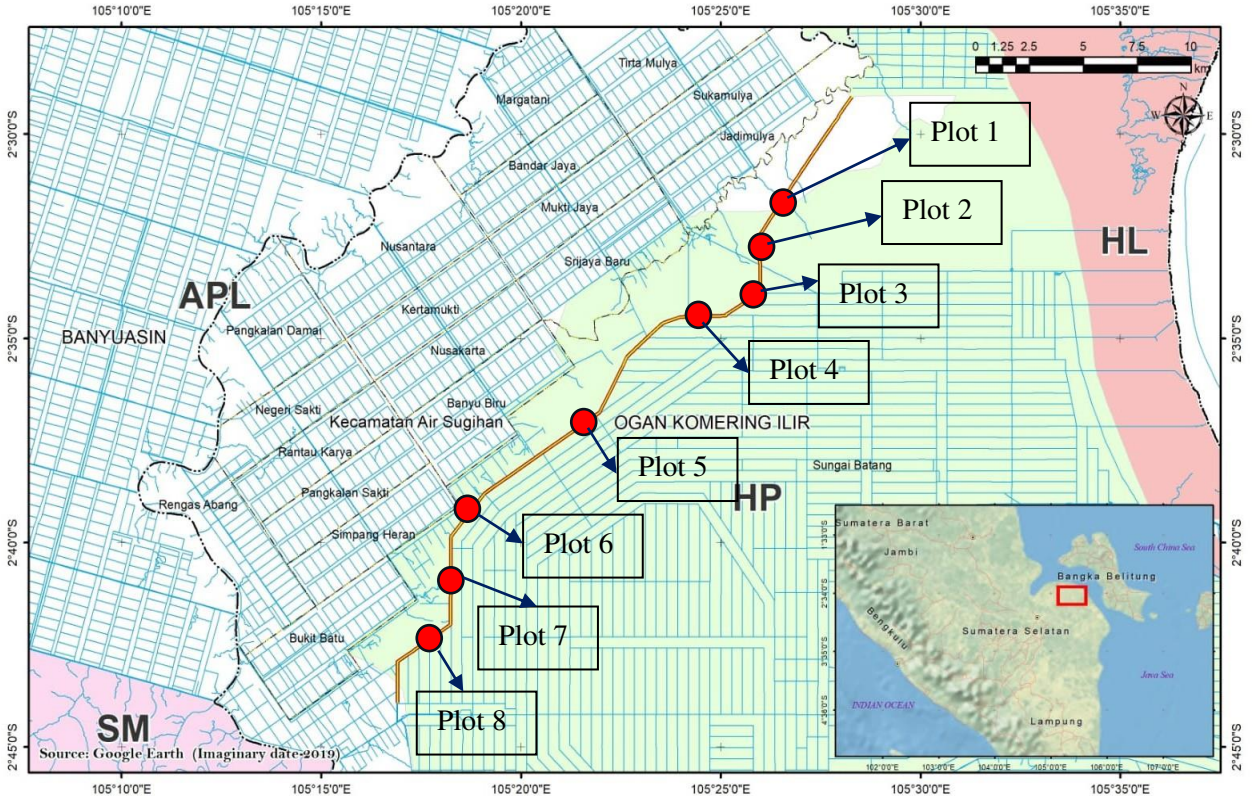

Figure 1. Map of sampling location in PT. Bumi Andalas Permai (PT BAP), Ogan Komering Ilir, South Sumatra.

Locations for determining sampling points for vegetation analysis are spread along the canal where the Sumatran Elephant barrier will be built with a length of 38 km and a width of 50 meters (Table 1).

Table 1. Location of vegetation analysis plots within the PT BAP area.

No	Location	Coordinate		Vegetation Type
		S	E	
1.	Plot 1	2.553736	105.433005	Bushes and rice fields
2.	Plot 2	2.565100	105.433133	Bushes and rice fields
3.	Plot 3	2.565358	105.433383	Bushes and swamps
4.	Plot 4	2.574799	105.419509	Bushes and swamps
5.	Plot 5	2.613917	105.365839	Bushes, swamps and rice fields
6.	Plot 6	2.656439	105310398	Shrubs and thickets
7.	Plot 7	2.686733	105.304149	Shrubs and thickets
8.	Plot 8	2.705460	105.296364	Bushes and swamps

This study is carried out using several methods, namely conducting direct exploration of the research area and using vegetation analysis methods by creating observation plots which are expected to represent each existing vegetation. To determine the composition or type and structure of vegetation, a combination of paths and plot lines is used (Kusmana 1997).

Flora data was taken by making observation plots by making measuring plots based on plant categories, namely seedling level sample plots (2 m x 2 m), sapling level sample plots (5 m x 5 m), pole level sample plots (10 m x 10 m) and sample plots. tree level. plot (20 mx 20 m). then data was collected in the form of plant type data, number of individuals, height and diameter of each plant. Apart from that, it records plant types outside the plot as additional data for types that have conservation or economic value. Data are presented in tables and classified taxonomically and according to habitus, conservation status (IUCN, PP and CITES).

Data Analysis

Relative Density (KR), Relative Frequency, Relative Dominance (DR) and Importance Value Index (INP) were analyzed using the Dumbois – Muller formula (1974). The data that needs to be known from the forest ecosystem to get an overview of the structure and function of vegetation is: Important Value Index which is defined as: ***INP = KR + FR + DR***

The importance value of a species ranges between 0 and 300%. This importance value provides an overview of the influence or role of a type of mangrove ecosystem in the community. The Importance Value Index is the sum of the values of relative density of type-i (Kri), relative frequency of type-i (Fri) and relative dominance of type-i (Dri), each of which is obtained from:

$$\text{Density (K)} = \frac{\text{The number of individuals of a species}}{\text{Total area of sample units}}$$

$$\text{Relative Density (KR)} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{The number of plots found for a species}}{\text{Total number of sample units}}$$

$$\text{Relative Frequency (FR)} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100\%$$

$$\text{Dominancy (D)} = \frac{\text{The basic area of a species}}{\text{Total area of sample units}}$$

$$\text{Relative Dominancy (DR)} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100\%$$

The INP (Importance Value Index) for each stratum per sampling location will be calculated. Where: INP for tree and pole level = KR + FR + DR and INP for sapling, seedling, understory and vine level = KR + FR

Shannon-Wienner diversity index (Odum 1971)

$$H' = -\sum Pi \ln Pi$$

Note: H′ = Shannon-Wienner diversity index Ni = Total number of species based on tree level (seedlings, saplings, poles and trees) N = Total number of all species.

Evenness Index to determine the distribution of species in a community (Krebs 1994)

$$E = \frac{H'}{\text{Log } S}$$

Note: E = evenness index, H′ = Shannon-Wienner diversity index, S = Total amount of vegetation by tree level.

Results and Discussion

Importance Value and Diversity Index

The structure and composition of vegetation is very necessary in vegetation analysis, such as knowing the density of individual plants, frequency, dominance, importance value index and diversity index (H') in a research area.

The Importance Value Index of plant species in a community is one of the parameters that shows the role of the plant species in the community. The presence of a plant type in an area shows its ability to adapt to its habitat and wide tolerance to environmental conditions. The greater the INP value of a species, the greater the level of control over the community and vice versa (Soegianto 1994). Domination of a certain species in a community if the species in question succeeds in locating most of the available resources compared to other species. According to Sundarapandian & Swamy (2000), the importance value index is a parameter that can provide an overview of the role of the species in question in the community or at the research location. The following important value indices calculated, relative density, relative frequency and relative dominance are presented in the table 2-4.

Table 2. Tree level plant species and Importance Value Index (INP).

No	Family/Species	KR (%)	FR (%)	DR (%)	INP
1.	*Acacia mangium*	2,63	4,17	0,57	300
	Total	**100**	**100**	**100**	**300**

Table 3. Pole level plant species and Important Value Index (INP)

No	Family/Species	KR (%)	FR (%)	DR (%)	INP
1.	*Acacia mangium*	4,00	5,26	6,07	300
	Total	100	100	100	300

Table 4. Plant species at sapling level and Importance Value Index (INP)

No	Family/Species	KR (%)	FR (%)	DR (%)	INP
1.	*Melastoma malabathricum*	22,22	12,50	10,99	162,61
2.	*Melicope lunu-ankenda*	11,11	12,50	5,49	137,39
	Total	**100**	**100**	**100**	**300**

The data obtained shows the structure and composition of plants whose values vary for each type due to differences in the characteristics of each individual. According to Kimmins (1987), variations in plant structure and composition in a community are influenced among other various conditions, by plant phenology, dispersal and natality. Its success in becoming a new individual is influenced by the different fertility and fecundity of each species so that there are differences in the structure and composition of each type. The survey results of the diversity of flora species in the Elephant Barrier study area consisted of 1 species at the tree level, 1 species at the pole level, and 2 species at the sapling level, as well as 32 species at the seedling level. There are very few species of plants at the level of trees, poles and stakes because the land is an open area in the form of bushes, thickets, swamps and rice fields on the side of an artificial canal.

Tree diversity can be used as an indicator of forest health because of its sensitivityto change and as an indicator of ecology and spatial, temporal and heterogeneitytropic. According to Safei (2016) diversity is very easily influenced by the environment, interactions between organisms and their environment. These changes are due to responsepositive or negative from interactions, for example growth, development, mortality, natality and migration.

The importance value index (INP) for each type in the table above shows that there are striking variations in the importance of the plant species found in the study area. At the tree and pole level, only 1 species of plant was found, namely the Acacia *Acacia mangium*, then at the pole level, 2 species of plants were found, namely the senduduk *Melastoma malabathricum* and the Tenggek burung *Melicope lunu-ankenda*. In this case, the seedling/forest floor level is the focus of the study because it is the most dominant compared to other levels. Prumpung *Phragmites karka* clearly dominates with an important value of 42.32%, then next there is elephant fern / kelakai *Stenochlaena palustris* with an important value of 34.61 and senbangun *Melastoma malabatricum* with an important value of 33.52.

Table 5. Species of forest floor plants and Importance Value Index

No	Family/Species	KR (%)	FR (%)	DR (%)	INP
1.	*Acacia mangium*	2,45	7,25	0,76	10,26
2.	*Acrostichum aureum*	8,66	5,80	4,58	18,87
3.	*Ageratum conyzoides*	0,29	1,45	0,76	2,46
4.	*Alstonia scholaris*	0,72	2,90	0,76	4,30
5.	*Blechnum orientale*	1,73	1,45	4,58	7,72
6.	*Causonis trifolia*	0,72	1,45	4,58	6,71
7.	*Clibadium surinamense*	0,29	1,45	0,76	2,46
8.	*Cleome rutidosperma*	0,43	1,45	0,76	2,60
9.	*Cyperus rotundus*	2,02	4,35	4,58	10,83
10.	*Eclipta prostrata*	0,58	1,45	0,76	2,75
11.	*Erechtites hieraciifolius*	0,29	1,45	0,76	2,46
12.	*Fimbristylis miliacea*	0,72	1,45	4,58	6,71
13.	*Ludwigia peploides*	0,29	1,45	0,76	2,46
14.	*Lygodium microphyllum*	1,59	5,80	0,76	7,98
15.	*Mallotus paniculatus*	0,43	1,45	0,76	2,60
16.	*Melaleuca leucadendra*	1,44	2,90	4,58	8,84
17.	***Melastoma malabathricum***	**20,49**	**8,70**	**4,58**	**33,52**
18.	*Melicope lunu-ankenda*	1,15	2,90	0,76	4,73
19.	*Mikania micrantha*	2,16	4,35	4,58	10,97
20.	*Mimosa pigra*	0,29	1,45	0,76	2,46
21.	*Nephrolepis biserrata*	0,29	1,45	0,76	2,46
22.	*Nephrolepis hirsutula*	0,72	1,45	4,58	6,71
23.	*Panicum dichotomiflorum*	1,73	2,90	4,58	9,13
24.	***Phragmites karka***	**17,60**	**2,90**	**19,08**	**42,32**
25.	*Phylantus niruri*	4,62	2,90	4,58	12,01
26.	*Scleria sumatranus*	7,07	7,25	4,58	18,69
27.	*Spermacoce alata*	0,29	1,45	0,76	2,46
28.	*Spermacoce latifolia*	0,14	1,45	0,76	2,32
29.	***Stenochlaena palustris***	**18,76**	**11,59**	**4,58**	**34,61**
30.	*Trema micrantha*	0,72	1,45	4,58	6,71
31.	*Trema orientalis*	0,58	2,90	0,76	4,16
32.	*Uncaria tomentosa*	0,72	1,45	4,58	6,71
	Total	100	100		300

Perumpung *Phragmites karka* is a type of large, perennial grass from the Poaceae family. The perch grows along riverbanks, marshes, and wet prairies; muddy soil or in damp places. This grass is flood resistant and spreads throughout tropical regions. Usually this grass grows in clay soil with a pH ranging from 4.5 (acid) to 7.5 (alkaline). Prumpung usually grows in groups and often in large numbers. This plant is found in all research plots and is almost found along artificial canals.

Elephant fern *Stenochlaena palustris* spreads naturally in tropical Asia, starting from India in the west, to Southeast Asia where it spreads widely, including in the Indonesian Archipelago, to Polynesia and Australia. It grows to a height of 900 meters above sea level and propagates in forests former logging, especially near fresh water, brackish water, mangrove forests, on sandy soil, especially along river banks and water sources (Arsyad 2011). This fern is found everywhere in the lowlands, in open areas and secondary forests, and is commonly found in swampy areas, including peat swamps. *Melastoma malabathricum* or what is also known as Senduduk is easy to found in Indonesia, especially on successional land. This plant has a beautiful purple flower crown so it is often used as an ornamental plant. The fruit is also often eaten, especially by people who live in rural areas. Based on the results of the vegetation analysis, the diversity index value found in study area was obtained (Table 6).

Table 6. Diversity index in each location.

No	Habitus	Diversity Index (H')	Category*
1.	Tree	0	Low
2.	Pole	0	Low
3.	Stake	0,69	Low
4.	Seedling	3,05	High

* category based on Fachrul (2007)

Species diversity at the tree, pole and sapling level in the PT area. BAP is included in the low level category, namely H'=0, H'=0 and H'=0.69 respectively. Meanwhile, for the seedling/undergrowth level, H'= 3.05. Based on these values, the condition of the forest/vegetation in the PT area. BAP is experiencing good regeneration or growth. When viewed from the normal growth structure in natural forests, the species diversity index is the seedling level > sapling level > pole level > tree level > understory level, so that regeneration of plant species can run well. If growth does not follow this pattern or there is disturbance at one level, then the forest can be said to be experiencing succession (Resosoedarmo *et al* 1992).

Apart from using the plot method, other observations also involve using the observation method or directly observing the conditions around the road leading to each transect and outside the transect. These observations are useful for additional data on flora that are not included in the transects. Plant data outside the transect is presented in the table 8.

Species diversity at the tree, pole and sapling level in the PT area. BAP is included in the low level category, namely H'=0, H'=0 and H'=0.69 respectively. Meanwhile, for the seedling/undergrowth level, H'= 3.05. Based on these values, the condition of the forest/vegetation in the PT area. BAP is experiencing good regeneration or growth. When viewed from the normal growth structure in natural forests, the species diversity index is the seedling level > sapling level > pole level > tree level > understory level, so that regeneration of plant species can run well. If growth does not follow this pattern or there is disturbance at one level, then the forest can be said to be experiencing succession (Resosoedarmo *et al*. 1992).

Judging from the importance of the species that grow dominantly, these are species that have utility value that can be utilized by the local community. Prumpung and Seduduk are one of the first types of pioneer plants that usually appear in open land so they are often found around the study location. Split prumpung stems are used as a substitute for bamboo to make roofs. In Java, prumpung stems, after being flattened and split, are used as rough woven material. In the Philippines, the leaves are used as soil fertilizer. After being cut, the branches are quite good and productive animal feed.

Flood-resistant perumpung clumps also function very well as soil protectors (stabilizers) from erosion. *M. malabathricum* or seduduk is a multifunctional plant that is used as decoration, food and traditional medicine. The use of plants as traditional medicines is related to their secondary metabolite content and bioactivity. Ethnobotanically, *M. malabathricum* is used to treat diarrhea, broken bones, wounds, to treat irritation, seizures, epilepsy and cancer sores. The bioactivities of *M. malabathricum* include anti-cancer, hepatoprotective, anti-cholesterol, anti-microbial, antioxidant, anti-ulcer, analgesic and anti-diabetes mellitus. The potential for developing *M. malabatricum* as an antimicrobial and anticancer agent can be used as an alternative medicine for digestive tract disorders and cancer.

Elephant fern/ kelakai (*Stenochlaena palustris*) is a plant that has health benefits. Kalakai has the potential to increase the body's endurance because the antioxidant activity it produces is very high.The habitat of a type of plant vegetation and its growth conditions can provide an overview of its function in improving environmental quality as well protection (Naemah *et al.* 2020), sound dampening and aesthetic improvement in environmental quality played by plants is due to their ability to carry out the process of photosynthesis which can absorb CO2 gas and produce oxygen (O2) which is beneficial for humans and animals for the respiration process, in addition to the high diversity of plant species in a country. The location will support a diversity of wild animal species, this is because each wild animal has a different ecological niche (niche) and natural food suitability in a habitat.

Table 7. List of plant species and protection status based on IUCN and Minister of Environment and Forestry Regulation 106 of 2018. Note: LC (Least Concern), NE (Not Evaluated), DD (Data Deficient) TD (Not Protected by Government Law).

No	Scientific Name	Local Name	IUCN Redlist	Permen LHK 106
1.	*Acacia mangium*	Akasia	LC	TD
2.	*Acrostichum aureum*	Paku laut	LC	TD
3.	*Ageratum conyzoides*	Babadotan	LC	TD
4.	*Alstonia scholaris*	Pulai	LC	TD
5.	*Blechnum orientale*	Paku lipan	NE	TD
6.	*Causonis trifolia*	Kepialu	NE	TD
7.	*Clibadium surinamense*	Bunga jopan	LC	TD
8.	*Cleome rutidosperma*	Maman lanang	NE	TD
9.	*Cyperus rotundus*	Rumput teki	LC	TD
10.	*Eclipta prostrata*	Urang aring	LC	TD
11.	*Erechtites hieraciifolius*	Bunga bakar	NE	TD
12.	*Fimbristylis miliacea*	Babawangan	NE	TD
13.	*Ludwigia peploides*	-	NE	TD
14.	*Lygodium microphyllum*	Hata leutik	LC	TD
15.	*Mallotus paniculatus*	Balik angin	LC	TD
16.	*Melaleuca leucadendra*	Gelam	DD	TD
17.	*Melastoma malabathricum*	Senduduk	NE	TD
18.	*Melicope lunu-ankenda*	Tenggek burung	LC	TD
19.	*Mikania micrantha*	Sembung rambat	NE	TD
20.	*Mimosa pigra*	Putri malu besar	LC	TD
21.	*Nephrolepis biserrata*	Paku pedang	NE	TD
22.	*Nephrolepis hirsutula*	Paku pedang	NE	TD
23.	*Panicum dichotomiflorum*	-	NE	TD
24.	***Phragmites karka***	Prumpung	LC	TD
25.	*Phyllantus niruri*	Meniran hijau	NE	TD
26.	*Scleria sumatranus*	Rija-rija	LC	TD
27.	*Spermacoce alata*	Rumput setawar	NE	TD
28.	*Spermacoce latifolia*	-	NE	TD
29.	*Stenochlaena palustris*	Paku gajah/kelakai	NE	TD
30.	*Trema micrantha*	Mengkirai	LC	TD
31.	*Trema orientalis*	Mengkirai	LC	TD
32.	*Uncaria tomentosa*	Kayu bajakah	NE	TD

Table 8. List of other plants found around the transect.

No	Scientific Name	Local Name
1.	*Aleurites moluccana*	Kemiri
2.	*Areca catechu*	Pinang
3.	*Artocarpus heterophyllus*	Nangka
4.	*Mangifera indica*	Mangga
5.	*Musa paradisiaca*	Pisang
6.	*Oryza sativa*	Padi
7.	*Parkia speciosa*	Petai cina
8.	*Psidium guajava* var. pyrifera	Jambu biji putih
9.	*Psidium guajava* var. pomifera	Jambu biji merah
10.	*Oryza sativa*	Padi

Plant Management Efforts

Based on research conducted, there are 32 plant species, of which only 1 plant species is at the tree level, 1 species at the pole level, and 2 species at the sapling level, and 32 species at the seedling level. Species diversity at the tree, pole and sapling level in the PT area. BAP is included in the low level category, namely H'=0, H'=0 and H'=0.69 respectively. Meanwhile, for the seedling/undergrowth level, H'= 3.05. There are very few species of plants at the level of trees, poles and stakes because the land is an open area in the form of bushes, thickets, swamps and rice fields on the side of an artificial canal.

High conservation value species level are not detected in this area (Table 7). It was presumed previously the forest had undergone changes to no longer be good forest but had secondary forest succession and also land degradation caused by land conversion. Most species of plants are also pioneer species which are easy to grow and some of them include Alien Species and Invasive Species. Foreign or alien species are species that are brought into an ecosystem unnaturally. Invasive species are species, whether native or not, that widely affect their habitat and can cause disturbances to other species. Conservation efforts are highly recommended to control and mitigate the impact of invasive species, such as eradicating or eliminating foreign and invasive species.

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