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Preliminary Study of Mangrove Eco-Structures and Natural Regeneration at Gili Lawang, East Lombok, West Nusa Tenggara)

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Abstract: Gili Lawang mangroves as a unique ecosystem, unstable, dynamic and complex. The purpose of this study is to determine the eco-structure and natural regeneration of the Gili Lawang mangroves as an initial study in sustainable mangrove forest management. This study used a systematic sampling method with random start, at 6 stations with a total of 60 plots. Seven types of mangroves were obtained, namely A. marina, B. cylindrica, B. gymnorrhiza, R. apiculata, R. mucronata, R. stylosa, and S. alba at the study site. The highest IVI was R. mucronata with a value of 79.34% (seedlings), B. gymnorrhiza with an IVI of 77% (saplings) and tree stage (96.2%). Canopy stratification is type C, D and E. The concentration of horizontal structures is in class 1 (10-16 cm). At the seedling growth stage H' was classified as moderate (1.33), E' was moderate (0.69), and R1 was low (1.13). At the stake level H' classified as Moderate (1.31), E' is moderate (0.67) and R1 is low (1.04) and at the tree level H' is classified as moderate (1.59), E' is high (0.82), R1 is low (0.95). The distribution of mangrove species in Gili Lawang was normally distributed with a distribution pattern of plant species generally clustered, except for S. alba at the sapling growth stage which were scattered randomly. The regeneration status of mangrove species in Gili Lawang is good in species*A. marina, B. gymnorrhiza, R. apiculata,*and R. mucronata, and sufficient/moderate on B. cylindrica, R. stylosa and S. alba.

Keywords: Eco-structures; ecological index; Gili Lawang; Mangroves; Natural Regeneration

Introduction

Mangrove is a simple typical ecosystem that grows as a landscape architecture that is unstable but complex and dynamic and becomes a link in the chain of ecological cycles on small islands. The complexity and dynamics of mangroves are inseparable from the functional unit between the mangrove community itself and environmental factor parameters that form a typical vegetation type as a highly productive intertidal community and distributed along tropical coasts as a buffer zone between land and sea. As is the view of Valentino (2017) and Valentino et al. (2022) states that the variable diversity is biodiversity, population composition and structure, and the distribution of mangrove species including the productivity of organic matter that is adaptive tolerable to certain environmental and climatic conditions and forms a fluvio-marine ecological landscape is a determinant of the area of distribution of mangrove habitat both spatially and temporally.

This variable is known as the mangrove eco-structure. Therefore it is only natural that Indonesia has the largest mangrove area in the world, namely around 19.5% of the world's total mangroves (Bunting et al. 2018) or the current reliable reference for mangrove area estimates in Indonesia is ± 3 million hectares (Rahadian et al. 2019) spread across 257 districts and cities in Indonesia as well as along the coastline along with small islands in Indonesia (Muhtadi 2020), with genetic resources recorded as many as 202 mangrove plant

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species, 43 of which are true mangrove species and 159 species are associated mangroves (Kusmana et al. 2013).

One of the main habitats of the mangrove ecosystem is Gili Lawang which is part of a group of small islands in Indonesia. In the context of plant geography, Gili Lawang, which is in the province of West Nusa Tenggara, is included in the Lesser Sunda Islands bioecoregion (Latifah et al. 2021). In addition, Gili Lawang is also included in a protected forest area managed by the East Rinjani Protected Forest Management Unit (KPHL Rintim) with an area of 506.2 ha based on the Decree of the Minister of Forestry Number: SK.337/Menhut-VII/2009 on 15 june 2009. Therefore,

Based on the research metasynthesis that has been traced by researchers, it shows that in the period 2003-2022, namely the research of Arifin & Yulianda (2003); Hilyana (2011); Blue (2013); Subhan et al. (2014); Mustaruddin et al. (2016); Fahlevy (2017); Murniati (2017); Prabowo (2017); Rudiastuti et al. (2018); Hartini & Lestarini (2019); Kartini (2019); Rizal (2019); Adiyoga et al. (2020); Aziz et al. (2020); Hilyana et al. (2020); Atmaja et al. (2021); Nana (2021); Akhyar & Prasetyo (2022); Atmaja & Laharjana (2022); Damayanti et al. (2022); Pratomo et al. (2022) focuses more on gastropod ecology, coral reef ecology, seagrass ecology, crab ecology, marine eukaryotic ecology, reef fish ecology, development of marine ecotourism, mangrove carbon mapping using satellite imagery, social economy, community culture, economic value of fish resources, development of suitability of water conservation areas, and fishing activities. However, detailed research on the ecological characteristics of mangrove vegetation is not yet available. Even though this research is a basic study in the management of small island ecosystem landscapes which should be a major consideration in the development of sustainable ecotourism areas. As is the view of Spies & Tunner (1999) which states that dynamic management of a landscape must be based on vegetation processes which form the basis of the ecological processes of an ecosystem. Therefore, this study aims to determine the eco-structure and natural regeneration of mangroves in Gili Lawang as an initial study in sustainable mangrove forest management. development of the suitability of water conservation areas, and fishing activities. However, detailed research on the ecological characteristics of mangrove vegetation is not yet available. 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Method

The research was conducted in November 2022. This research was conducted in the Gili Lawang mangrove area, East Lombok, West Nusa Tenggara (Figure 1).

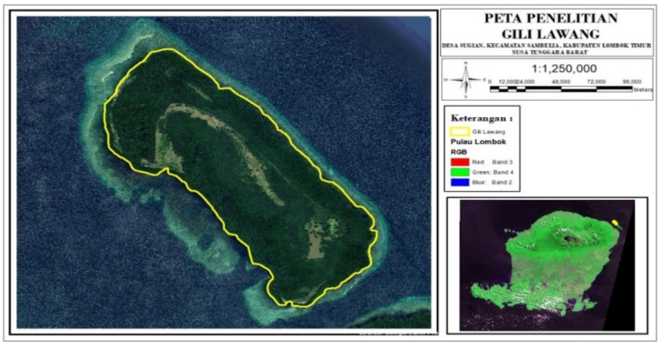

Figure 1. Research sites

Tools and materials

The tools used in this study were area maps, sampling land maps, compasses, GPS, machetes, stakes, raffia rope, measuring tape (phiband meter), sewing meter, haga hypsometer, digital camera, markers, label paper, clear trashbags, tally sheets, stationery and computer equipment such as Microsoft Word and Microsoft Excel. The main material needed is mangrove vegetation in Gili Lawang, East Lombok, West Nusa Tenggara.

Data retrieval

The placement of the sample unit (sampling design) was determined by systematic sampling with random start method with reference to the representativeness of the sample area, the density of vegetation and the ability of the researcher to reach the observation location (Valentino et al. 2022). Based on the field survey, the research location was divided into 6 stations (Figure 2). Stations 1, 2 and 3 represent the density of vegetation consisting of two vegetation genera (genus Rhizophora sp. and Bruguiera sp.) and stations 4, 5, 6 are located at locations that have vegetation density of more than two genera of mangrove vegetation (genus Rhizophora sp. , Bruguiera sp., Avicennia sp., and Sonneratia sp.). The number of sample units or observation lines made is 6 observation lines by cutting the contour/perpendicular to the coast so that the sample lines can cover changes in the composition of the vegetation from the coast to the interior. The geographic location of the observation stations is presented in Table 1.

Figure 2. Observation Station Location Map

Each observation strip consisted of 10 plots with a size of 10 m x 200 m and each measuring plot of 10 m x 10 m was divided into sub-plots measuring 2 m x 2 m for measuring seedlings, 5 m x 5 m for measuring saplings and 10 m x 10 m for measuring tree. The vegetation analysis technique applied is the checkered line technique, which is a combination method between the path method and the checkered line (Fig. Kusmana, 2017). In each predetermined sample plot, each mangrove plant species found was identified in-situ in the field with reference to Kitamura et al. (1997), Giesen et al. (2007), Noor et al. (2012) and Kusmana et al., (2013)

Table 1. Geographical location of observation locations

Station	Coordinate point	Dominant Vegetation Density (Zonation)
1	E 1160 69'47.65'' S 080 29'67.58''	The genus Rhizophora sp. (Rhizophora mucronata, Rhizophora apiculata, Rhizophora stylosa) and Bruguiera sp. (Bruguiera gymnorrhiza)
2	E 1160 68'82.75'' S 080 28'24.50''	The genus Rhizophora sp. (R. mucronata, R. apiculata, R. stylosa) and Bruguiera sp. (Bruguiera gymnorrhiza)
3	E 1160 70'92.30'' S 080 30'93.00''	The genus Rhizophora sp. (R. mucronata, R. apiculata) and Sonneratia sp. (Sonneratia alba)
4	E 1160 71'17.05'' S 080 30'21.90''	The genus Rhizophora sp. (R. mucronata, R. apiculata, R. stylosa) and Bruguiera sp. (B. gymnorrhiza, B. cylindrica), Sonneratia sp. (S. alba) and Avicennia sp. (Avicennia marina).
5	E 1160 70'46.00'' S 080 29'21.10''	The genus Rhizophora sp. (R. mucronata, R. apiculata) and Bruguiera sp. (B. gymnorrhiza, B. cylindrica) and Avicennia sp. (A. Marina).
6	E 1160 71'08.00'' S 080 29'84.00''	The genus Rhizophora sp. (R. mucronata, R. apiculata) and Bruguiera sp. (B. gymnorrhiza, B. cylindrica) and Avicennia sp. (A. Marina).

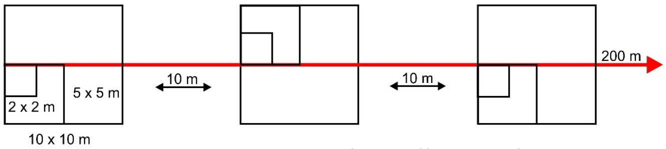

Figure 3. Mangrove data collection plot

Data analysis

To find out the eco-structural information of a mangrove community, density (ind/ha), frequency, dominance, important value index, ecological index, and distribution pattern of mangroves are needed. For the calculation of the important value index obtained from the total addition of relative density and relative frequency for growth stages of seedlings and saplings while for growth stages of tree level added relative dominance. Furthermore, this ecological index is formulated through the following formula:

a. Species Diversity Index (H')

This ecological index is calculated using the equation from Shannon-Wienner (Magurran 1988) as follows:

$$\mathbf{H'} = -\sum\left[\left(\frac{ni}{N}\right)\ln\left(\frac{ni}{N}\right)\right] \quad (1)$$

Information: H'= Species diversity index
ni =The number of individuals of each type i
N = Totalnumber of individuals

There are three criteria for the index value of species diversity, namely low if the value of H' < 1, moderate if the value of H' = 1-3 and high if the value of H' > 3 (Magurran 1988).

b. Evenness Index of Type(E)

This ecological index is calculated using the equation from Shannon-Wienner (Magurran 1988) as follows:

$$\mathrm{E} = \frac{H'}{\ln S} \quad (2)$$

Description: E =Evenness index of types
H' =Species diversity index
S =Number of species found

There are three criteria for the evenness index value of species, namely low if the value of E < 0.5, medium if the value of E = 0.5-0.75 and high if the value of E = 0.75-1 (Magurran 1988).

c. Species Richness Index (R1)

This ecological index is calculated using the equation from Margalef (Ludwig & Reynold 1989) as follows:

$$\mathrm{R}_1 = \frac{S-1}{\ln N} \quad (3)$$

Information:
R1= species richness index
S =Number of species found
N = Total number of species

Type Distribution

Raunkiaer's frequency law (Misra, 1980) is used to analyze the distribution of plant species in a community consisting of 5 frequency classes:

- Class A : Species with a frequency of 1-20%
- Class B : Species with a frequency of 21-40%
- Class C : Species with a frequency of 41-60%
- Class D : Species with a frequency of 61-80%
- Class E : Species with a frequency of 81-100%

Forest communities are categorized as normally distributed if:

$$\boxed{A > B > C = D < E}$$

By criteria:

a) E>D	: Indicates a community homogeneous
b) E < D	: Indicates a community degraded
c) A, E	:Indicates an artificial community
d) B, C, D high	:Indicates community Heterogeneous

Type Distribution

The distribution index calculation of the mangrove species found in the research plots was then analyzed using the Morishita (1962) equation as follows:

$$\mathbf{id} = \mathbf{q}.\frac{(\sum xi^2 - \sum xi^2)}{(T)^2 - \sum T} \quad (4)$$

Where xi is the number of individuals of a species in each plot, T is the total number of a species in all plots, and q is the number of sample plots. A species is considered to have a random pattern if id=1, is considered clumped if id>1, is considered uniform if id<1. Then an F test was carried out to validate the results of the resulting morista index (Morishita, 1962) with the following equation:

$$F_0 = \mathrm{IS}.\frac{(\mathrm{T}-1)+q-T}{\mathrm{q}-1} \quad (5)$$

If the result is F0≥Faq-1 on probabilities (0.05 and 0.01), with (q-1) as the quantifier and an infinite value (∞) for the denominator, then the distribution pattern is considered clumped.

Regeneration State

Shankar (2001) classifies the status of forest regeneration into five, namely: a). Good (good) if the number of seedlings > saplings > trees, b). Enough/moderate (fair) if the number of seedlings > saplings < trees, c). low (poor) if the species can survive only at the sapling growth stage but not at the seedling level or with a greater or lower number of saplings and even the same as a tree, d). There is no generation or (none) if there are no species at the seedling and sapling levels, and e). only regenerates (new) if no species are found at the tree level but are found at the seedling and sapling levels.

Result and Discussion

Type Composition

Based on the results of observations and analysis of vegetation in the field, it was found 3 families, with 4 genera consisting of 7 types of mangrove plants as a result of the inventory in all research plots (Table 2.)

Table2. Composition and Abundance of Mangrove Species

Type	Seedling			Stake			Tree			
	K (eng/ha)	F	IVI (%)	K (eng/ha)	F	IVI (%)	K (eng/ha)	F	Dm2/ha	IVI (%)
Avicennia marina	83.3	0.02	2,32	26,7	0.03	3.2	18.3	0.07	4.54	16.3
Bruguiera cylindrica	333,3	0.05	7.95	20.0	0.02	1.9	23.3	0.08	1.72	10.3
Bruguiera gymnorrhiza	2791.7	0.45	69.03	893.3	0.60	77.0	336.7	0.68	12.65	96.2
Rhizophora apiculata	1375.0	0.25	36.24	386.7	0.42	42.6	196.7	0.62	6.08	62,2
Rhizophora mucronata	3541.7	0.47	79.34	766.7	0.55	68.2	326.7	0.65	10.52	88.4
Rhizophora stylosa	125.0	0.02	2.82	13,3	0.02	1.6	23.3	0.05	0.47	5.7
Sonneratia alba	83.3	0.02	2.32	33,3	0.07	5.5	36.7	0.20	3.36	209
Total	8333.3	1.27	200.00	2140.00	1.70	200.00	961.67	2.35	39.34	300.00

True mangroves from 3 plant families identified in all observation stations include Avicenniaceae (A. marina), Rhizophoraceae (B. cylindrica, B. gymnorrhiza, R. apiculata, R. mucronata, R. stylosa), Sonneratiaceae (S. alba).

An abundance of types

The level of mangrove abundance in an ecosystem can be ascertained through the Density parameter (density). Frequency, and dominance, these three parameters are used to obtain relative density, relative frequency, and relative dominance values which are the constituents of the important value index of a plant species. The importance value index provides an illustration of how high the level of adaptation, role and level of dominance of a species is in a community (Ghufrona et al., 2015; Valentino et al., 2022). Based on the results of data processing as stated in Table 2. It can be seen that at the seedling growth stage, R. mucronata dominated with IVI (79.34%), followed by B. gymnorrhyza (69.03%) and R. apiculata (36.24%). In the sapling growth stage, B. gymnorrhiza dominated with IVI (77%), followed by R. mucronata (68.2%) and R. apiculata (42.6%). In tree growth stages, B. gymnorrhiza dominated with IVI values (96.2%), followed by R. mucronata (88.4%), and R. apiculata (62.2%). As for the three types of growth stages, A. marina and S. alba at the seedling growth stage had the lowest IVI value (2.32%), R. Stylosa (1.6%) and B. cylindrica (1.9%), meanwhile at tree level R. stylosa had the lowest IVI value (5.7%). Hidayat et al. (2017) mention that IVI > 42.66% is included in the high category, IVI 21.96-42.66% is included in medium and (3). IVI <21.96 is categorized as low. Plant species that have a high IVI value are said to have better adaptability, competition, and reproduction compared to other types. Conversely, plant species with low IVI values indicate that these species may disappear from the ecosystem if pressure occurs due to their low numbers, reproduction and distribution (Zulkarnain et al., 2015).

Hidayat (2018), explains that the density value of a species reflects the ability and suitability of that species to grow and reproduce effectively in a location. The high frequency of a species indicates that the species is spread evenly in various research areas. On the other hand, the dominance value indicates that a plant species is able to adapt to the environment in which it grows and has good regeneration abilities. Amrina et al. (2019) states that the high or low IVI value is influenced by the distribution factor, where the more evenly distributed a species is, the higher the IVI value of the plant. The ability of a species to grow and develop at its distribution location is determined by environmental factors where it grows, such as temperature and sunlight.

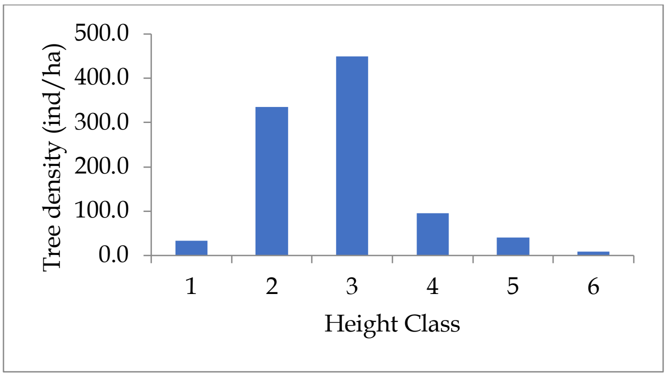

Figure 4. Density Relationship with High Class

The abundance of B. gymnorrhiza and R. mucronata species at the study site both at the growth stages of seedlings, saplings, and trees was caused by environmental conditions in Gili Lawang that matched the habitat characteristics of these species. Kusmana (1983) stated that R. mucronata can live in a salinity range of 12-30 ppt. and B. gymnorhiza can grow optimally at a salinity of 0-15 ppt. This is in accordance with the results of research by Valentino et al., (2022) that Gili Lawang waters have salinity levels ranging from 21-25%, with current speeds of 0.16-0.19 m/s with the dominant substrate found being sand (75.42%) – 222.58%), silt (2.69% – 73.31%) and clay (1.19% – 155.23%). Rosalina and Rombe (2021) added that the type of Rhizophora sp. dominates because it has a high level of adaptation to environmental factors such as salinity, substrate, pH and temperature. Valentino (2017) and Irwan et al., (2019) also mentioned that the viviparous nature of the genus Rhizophora sp. cause it to spread evenly in an area.

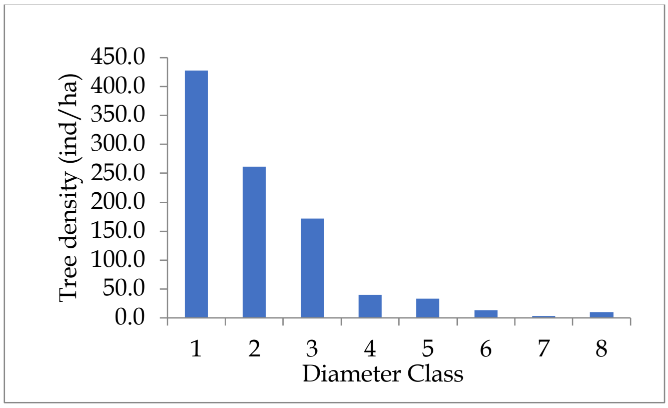

Figure 5. Density Relationship with Diameter Class

Table 3. Density Value (ind/ha) Based on Mangrove Type Diameter Class

Type	Diameter Class (m)							
	1	2	3	4	5	6	7	8
Avicennia marina	-	8.3	1.7	-	-	-	-	8.3
Bruguiera cylindrica	-	6.7	5.0	8.3	-	3.3	-	-
Bruguiera gymnorrhiza	141.7	81.7	60.0	18.3	16.7	6.7	1.7	1.7
Rhizophora apiculate	95.0	70.0	23,3	8.3	6.7	-	-	-
Rhizophora mucronate	145.0	90.0	76,7	3.3	6.7	1.7	-	-
Rhizophora stylosa	20.0	-	3,3	-	-	-	-	-
Sonneratia alba	26.7	5.0	1,7	1.7	3.3	1.7	-	-

Description : Class 1 (10.00-16.00 cm), class 2 (16.01-22.00 cm), class 3 (22.01-28.00 cm), class 4 (28.01-34.00 cm), class 5 (34.01-40.00 cm) , grade 6 (40.01-46.00 cm), grade 7 (46.01-52.00 cm), grade 8 (>52 cm)

Table 4. Density Value (ind/ha) Based on Mangrove Type High Class

Type	High grade					
	1	2	3	4	5	6
Avicennia marina	1.7	1.7	8.3	-	3.3	3.3
Bruguiera cylindrica	-	11.7	10.0	1.7	-	-
Bruguiera gymnorrhiza	5.0	93.3	181.7	36.7	11.7	-
Rhizophora apiculate	8.3	85.0	90.0	15.0	5.0	-
Rhizophora mucronata	18.3	101.7	145.0	35.0	20.0	5.0
Rhizophora stylosa	-	21.7	1.7	-	-	-
Sonneratia alba	-	20.0	13.3	6.7	0.0	-

Description: class 1 is a tree with a height of> 5 meters, class 2 (5-7.5 meters), class 3 (8-10.5 meters), class 4 (11-13.5 meters), class 5 (14- 16.5 meters), class 6 (17-19.5 meters)

Vertical Structure (Stratification)

The relationship between density and height at the growth rate of trees as shown in Table 4 can be used to see the stand structure vertically. Smith (1977); and Seran (2019) stated that vertical structure is related to plant tolerance to sunlight. Figure 4. Shows that density values are centered on height classes 2 (5-7.5 meters) and 3 (8-10.5 meters) so that the curve is shaped like a bell with density values of 335 (ind/ha) and 450 (ind/ha)). According to Soerianegara and Indrawan (2016) and Septiawan et al., (2017) this phenomenon naturally occurs because stands with a certain age will be replaced by stands with a lower age class or known as forest regeneration. The high value of Density in the 2 classes is influenced by Type R. mucronata quite dominates in all altitude classes with the highest density in class 2 (5-7.5 meters) with a value of 101.7 ind/ha) followed by B. gymnorrhiza which dominates in several altitude classes, one of which is in class 3 (8- 10.5 meters) with a density value of 187.7 ind/ha. The types of plants that reach a height of 17 meters and above are only A. marina and R. mucronata. This range of height values indicates that the type of crown stratification in the Gili Lawang mangrove forest stands consists of 3 strata, namely stratum C (4-20 m), stratum D and E which are occupied by saplings and seedlings. 7 ind/ha.

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Horizontal Structure

The horizontal stand structure can be described through the class relationship in the tree mater with its density. The distribution of individual tree trunk diameter classes forms an L curve (Figure 5.) where the highest density is in the smallest diameter class 1 (10.00-16.00 cm) of 428.3 ind/ha. According to Ghufrona et al., (2015) this phenomenon illustrates that the condition of the mangrove forest in Gili Lawang tends to form an uneven-age balanced forest or in other words the tree density decreases exponentially as the tree diameter increases, where this phenomenon guarantees the sustainability of the stand in the future. which will come. Then Table 5 shows that B. gymnorrhiza is the dominant species with a diameter distribution of 10-53 cm, with the highest density being in the 10.00-16.00 cm diameter class with 141.7 ind/ha just below R. mucronata worth 145 ind/ha. A

Ecological Index

Diversity Index

The species diversity index is a parameter that is able to see the structure and level of stability of plant communities in nature and indicates how diverse a species is in an area. (Andesmora et al., 2021; Baderan et al. 2021).

Table 5. Growth Stadia Diversity Index

Growth Rate	H'	Category
Tree	1.59	Currently
Stake	1.31	Currently
Seedling	1.33	Currently

Table 5 shows that the range of diversity index values at all growth levels shows a range of values between 1-3 which is included in the medium category (Magurran 1988). According to Soerianegara and Indrawan, (2005) environmental factors are the cause of differences in the shape and number of species in an area. In addition, high or low diversity values in a plant community indicate the vulnerability of a vegetation to disturbance.

Species Evenness Index

Based on the results of data analysis, the species evenness index was obtained in the Gili Lawang mangroves, namely:

Table 6. Index of evenness of types of growth stages

Growth Rate	E	Category
Tree	0.82	Tall
Stake	0.67	Currently
Seedling	0.69	Currently

Table 6 shows that the evenness index values of mangrove species at the seedling and sapling growth stages have a moderate evenness level, while the tree growth stages have a high evenness level. The evenness index of a species can indicate the level of stability of a vegetation. The level of vegetation that has a high evenness value will indicate that the vegetation will recover quickly when a disturbance occurs

Margalef Species Richness Index

Table 7. The Richness of the Types of Growth Stages

Growth Rate	R1	Category
Tree	0.95	Low
Stake	1.04	Low
Seedling	1.13	Low

The data in Table 7 shows that all growth stages have a low species richness index with a value of 0.95 - 1.13 according to the Maguran category, (1988). A low species richness index indicates a low number of species found in an ecosystem. This is presumably because the collection of species data has not represented the representativeness of the area studied, bearing in mind that differences in species richness values are caused by the area and habitat conditions of a species.

Based on the Raunkiaer frequency class law (Figure 6.) it is known that the species in the Gili Lawang mangrove ecosystem are normally distributed with the number of species compared between classes following the pattern A > B > C = D < E. However, the Gili Lawang mangrove ecosystem cannot be categorized as a community. homogeneous or heterogeneous or artificial, or degraded because the number of research samples has not fully represented the total area of the Gili Lawang ecosystem. As Krebs (1978) stated that one of the factors that determines the distribution of species diversity is spatial heterogeneity, the more heterogeneous a physical environment is taken from the measurement mechanism, the more complex the community of species found and the higher the diversity of species.

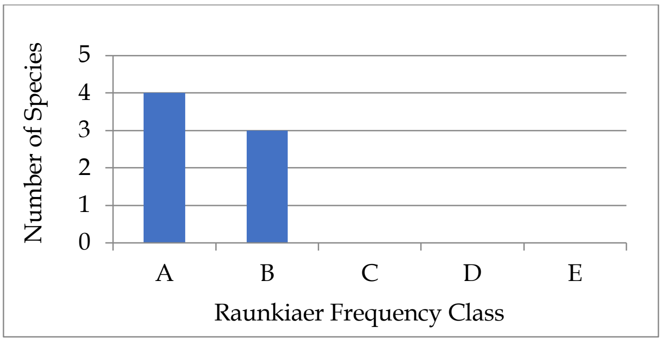

Figure 6. Distribution of Mangrove Types in Gili Lawang

Pattern of Plant Distribution

Table 8. Morisita Index for Each Growth Stage

	Type	Morisita Index (id)
Tree	*Avicennia marina*	60**
	Bruguiera cylindrica	17.1**
	Bruguiera gymnorrhiza	2**
	Rhizophora apiculata	2.8**
	Rhizophora mucronata	1.9**
	Rhizophora stylosa	60**
	Sonneratia alba	60**
Stake	*Avicennia marina*	30**
	Bruguiera cylindrica	60**
	Bruguiera gymnorrhiza	1.6**
	Rhizophora apiculata	1.9**
	Rhizophora mucronata	1.8**
	Rhizophora stylosa	60**
	Sonneratia alba	6.0
Seedling	*Avicennia marina*	14.18**
	Bruguiera cylindrica	17.8**
	Bruguiera gymnorrhiza	1.69**
	Rhizophora apiculate	1.56**
	Rhizophora mucronate	1.75**
	Rhizophora stylosa	21.1**
	Sonneratia alba	3.38**

Note: (**) indicates a significant difference from randomness at the 0.05 and 0.01 levels.

Based on the moricita index presented in Table 8. All morishita indices have a grouped distribution category with an id> 1 value, but after testing the f distribution it is known that*S. alba*the sapling growth rate has a value that shows a random distribution pattern. In general, a stable plant community will form a clustered distribution pattern. The clustering distribution pattern is a form of grouping that is carried out to deal with changes in the environment that affect space for movement and food. (Odum 1993; Tarida et al., 2018) However, given random values for species*S. alba*the growth rate of saplings indicates that environmental factors do not significantly affect the existence of the species*S. alba*at the research location.

Regeneration State

Based on Shankar (2001) the regeneration status of mangrove species in Gili Lawang is*good*(good) on type*Avicennia marina, Bruguiera gymnorrhiza, Rhizophora apiculata,*and Rhizophora mucronata, fair (fair/moderate) on Bruguiera cylindrica, Rhizophora stylosa and Sonneratia alba. The natural regeneration of mangrove species is influenced by several biological and physical factors, namely soil stability and inundation, elevation where it grows, salinity and availability of propagules (Krauss & Allen, 2003; Ebigwai & Akomaye, 2014).

Conclusion

The composition of mangrove species in a preliminary study of the mangrove eco-structure of Gili Lawang showed that there were 7 mangrove species found, namely Avicenniaceae (A. marina), Rhizophoraceae (B. cylindrica, B. gymnorrhiza, R. apiculata, R. mucronata, R. stylosa), Sonneratiaceae (S. alba). In addition, the level of mastery of the species at each growth stage showed that R. mucronata had the highest IVI (79.34%) at the seedling growth stage, while at the sapling and tree growth stages, B. gymnorrhiza had the highest level of mastery, namely IVI at the sapling and tree growth stages. sapling (77%) and IVI at the tree level (96.2%). Canopy stratification is found in stratum C, D and E while the concentration of horizontal structures is in class 1 (10-16 cm) at the same time the tree density decreases exponentially as the tree diameter increases, where this phenomenon guarantees the sustainability of stands in the future. The ecological index (H', E' and R1) at the seedling growth stage showed that H' was classified as moderate (1.33), E is classified as moderate (0.69), R is classified as low (1.13). At the sapling growth stage, H' was classified as Medium (1.31), E was classified as Medium (0.67) and R was classified as Low (1.04) and at the tree growth stage, H' was classified as moderate (1.59), E was classified as high (0.82), R is low (0.95). The distribution of mangrove species in Gili Lawang based on the Raunkiaer frequency law shows that mangrove species in the Gili Lawang ecosystem are normally distributed with the number of species compared between classes following the pattern A > B > C = D < E. all growth stages. However, for S. alba, the sapling growth stage showed a random pattern.Regeneration status of mangrove species in Gili Lawang namely*good*(good) on type*Avicennia marina, Bruguiera gymnorrhiza, Rhizophora apiculata,*and Rhizophora mucronata, fair (fair/moderate) on Bruguiera cylindrica, Rhizophora stylosa and Sonneratia alba.Given the importance of the functions and benefits of the existence of mangrove ecosystems, further research is needed related to mangrove eco-structure which is more detailed and comprehensive based on overall species autocology so that it can be used as a basis or basis for integrated mangrove ecosystem management.

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