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Mangrove Community Structure on the North Coast of Bengkalis Island, Riau Province

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ABSTRACT

This research was conducted in April 2022 on the North Coast of Bengkalis Island, Riau Province. The purpose of this study was to determine the structure of the mangrove community on the North Coast of Bengkalis Island, Riau Province. The method used in this study is a survey method, through direct observation in the field (in situ). Determination of research stations was carried out by purposive sampling method, the research location was divided into 3 stations then the stations were divided into 3 transects and 3 plots were placed on each transect. The results showed that the mangrove species found consisted of 8 species. The highest density of mangroves in the tree category was at station I, namely 1,767 ind/ha, the highest density of mangroves in the sapling category was at station I, namely 3,645 ind/ha. The species with the highest density, both from the category of trees and saplings, is *R. apiculata*. The diversity index belongs to the medium category (H' = 1.49 - 1.69) which means that the mangrove community is experiencing significant pressure (disorder). The uniformity index value obtained is in the high category (E = 0.89 - 0.90) where the distribution of species in these waters is in a balanced state. The dominance index value (C = 0.18 - 0.26) indicates that there are no species that dominate in these waters.

Keywords: Mangrove, Density, Community Structure

1. INTRODUCTION

Community structure is one of the studies studied in Synecology which includes diversity, uniformity, dominance, and abundance. It is important to study community structure, namely to find out the distribution, composition, and composition of a community. Community structure is always studied in ecology, both the community structure of living things that live on land and the community structure that lives in water or waters. Community consists of organisms that interact with each other in a particular environment (Irwan, 2012).

Coastal areas are transitional areas between terrestrial and marine ecosystems that are affected by changes in land and sea. Most of the civilizations that exist on earth developed in coastal areas. In Indonesia, about 60% of the population lives in coastal areas (Malik, 2011). As an area that is a multiple-use zone (can be functioned for various uses), coastal areas not only have the potential as providers of environmental services, but the main potential is marine and fishery resources.

One of the natural resources that can be utilized and managed by humans in coastal areas is the mangrove ecosystem. The mangrove ecosystem is one of the three ecosystems (triple ecosystem) that make up coastal and small island ecosystems (mangrove, seagrass and coral reef ecosystems). Mangroves are a very important part of the coastal ecosystem because they have the ability to minimize the impacts caused by hydro-oceanographic and hydro-meteorological influences. In addition, according Akbar et al. (2015) Mangroves have ecological and economic functions for various kinds of fulfillment of human needs. Noor et al. (2006) stated that seeing the various benefits of mangrove ecosystems, the category and pace of the rural economy in coastal areas and small islands often depend on the surrounding mangroves.

However, along with utilization without regard to mangrove sustainability, the sustainability of the mangrove ecosystem and its associated biota and other constituent

components is threatened. The most crucial threat from this utilization activity is damage and deforestation of mangrove forests which causes a decrease in its function as the front guard for climate change mitigation, as well as a decrease in production capacity and land use from an economic perspective.

One of the areas experiencing degradation of the mangrove ecosystem is Bengkalis Island. This happens because the mangrove utilization activities that have been carried out so far are physical utilization in the form of continuous use of wood without replanting activities by the local community (Miswadi et al., 2017). In addition, part of the area has been converted for residential land, ponds and fish farming. This change in the mangrove forest area is marked by reduced diversity and density of mangrove forests along the coast of Bengkalis Island. The main factor causing the high abrasion rate is caused by the deforestation of the mangrove ecosystem as the buffer zone of the area.

Based on the description above, the purpose of this research is to analyze the structure of the mangrove community on the north coast of Bengkalis Island, Riau Province, which is expected to be used as a first step for future mangrove conservation and rehabilitation efforts on Bengkalis Island

2. RESEARCH METHODS

Time and Place of Research

This research was carried out in April 2022. Sampling of mangrove structures and communities was carried out on the north coast of Bengkalis Island, Riau Province (Figure 1). Sample handling, species identification and mangrove data analysis will be carried out at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Riau.

Method

The method used in this study is a survey method, through direct observation in the field (in situ). Determination of the stations in this study was carried out using the purposive sampling method, the research location was divided into 3 stations then at each station 3 transects were placed and 3 plots were placed on each transect. In each plot identified and calculated the density, frequency and cover of mangroves that grow in the study area.

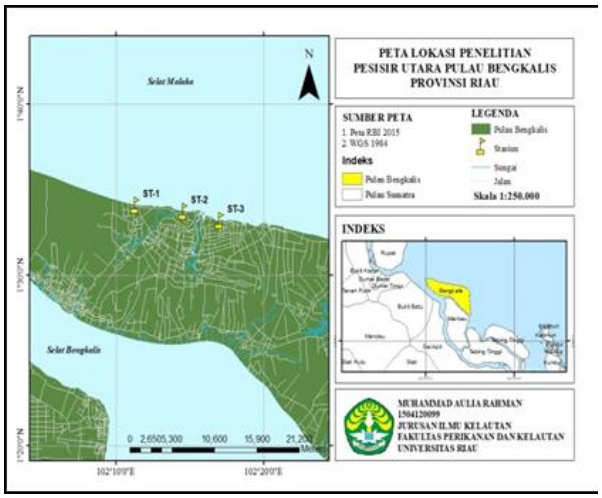

Figure 1. Research location

Procedure

Sampling of mangrove vegetation at each station, transect lines were drawn perpendicular from the coast to the land along 50 meters for 3 transects with a distance of 30 meters (Akbar et al., 2018; Karnanda et al., 2016). On each transect there are three plots measuring 10 m x 10 m. Within each of these plots, smaller plots were made with dimensions of 5 m x 5 m and 1 m x 1 m. Plots of 5 x 5 m were used for sapling data collection with diameters between 1–4 cm (1 cm ≤ trunk diameter <4 cm) and heights > 1 m. Meanwhile, plots measuring 1 m x 1 m were used for seedling data collection (seedling) with a height of < 1 m (Renta et al., 2016; Darmadi et al., 2012). Data collection in this study included: identification of mangrove species using an identification book Bengen (2002), number of stands, and stem diameter at breast height (DBH) for further processing and analysis.

Data Analysis

The community structure of the mangrove ecosystem was carried out by determining the value of Density (K), Basal Area (BA), Relative Density (KR), Relative Dominance (DR), Diversity Index (H'), uniformity Index (E) and Dominance Index (C) using the help of Microsoft Excel.

3. RESULT AND DISCUSSION

Mangrove Species Composition

The types of mangrove vegetation found on the North Coast of Bengkalis Island, Riau Province at all stations consisted of 5 (five) families, 6 (six) genera, 8 (eight) species. The mangroves found consisted of the families

Acanthaceae, Rhizophoraceae, Arecaceae, Lythraceae and Meliaceae. The mangrove species found at the study site can be seen in Table 1.

Table 1. Mangrove species found on the north coast of Bengkalis Island

No.	Family	Genus	Species	Local name
1.	Acanthaceae	Avicennia	*Avicennia alba*	Api-api putih
			Avicennia marina	Api-api
2.	Rhizophoraceae	Bruguiera	*Bruguiera gymnorrhiza*	Tancang
		Rhizophora	*Rhizophora apiculata*	Bakau
3.	Arecaceae	Nypa	*Nypa fruticans*	Nypa
4.	Lythraceae	Soneratia	*Sonneratia casiolaris*	Pidada merah
			Sonneratia ovata	Kedabu
5.	Meliaceae	Xylocarpus	*Xylocarpus granatum*	Nyireh

Table 2. Mean density of mangroves

Observation Place	Density Average (ind/ha) ±Std. Dev	
	Tree	Sapling
Station I	1.766,67 ± 72,43	3.644,44 ± 463,78
Station II	1.266,67 ± 58,44	2.622,22 ± 171,90
Station III	1.511,11 ± 137,48	3.244,44 ± 458,10
Average	1.514,82±204,14	3.170,37 ±420,59

Based on observations at each station, it can be stated that the number of mangrove species on the north coast of Bengkalis Island is relatively small. This can be seen from the less amount of vegetation found when compared to the composition of mangrove species in Dompak, Riau Islands, namely 10 types of mangroves including *A.lanata, B. gymnorrhiza, B. cylindrica, R.apiculata, R. stylosa, N. fruticans, S.alba, X.granatum, Scyphiphora hydrophyllacea* and *Hibiscus tiliaceus* (Imanuel et al. 2020). There are more types of mangroves on the north coast of Bengkalis Island than those obtained Alpian et al. (2021) which are on the west coast of West Sumatra, namely 4 species, *S.caseolaris, S.alba, R. mucronata, N.fructicans*. The different types of mangroves found are thought to be closely related to the environmental conditions of the mangroves on the north coast of Bengkalis Island, which are directly opposite the Malacca Strait.

Mangrove Density

Based on Table 2 above, it is known that the highest tree density is at station I, namely 1,7667.67 ind/ha, while the lowest density is at station II, namely 1,266.67 ind/ha. The highest density of tillers was at station I, namely 3,644.44 ind/ha, while the lowest abundance was at station II, namely 2,622.22 ind/ha. The high value of tree density at station I is thought to be due to the pristine condition of the mangroves. The low value of tree density at station II is suspected because at station II there are cultivation and tourism activities which cause logging by humans. According to Setyawan et al. (2017) few species are found in an area because the ecosystem is experiencing pressure or its condition has decreased, such as the magnitude of anthropogenic influences that change mangrove habitat for other purposes, such as clearing land for aquaculture and settlements.

According to Supardjo (2008), the low value of the density of tree category species is the condition of the tree roots which are classified as large so that the growth of the mangrove becomes less than optimal. Hotden et al. (2014) stated that the low value of the density of tree category species is the condition of the tree roots which are classified as large so that the growth of the mangrove becomes less than optimal.

According to Eddy et al. (2019), most of the causes of damage to mangrove ecosystems around the world are caused by human activities such as land conversion and illegal logging. This is supported by research Ajithkumar et al. (2008) which states that the spectral characteristics of mangroves are not only influenced by chlorophyll content but are also supported by the surrounding environmental conditions. According to Nybakken (1988) certain types of mangroves

(Rhizophora, Bruguiera) which develop on their own in ocean waters have specific forms of development for the development and dispersal of their seeds. This seed, while still on the mother plant, germinates and begins to grow in the seedling without experiencing rest.

Relative Density and Mangrove Density Frequency

Table 3 it can be seen that *R. apiculata* is a type of mangrove that has a relatively high density. The same is also obtained Andrito et al. (2020) on the eastern coast of Jemaja Island, the Anambas Archipelago. Nybakken (1988) states that the Rhizophora zone lies on the edge facing the sea.

Based on the results of the calculation of the frequency of mangrove trees and saplings category ranged from 2.22 - 4.44. The highest mangrove frequency value of trees is found at station I with a value of 4.44. In the category of saplings highest mangrove frequency found at station I with a value of 3.11, can be seen in Table 4.

Table 3. Average relative abundance (%) of mangroves

Species	Tree			Total	Saplings			Total
	St I	St II	St III		St I	St II	St III	
A. alba	15,72	13,16	30,88	59,76	18,29	18,64	13,70	50,63
A. marina	10,69	21,93	19,85	52,47	10,98	27,12	20,55	58,65
B. gymnorrhiza	12,58	0,00	7,35	19,93	7,32	0,00	5,48	12,80
N. fruticans	11,95	14,04	4,41	30,40	0,00	0.00	0,00	0,00
R. apiculata	23,27	20,18	17,65	61,10	43,90	25,42	46,58	115,90
S. casiolaris	15,09	0,00	3,68	18,71	12,20	0,00	0,00	12,20
S. ovata	0,00	9,65	0,00	9,65	0	8,47	0,00	8,47
X. granatum	10,69	21,05	16,18	47,89	7,32	20,34	13,70	41,36
Total	100,00	100,00	100,00	300,00	100,00	100,00	100,00	300,00

Table 4. Mangrove frequency at the research station

Species	Tree			Saplings		
	St I	St II	St III	St I	St II	St III
A. alba	0,54	0,56	0,89	0,56	0,33	0,33
A. marina	0,44	0,78	0,67	0,33	0,78	0,44
B. gymnorrhiza	0,56	0,00	0,33	0,33	0,00	0,11
N. fruticans	0,56	0,44	0,33	0,00	0,00	0,00
R. apiculata	1,00	1,00	1,00	1,00	0,67	0,89
S. casiolaris	0,67	0,00	0,11	0,56	0,00	0,00
S. ovata	0,00	0,33	0,00	0,00	0,22	0,00
X. granatum	0,67	0,56	0,67	0,33	0,33	0,44
Total	4,44	3,67	4,00	3,11	2,33	2,22

Mangrove Relative Frequency

Based on the calculation of the relative frequency of the mangrove tree category and saplings can be seen that the relative frequency value of the mangrove tree category ranges from 0-27.27%. The highest relative frequency value of the mangrove tree category is found in station II species *R.apiculata* with a value of 27.27%. In the category of saplings, the highest relative frequency value of mangroves owned by *A.marina* was found at station II with a value of 33.48% (Table 5).

Overall, *A. alba, A. marina, R. apiculata,* and *X.granatum* were found at every station in the sapling and tree categories. This shows that these four species have a higher species distribution and presence when compared to other species. When viewed from the placement location, the three stations are in the brackish water zone (coastal areas to river mouths), these conditions confirm the presence of the four types of species found at each station.

Overall, *A.alba, A. marina, R. apiculata* and *X. granatum* species were found at each station for the sapling and tree categories. This shows that the four types have a higher distribution and presence than the other types. When viewed from the placement locations, the three stations are in the brackish water zone

(coastal area to the mouth of the river), this condition emphasizes the existence of these four species that are found at each station.

Mangrove Species Dominance

Based on the results of the calculation of mangrove dominance of tree and sapling categories, it can be seen that the highest value of mangrove species dominance in the tree category is found in the *X.granatum* species with a value of 26.80 and in the sapling category is found in the *R.apiculata species* with a value of 0.46. Factors that influence the dominance value of species are the presence of heterogeneous mangroves. According to Raymond et al. (2010), the more heterogeneous mangrove species in a community, the role will be divided and the magnitude of the index will vary. More details can be seen in Table 6.

Table 5. Frequency relative (%) of mangrove on the north coast of Bengkalis Island

Species	Tree			Saplings		
	St I	St II	St III	St I	St II	St III
A. alba	12,5	15,5	22,22	17,85	14,28	15
A. marina	10	21,21	16,66	10,71	33,33	20
B. gymnorrhiza	12,5	-	8,33	10,71	-	5
N. fruticans	12,5	12,12	8,33	-	-	-
R. apiculata	22,5	27,27	25	32,14	28,57	40
S. casiolaris	15	9,09	2,7	17,85	9,52	-
S. ovata	-	-	-	-	-	-
X. granatum	15	15,15	16,66	10,71	14,28	20
Total	100	100	100	100	100	100

Table 6. The dominance of mangrove species at the research station

Species	Tree			Saplings		
	St I	St II	St III	St I	St II	St III
A. alba	3,25	1,18	4,91	0,19	0,13	0,12
A. marina	3,32	2,02	2,89	0,13	0,27	0,19
B. gymnorrhiza	4,78	-	2,75	0,08	-	0,06
N. fruticans	5,69	1,25	3,30	-	-	-
R. apiculata	8,98	1,72	2,30	0,46	0,22	0,46
S. casiolaris	2,27	-	26,30	0,13	-	-
S. ovata	-	1,13	-	-	0,08	-
X. granatum	10,45	1,88	26,80	0,03	0,18	0,14
Total	38,74	9,18	69,25	1,02	0,89	0,96

Table 7. Relative dominance of mangrove species at research stations

Species	Tree			Saplings		
	St I	St II	St III	St I	St II	St III
A. alba	8,38	12,88	7,09	18,89	15,06	12,66
A. marina	8,57	22,04	4,17	12,24	30,28	19,78
B. gymnorrhiza	12,34	-	3,98	7,85	-	5,80
N. fruticans	14,69	13,58	4,76	-	-	-
R. apiculata	23,19	18,71	3,32	45,08	25,15	47,61
S. casiolaris	5,85	-	37,97	12,83	-	-
S. ovata	-	12,27	-	-	9,06	-
X. granatum	26,98	20,52	38,71	3,07	20,42	14,13
Total	100	100	100	100	100	100

Mangrove Relative Dominance

Based on the results of the calculation of the relative dominance of mangroves in the category of trees and saplings can be seen that the relative dominance value of the highest tree category mangroves found at station III with a value of 38.71%. While the category of the highest relative dominance of mangroves was

found at station III with a value of 47.61% (Table 7).

The high relative dominance value of mangroves in the tree category of *X.granatum* species and the sapling category of *R.apiculata* species is due to the condition of the tree which has a larger diameter when compared to other species that have a small diameter so that the relative dominance value of mangroves is lower. According to Nontji (2005), in places protected from waves, the mangrove community is superior to Rhizophora apiculata. Furthermore Sofian et al. (2012), stated that the condition of the mangrove forest which is directly facing the sea so that it gets sea tides strongly supports this type of growth.

Mangrove Diversity, Uniformity, and Dominance Index

Mangrove diversity in the North Coast of Bengkalis Island, Riau Province can be known by using the diversity index (Table 8). Based on the results of research that has been done, the highest mangrove diversity index is found at station I of 1.91, it is thought to be due to the many types of mangroves found. The lowest diversity index is at station II with a value of 1.42, the low mangrove diversity index is caused by the few types of species obtained compared to station I and station III.

Table 8. Mangrove diversity, uniformity and dominance index

Place of Observation	Index diversity (H')		index uniformity (E)		index dominance (C)	
	Trees	Saplings	Trees	Saplings	Trees	Saplings
Station I	1,91	1,55	0,98	0,87	0,15	0,26
Station II	1,42	1,55	0,79	0,96	0,18	0,22
Station III	1,74	1,38	0,89	0,86	0,20	0,30
Average	1,69	1,49	0,89	0,90	0,18	0,26

Based on the results of research that has been done, the highest mangrove tree uniformity index is found at station II of 0.96, it is thought because the species found are uniform. The lowest uniformity index is at station III with a value of 0.86, the low uniformity index of mangrove trees is caused by the non-uniform species found at station III.

The dominance value of mangrove trees at stations I, II and III is 0.15, 0.18 and 0.20. Based on the results of research that have been done, the highest mangrove tree dominance index is found at station III at 0.20, it is thought to be due to the presence of mangrove species that dominate at station III, the lowest mangrove tree dominance value is at station I with a value of 0.15, the low mangrove dominance index is caused by the absence of species that dominate at station I.

4. CONCLUSIONS

The results showed that mangrove species found consisted of 8 types of species namely *A. alba*, *A.marina*, *B. gymnorrhiza*, *R.apiculata*, *N.fruticans*, *S.casiolaris*, *S.ovata*, and *X.granatum*. The highest mangrove density at each observation station is tree species. The diversity index (H') is classified in the medium category which means that the mangrove community is experiencing moderate pressure (disturbance) in these waters. The value of the uniformity index (E) obtained is in the high category, where the distribution of species in these waters is in a balanced state. The dominance index value (C) obtained states that there is no dominating species in these waters.

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