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Mangrove community structure in Lubuk Damar Coast, Seruway, Aceh Tamiang

Ananingtyas S Darmarini[a], Yusli Wardiatno[b], Tri Prartono[c], Kadarwan Soewardi[b], Agustinus Mangaratua Samosir[b], M Zainuri[d]

[a] Department of Aquatic Resources, Faculty of Fisheries and Marine Science, Teuku Umar University, Meulaboh, 23681, Indonesia [+62 8179257957]
[b] Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University, IPB Dramaga Campus, Bogor, 16680, Indonesia
[c] Department of Marine Sciences and Technology, Faculty of Fisheries and Marine Science, IPB University, IPB Dramaga Campus, Bogor, 16680, Indonesia
[d] Environment Division, PT Karya Nusa Bersama, Tanah Abang, Jakarta, 10220, Indonesia

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Corresponding Author:
Ananingtyas S Darmarini
Department of Aquatic Resources, Faculty of Fisheries and Marine Science, Teuku Umar University;
Tel. +62-655-7110535
Email: ananingtyas.s@gmail.com

Abstract. *Mangrove is an important ecosystem in coastal areas because it is the basis for the formation of food webs and has direct and indirect impacts on aquatic and terrestrial ecosystems. This research aims to determine the community structure of mangrove vegetation on the coast of Lubuk Damar, Seruway, Aceh Tamiang. The study was conducted in August 2017. The method used a quadratic transect that was pulled straight from the coastline to the mainland. The results found 10 species of mangrove consisting of* A. alba, B. parviflora, B. sexangula, S. alba, R. apiculata, Acrostichum aureum, Aegiceras floridum, Excoecaria agallocha, X. granatum, *and* Acanthus ilicifolius. *Mangrove species with the highest percentage are in the A. floridum species. Important value index the tree phase in the range of 4.75 to 117.91. Lubuk Damar mangrove vegetation is in the damaged category. However, the number of saplings and seedlings was found to have a high density so the ecosystem has the potential to regenerate naturally.*

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INTRODUCTION

The mangrove ecosystem is productive (Carugati *et al.*, 2018; Ribeiro *et al.*, 2019; Medina-Contreras *et al.*, 2020) whose productivity is assessed from primary and carbon productivity (Twilley *et al.*, 2017), as a provider of important food sources in estuarine consumer (Abrantes *et al.*, 2015). Mangrove ecosystem has a notable function as a major resource in coastal areas and forming the basis of food webs (Kruitwagen *et al.*, 2010; Thilagavathi *et al.*, 2013; Hutchison *et al.*, 2014; Bernardino *et al.*, 2018), an open ecosystem that provides energy, organic matter, inorganic estuary and coastal areas for organisms (Shafique and Shiddiqui, 2015). This ecosystem is also considered an ecosystem with complex trophic dynamics and is an area with high diversity (Medina-Contreras *et al.*, 2020). Moreover, the mangrove ecosystem is the habitat of various coastal biota (Onrizal *et al.*, 2020), fisheries production (Donato *et al.*, 2011), and the production of coastal fisheries can be maintained by the existence of the mangrove ecosystem (Manson *et al.*, 2005). In addition, fauna in the mangrove area can influence the structure of the vegetation which in turn will have an impact on the function of the mangrove ecosystem (Cannicci *et al*., 2008).

Furthermore, the complex role of coastal ecosystems, mangroves in Indonesia also have a high diversity of species. Reports of several research results related to the diversity of mangrove vegetation spread across the territory of Indonesia, for example; 27 species in Bangi, Rembang, Central Java (Setyawan and Winarno, 2006), 20 species on the East Coast of North Sumatra (Onrizal and Kusmana, 2008), 10 species on the coast of West Muna Regency (Rahman *et al*. 2020a, 2020b); 7 species in the Surabaya mangrove ecosystem (Susanto *et al*., 2013), 3 species in the Tallo River-Makassar (Rahman *et al*. 2017); 2 species in Tongkaina Manado (Sasauw *et al*., 2016). The estimation of mangrove plant diversity is based on 5 major islands in Indonesia, so Indonesia has 157 species, namely 52 species of trees, 21 species of shrubs, 13 species of lyanas, 7 species of palms, 14 species of grasses, 8 species of herbs, 3 species of parasites, 36 species of epiphytes and 3 types of ferns (Kusmana and Sukristijiono, 2016). High diversity is decreasing due to several reasons related to management. As in the case in Java, which was mentioned by Rudianto and Bengen (2020) that one of the causes of a disadvantage of the mangrove ecosystem is intensive land-use change.

Mangrove areas in Aceh Province, especially East Aceh in Seruway Sub-district, Lubuk Damar Village, in 1998 began to experience land conversion. This area from 2001 to 2010 decreased by 361.53 ha (Hasri *et al*., 2014). In 2017 based on the research results of Darmarini *et al*. (2017) the dominant vegetation in Kupang Beach, the coast of Lubuk Damar village, consists of *Avicennia alba*, *Bruguiera sexangula*, *Sonneratia* sp., *Rhizophora apiculata*, and *Scyphiphora hydrophyllaceae*. This mangrove area in front of the Malacca Strait does require attention and proper management because apart from land conversion, illegal logging in this area is still ongoing, and has an impact on an aquatic productivity. This water productivity condition is very important because some local people make this location a fishing area to meet their needs. Based on the above, it is required to study the construction of the coastal mangrove vegetation of Lubuk Damar, Seruway, Aceh Tamiang to provide sufficient information for management considerations.

METHODS

Location and Time

The study was conducted on the mangrove ecosystem along the coast of Lubuk Damar Village, Aceh Tamiang, in August 2017 (Figure 1). Data collection was carried out using a quadratic transect from the coastline to the mainland.

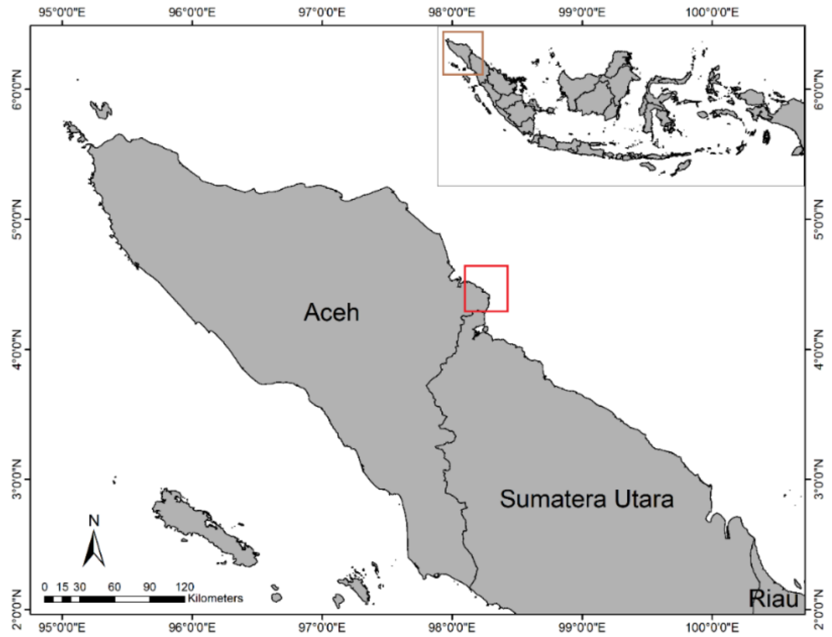

Figure 1 Research location of Lubuk Damar mangrove ecosystem, Seruway, Aceh Tamiang

Data Collections

Data were collected using a 10x10 m quadratic transect method (Onrizal, 2008; Kamal *et al.*, 2014). Grouping of mangrove plants based on tree growth rate (diameter 10 cm) was taken on a square transect measuring 10x10 m, saplings (diameter 10 cm, height more than 1.5 m), at a square of size 5x5 m, and seedlings (regeneration from sprouts to a height of 1.5 m) with a 1x1 m quadratic transect (Haya *et al*., 2015; Sahami, 2018).

Data Analysis

Data analysis in the form of Species Density (Di), Relative Species Density (RDi), Species Frequency (Fi), Relative Species Frequency (RFi), Species Cover (Ci), Relative Species Cover (RCi) to obtain an Important Value Index (INP) category trees, for the category of saplings and seedlings using Di, Rdi, (Fi), and RFi. The equation refers to Bengen (2004).

RESULTS AND DISCUSSION

Abundance and Composition

The results of this study indicate finding 10 species of mangroves in Lubuk Damar, namely: *Acanthus ilicifolius*, *Acrostichum aureum*, *Aegiceras floridum*, *A. alba*, *B. parviflora*, *B. sexangula*, *S. alba*, *Excoecaria agallocha*, *R. apiculata*, and *X. granatum*. The mangrove ecosystem on the Lubuk Damar beach is formed by true mangroves be composed of true mangroves (*A. alba*, *B. parviflora*, *B. sexangula*, *R. apiculata*, *S. alba*), supporting mangroves (*Acrostichum aureum*, *Aegiceras floridum*, *Excocaria agallocha*, *X. granatum*) and mangrove associations (*Acanthus ilicifolius*). The percentage of mangrove species presence along the Lubuk Damar coast is presented in Figure 2. At the tree level, 3 species were found that were always present at all sampling points, namely; *A. floridum*, *B. sexangula, and E. agallocha*, while the sapling and seedling levels were always found at all stations were *A. floridum* and *B. sexangula*.

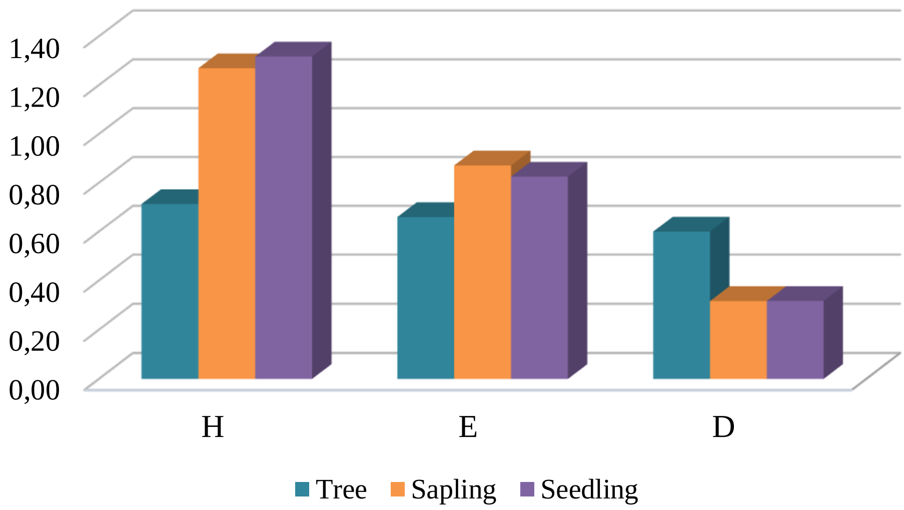

Figure 2 Average Diversity Index (H'), Evenness Index (E), and Dominance Index (C) of mangrove vegetation at all growth levels in the coastal mangrove ecosystem of Lubuk Damar, Seruway, Aceh Tamiang

The tree growth rate was dominated by *A. floridum*, *B. sexangula, and X. granatum*. Species *E. agallocha* and *A. alba* were found in lesser numbers (Figure 3A). More than 15% of *A. floridum*, *E. agallocha*, and *X. granatum* species were found and *B. sexangula* was present in higher numbers at the sapling growth rate (Figure 3B). The growth rate of seedlings was dominated by *E. agallocha*, *X. granatum*, and *A. aureum*. In general, at the growth levels of trees, saplings, and seedlings, the species *X. granatum* was the most frequently encountered species in the study area. The composition, which is based on Figure 3, shows that the types of vegetation found at all growth rates above 30% were species (seedling level) *X. granatum*, (sapling level) *B. sexangula*, and (tree level) *A. floridum*.

The type of vegetation on the coast of Lubuk Damar is similar to the results of Suryawan's research (2007) on the East Coast of Aceh, consisting of *R. apiculata*, *S. alba*, *B. parviflora*, *E. agallocha*, and *X. granatum*. In general, the coastal mangrove ecosystem of Lubuk Damar has several tree species *A. floridum* is more abundant with a total of 225 ind/ha compared to other species with a density of 76 ind/ha.

A. floridum is a shrub habitus with a height of up to 3.5 m (Ginantra *et al*., 2018), and is more common at tree growth rates. It is suspected that the presence of *A. floridum* is more abundant because this species is not an option for logging. In the research location, logging of mangrove trees often occurs because some people use it as a basic material for making charcoal. It is suspected that illegal logging activities are the main cause of the absence of certain species at the tree level. The loss of certain mangrove species according to Palidoro *et al*. (2010) will have an economic and environmental impact on coastal communities.

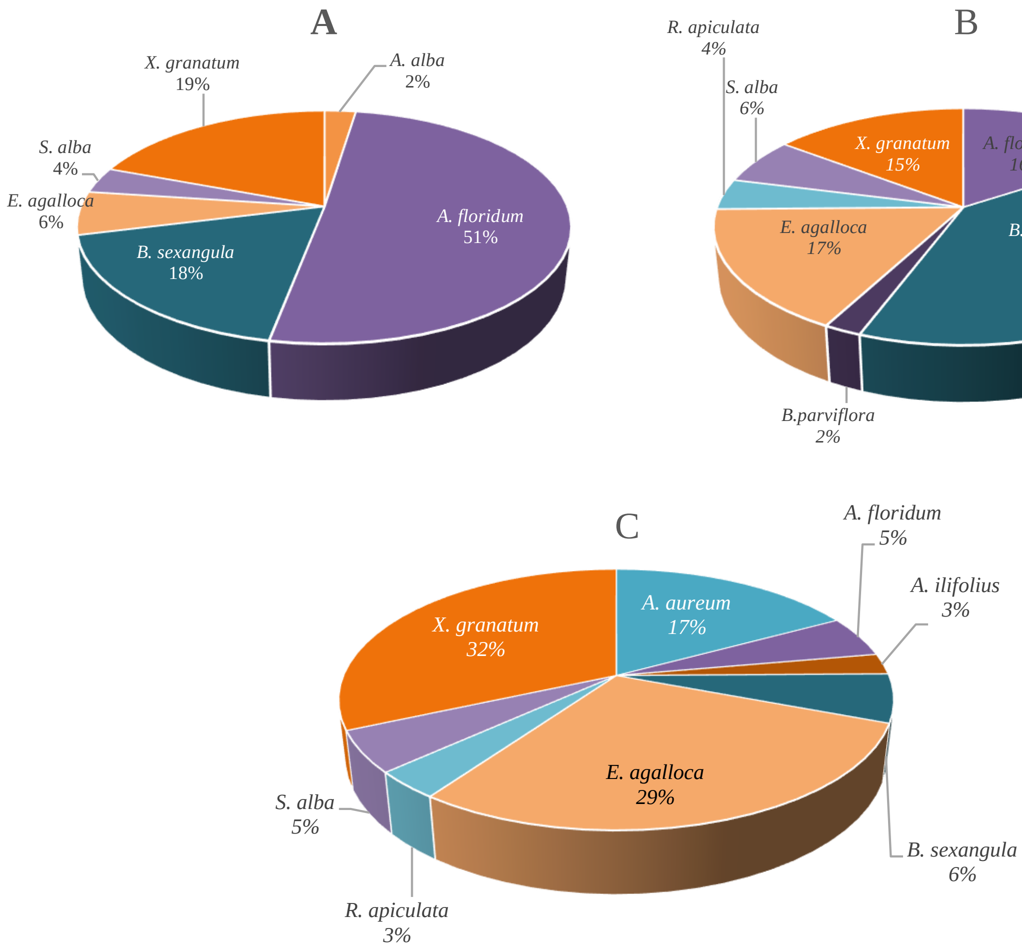

Figure 3 Species vegetation percentage of mangrove ecosystem in Lubuk Damar, Seruway, Aceh Tamiang on all growth level; A: trees, B: saplings, and C: seedlings

Mangrove Density

The results of data analysis performed at diverse levels of mangrove growth are presented in Table 1. The highest average tree density value is found in *A. floridum* and the lowest is *A. alba*. The topless growth rate of saplings was established in *B. sexangula*, followed by *E. agallocha* and *A. floridum*. The lowest density of sapling growth rates of *B. parviflora*. Meanwhile, the highest density seedling growth rate was *X. granatum*, the next were *E. agallocha* and *A. aureum*.

The number of tree-level vegetation per hectare is in the range between 10-225 ind/ha. The highest number is found in *A. floridum*. At the sapling level, the highest number was *B. sexangula* with ±803 ind/ha, with the lowest relative density for *B. parviflora* with ±38 ind/ha. The research location had a higher seedling growth rate than the other two growth rates with a total of 19 000 ind/ha on the species *X. granatum*. The high density of this species at the seedling level provides a breath of fresh air for future management plans, because this species has no less important potential than other mangrove species. *X. granatum* based on the results of research by Analuddin *et al*. (2019) has fruit with higher content of macronutrients kalium (K) and natrium (Na) compared to other species of mangrove fruit. This is a development opportunity if this species can develop well in the research location because it provides opportunities for the local community.

Table 1 Average density, relative density, relative frequency, and important value index at the level of trees, saplings, and seedlings in the mangrove ecosystem of Lubuk Damar, Seruway, Aceh Tamiang

Level	Mangrove Species	Di	Rdi	RFi	RCi	IVI
Trees	*A. alba*	10	1.45	1.45	1.85	4.75
	A. floridum	225	39.28	39.28	39.34	117.91
	B. sexangula	71	10.87	10.87	10.87	32.61
	E. agallocha	26	11.80	11.80	21.14	44.74
	S. alba	17	25.00	25.00	15.30	65.30
	X. granatum	76	11.59	11.59	11.50	34.69
	Total	425				300
Sapling	*A. floridum*	305	18.82	18.82	-	37.65
	B. parviflora	38	2.02	2.02	-	4.04
	B. sexangula	803	35.79	35.79	-	71.58
	E. agallocha	356	12.77	12.77	-	25.53
	S. alba	133	15.38	15.38	-	30.77
	R. apiculata	89	2.72	2.72	-	5.44
	X. granatum	282	12.49	12.49	-	24.99
	Total	2 006				200
Seedling	*A. aureum*	10 318	16.12	16.12	-	32.25
	A. floridum	3 175	5.77	5.77	-	11.54
	A. ilifolius	1 667	6.25	6.25	-	12.50
	B. sexangula	3 730	9.48	9.48	-	18.95
	E. agallocha	18 889	20.60	20.60	-	41.20
	S. alba	3 333	12.50	12.50	-	25.00
	R. apiculata	2 222	1.85	1.85	-	3.70
	X. granatum	19 365	27.43	27.43	-	54.85
	Total	62 699				200

Note: Di (ind/ha)= density, RDi (%)= relative density, RFi (%)= relative frequency, RCi (%)= relative closure, and IVI (%)= important value index

The relative density of the tree level shows a low density. The biggest assumption is that the low relative density is due to the high level of exploitation of mangroves (logging). The tree density of the research location is classified as a damaged mangrove ecosystem, based on the decree of the Ministry of Environment No. 201 of 2004 concerning Standard Criteria and Guidelines for Determining Mangrove Damage. This condition occurs because of illegal logging that takes place every day. Continuous logging will reduce the productivity of this ecosystem, and have an impact on other parts of the ecosystem such as biota. Bernardino *et al*., (2018) stated that the diversity of infauna groups is affected by the destruction of the mangrove ecosystem, and on a larger scale, it will have an effect on the food web in the estuarine. Mangrove forests are important not only for primary productivity but also for fauna, both of which are important in the food chain (Muro-Torres *et al*., 2020).

However, the low-density level at the tree level was not followed by the sapling and seedling phases. The relative density of the growth rate of saplings and seedlings has a high-density level. This condition indicates that the location can still be improved. The high growth rate of saplings and seedlings can regenerate trees that are classified as damaged. This study is in line with Anugra *et al*. (2014) in the mangrove forest of Malokosa Village, Balinggi, Parigi Mountong that good growth at the sapling and seedling levels can regenerate exploited trees.

The relative density of seedlings of *X. granatum* was higher than that of other species. The high relative density of this species is thought to be caused by the type of substrate at the study site which is compatible with the growth of *X. granatum,* as well as two other species, namely *E. agallocha* and *A. aureum*. The research location has variations in the percentage of substrate based on the report of Darmarini *et al*. (2019) 68% sand, 23% clay, 9% silt). This is supported by the results of research appearance that *X. granatum* is commonly found on muddy sand and sandy mud substrates (Rahman *et al.,* 2014). Both illustrate that the research location has a sort of texture classes so that it is probable for several types of mangroves to be able to spring up well on suitable substrates.

Mangrove Diversity, Evenness, and Dominance Index

The diversity index, evenness, and dominance of the research results are presented in Figure 3. The average value of the diversity index (H') at the research site at the tree level has a range of H' between 0.23-1.35, sapling 1.23-1.33, and seedling 1.05-1.48. The diversity index of the research site at the tree level was lower than the sapling and seedling growth rate. The average value of the uniformity index (E) at the study site was the growth rate of trees (0.33-0.84, saplings (0.83-0.90), and seedlings 0.78-0.92). The dominance index (C) at tree level (0.89-0.29), sapling (0.31-0.33), and seedling 0.25-0.40). The highest dominance index is found in the tree growth rate. The diversity index of research sites is lower when compared to previous studies with a value of 2.56 (Mawardi and Elisa, 2017), allegedly due to two things, namely the fewer number of species and differences in sampling locations even though they are still in one area.

The coastal diversity index of Lubuk Damar when compared to mangrove areas in other Aceh provinces, has a lower H' than the East Coast of Aceh (Suryawan, 2007) and Gampong Jawa Banda Aceh (Mandosir *et al*., 2017). The overall average value of E' at the level of tree growth to seedlings is 0.79. The value of the research location is higher than the mangrove area in several areas, namely; P. Sebatik East Kalimantan (Ardiansyah *et al*., 2012); Barangai Imelda, Philippines (Canizares and Serenay, 2016); Bulaksetra, Pangandaran, West Java (Kusmana and Chaniago, 2017). Overall, the value of C at the study site does not describe the dominance of a particular species, except for the tree growth rate which shows a high tendency compared to the other two growth rates, namely saplings and seedlings. The range of the dominance index of the seedling growth rate when compared with the research of Renta *et al*. (2016), the dominance index of the research location has a lower value.

The diversity index at all growth levels at the study site was low, especially at the tree level. This is presumably due to high levels of illegal logging activities. This is supported by the opinion of Ulfa *et al*., (2016) that one of the causes of the degradation of mangrove areas is due to excessive mangrove logging. The damaged condition of the mangrove ecosystem at the research site is not only described by the diversity index, but also by the uniformity and dominance index at the tree level. Both describe the distribution and dominance of trees growing at the observation site. At the tree growth rate, the uniformity index is very low which describes the tree species found to be not evenly distributed by species, while the dominance index is in certain species. The dominance index shows a high value inversely proportional to the uniformity index, this indicates the dominance of certain species at the tree level in the research location.

Important Value Index (IVI)

The significance value index (IVI) at the tree, sapling, and seedling levels at the study site is presented in Table 1. The tree-level significance index for each species found on the Lubuk Damar coast is in the range of 4.75-117.91, with a total INP value of 300. The lowest tree growth rate significance index was found in *A. alba* and the highest was *A. floridum*. The IVI value of the highest sapling growth rate was *B. sexangula* and the lowest was *B. parviflora*. At the growth rate of seedlings, the highest to lowest INP values were *X. granatum*, *E. agallocha*, and *A. aureum*, respectively. The types of mangrove vegetation that had high values at each growth stage were *A. floridum* (trees), *B. sexangula* (saplings), and *X. granatum* (seedlings). Different research locations have different types of vegetation with the highest IVI values. Based on the above analysis, it can be discussed that the importance of each mangrove area is different based on the unique conditions of each ecosystem. According to Bengen (2002), a high INP for certain species indicates a representative role in the ecosystem.

The condition of the mangrove ecosystem results represent of the study show that there is a need for recovery. Recovery can be done by replanting mangrove areas to be the right choice as an effort to sustain the ecosystem, taking into account the type of vegetation planted. Low tree density can have a lasting impact. This continuing effect is caused by decreased ecosystem productivity and affects the biota that uses mangroves directly or indirectly. Decreased productivity has a major impact on biota and associated waters because according to Lewis and Gilmore (2007), decreased tree productivity changes energy sources at other trophic levels and the surrounding aquatic environment.

CONCLUSION

The mangrove ecosystem in Lubuk Damar based on density at tree growth rate is classified as damaged with a low diversity index. However, it has a fairly good density at the growth rate of saplings and seedlings so the ecosystem is expected to be able to regenerate naturally.

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