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Composition and structure of mangrove community on sapling and seedling levels in Coastal of Dolulolong, Lembata, Indonesia

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Abstract

The study about condition of the composition and structure of the mangrove community is important to planning its sustainable management. The study was conducted to know condition of the composition and structure of the mangrove community at sapling and seedling level in the coastal of Dolulolong, Lembata, Indonesia was conducted. This study was used the line transect method, and the data obtained were analyzed using descriptive analysis. The results obtained in this study found mangrove species in Dolulolong consisted of five species of mangroves namely Rhizophora mucronata, Rhizophora stylosa, Brugiera gymnorhitza, Ceriops tagal and Osbornia octodanta. Furthermore, the condition of mangrove community, both sapling and seedling level as seen from the value of species density (Di): 87-137 ind/ha and 311-511 ind/ha, relative density of species (RDi): 28-87% and 31-91%, relative frequency of species (RFi): 14.29-26.53% and 19.44-36.11%, closure of species (Ci) 2-41 m^2/ha and 5-24 m^2/ha, relative closure of species (RCi): 26-81% and 52-83%, importance value index (IVI): 121-277 and 62-121. Condition of the composition and structure of the mangrove community in Dolulolong depends on low categories related to conditions of habitat, composition and structure of the mangrove community in this region that provide solutions or changes in conditions.

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Introduction

Dolulolong is one of a coastal village in Lembata, East Nusa Tenggara, and Indonesia. This region has the potential of marine resources which have provided many benefits to the coastal community. In the coastal waters of Dolulolong there is a fairly extensive mangrove ecosystem.

The characteristics of the Dolulolong coastal generally have a sloping beach conditions with a substrate of water in the form of mud. The waters around the study area are quite protected from waves and waves, where they are located in estuary areas so that the mass exchange of water due to tidal activity runs slowly, which then contributes to the slow movement of currents and waves in these waters as mangrove habitat. In some mangrove habitat areas is used by fishermen to anchor fishing boats and domestic activities.

The coastal community in Dolulolong is using mangroves as firewood, building material, and material for making fishing trap. They are also using the mangrove area for docking boats. This situation is evident from the results of preliminary observations that found traces of mangrove logging in the middle of the mangrove forest in Dolulong. Besides that, there was also an empty area which was used as a docking boat, where previously the area was overgrown with mangroves.

Ecological criticism on coastal ecosystems, especially mangrove ecosystems are increasing along with the increasing of coastal community and the increasing of development activities in the coastal region (Sambu, 2014). The impact of mangrove forest clearing is causing changes in mangrove composition, where will decrease the function mangrove ecosystems for feeding, spawning and nursery grounds for many kinds of fish, shellfish, crabs and shrimp.

Therefore, it is necessary to make a conservation effort so that the existing mangrove ecosystems are still preserved. Efforts to conserve mangrove forests are currently not evenly distributed throughout Indonesia, including in Dolulong. This condition is caused by the lack of data series about the condition of the mangrove ecosystem, so it is necessary to conduct a study of the condition of Mangrove at the sapling and seedling levels in the Dolulolong, which is important to planning the sustainable management strategies.

Material and methods

This research has been carried out for 1 month from April to May 2019 which is located on the coast in Dolulolong Village, Omesuri District, Lembata Regency, East Nusa Tenggara, and Indonesia. Equipment and materials used in this study are GPS, meter rollers, raffia ropes, and digital cameras and transect quadrants.

This research is quantitative with line transect method. Line transect method is used with placement perpendicular to the coastline toward the sea. The number of transects placed on the study site is five transects with a distance between transects considering the extent of mangrove habitat. The position of transect I: S = 8° 12'54.18 "and E = 123° 43'26.16", transect II: S = 8° 12'51.51 "and E = 123° 43'26.32", transect III: S = 8° 12'54.20 "and E = 123° 43'22.82", transect IV: S = 8° 12'51.75 "and E = 123° 43'22.50" and transect V: S = 8° 12'48.94 "E = 123° 43'22.75". The mangrove community is identified and counted the number of individuals of each species and measured the stem circumference. Then the level of community measured is determined based on the diameter measured by the provisions of the diameter pattern (diameter piles <10 cm with the height 1.5 m to <10 m, and seedlings with a height of less than 1.5 m).

Data collected from observations are then calculated the value of species density, relative density, frequency of species, relative frequency, species closure, relative closure, and important value index to determine the condition of the mangrove community. Whereas the value of the community structure can be chosen from the calculation of the diversity index value of Shannon-Wiener as follows:

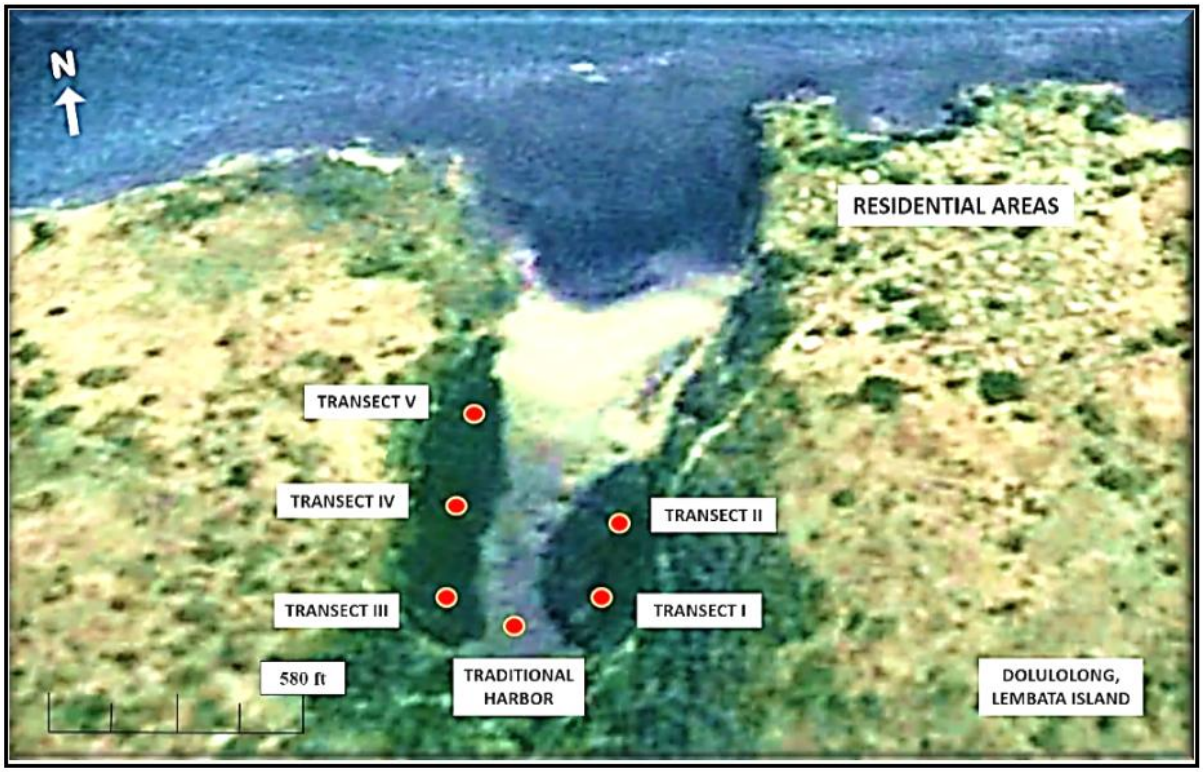

Fig. 1. Map of Mangrove Ecosystem in Dolulolong (Source: Google Map).

Density of Species (Di)

The values of the mangrove species density can be calculated using the formula:

$$\mathbf{Di} = \frac{\mathbf{ni}}{\mathbf{A}}$$

where:

Di = Density of i^{th} species.

ni = Total number of stands of i^{th} species.

A = Total area of sampling area (total area of sample plot).

Relative Density (RDi)

The relative density value of mangrove species can be calculated using the formula:

$$\mathbf{RDi} = \frac{\mathbf{ni}}{\sum \mathbf{n}} \mathbf{x\ 100\ \%}$$

where:

RDi = Relative density of i^{th} species.

ni = Total number of stands of i^{th} species.

∑n = Total number of stands of all species.

Frequency of Species (Fi)

The values of mangrove species frequency can be calculated using the formula:

$$\mathbf{Fi} = \frac{\mathbf{pi}}{\sum \mathbf{p}}$$

where:

Fi = Frequency of i^{th} species.

pi = Number of sample plots/plots where i^{th} species is found.

∑p = Total number of sample plots/plots of all species.

Relative Frequency of Species (FRi)

The values of mangrove species relative frequency can be calculated using the formula:

$$\mathbf{RFi} = \frac{\mathbf{Fi}}{\sum \mathbf{F}} \mathbf{x\ 100\ \%}$$

where:

RFi = Real-frequency frequency of i^{th} species.

Fi = Frequency of i^{th} species.

∑F = Total number of frequencies of all species.

Closure of Species (Ci)

The values of mangrove species closure were calculated using the formula:

$$Ci = \frac{\sum BA}{A}$$

where:

Ci = Closure of i^{th} species.

BA = Basal area [π DBH^2/4 (in cm^2)]

DBH = Number of tree trunks of the i^{th} species[CBH π (in cm)]

A = Total area of sampling area (total area of sample plots / plots)

CBH = Circumference of trees as high as 1.3 m

π = The constanta (3.1416)

Relative Closure of Species (RCi)

The value of mangrove species relative closure were calculated using the formula:

$$RCi = \frac{Ci}{\sum C} x\ 100\ \%$$

where:

RCi = Relative closureof i^{th} species.

Ci = The area of the i^{th} species closure area

$\sum C$ = Total closure area of all species.

Importance Value Index (IVI)

The importance value index of mangrove species can be calculated using the formula:

$$IVI_{Sapling} = RD_i + RF_i + RC_i$$

$$IVI_{Seedling} = RD_i + RF_i$$

The importance value index of mangrove species at the sapling level ranges from 0-300 and seedlings level 0-200.

This Important Value provides an overview of the influence or role of a mangrove plant species in the mangrove community.

Diversity Index (H´)

The mangrove diversity index values can be calculated using the formula:

$$H' = -\sum_{1=1}^{s} Pi\ lnPi$$

where:

H´ = Diversity index

Pi = ni / N

ni = Number of i^{th} species.

N = Total number of all species.

In addition to the formula above, a diversity index assessment system can be carried out by referring to the table below:

Results and discussion

Mangrove community conditions

The condition of mangrove community is seen from the value of species density (Di), relative density of species (RDi), frequency of species (Fi) and relative frequency of species (RFi), closure of species (Ci), relative dominance of species (RCi) and important value index (INP) from the level of saplings and seedlings at the coastal of Dolulolong are in a very low category which indicates that the habitat conditions, community conditions and structure of the mangrove community in this region have experienced certain stresses or disturbances. The condition of mangrove community from the level of sapling in the coastal of Dolulolong, can be detailed through the Table 2.

The condition of mangrove community at the sapling level is seen from the value of species density (Di), relative density of species (RDi), frequency (Fi) and relative frequency of species (RFi), closure of species (Ci) and relative closure of species (RCi) and important value index (The highest INP) based on the detailed table above is found in the *Rhizophora mucronata*, followed by *Rhizophora stylosa*, *Bruguieragym norhitza*, *Ceriops tagal* and *Osbornia octodanta* sequentially (Table 2).

The condition of seedling mangrove community can be seen from the value of species density (Di), relative density of species (RDi), frequency (Fi) and relative frequency of species (RFi), closure of species (Ci) and

relative closure of species (RCi) and the importance value index (IVI) is found in the *Rhizophora mucronata*, followed by the *Rhizophora stylosa*, then the *Bruguiera gymnorhitza*, then followed by the *Ceriop stagal* and the lowest is in the *Osbornia octodanta* (Table 3).

Table 1. Rating of the Shannon-Winner Diversity Index.

	Very Low	Low	Moderate	High	Very High
	1	2	3	4	5
Diversity Index (H´)	≤ 1,75	1,76-2,25	2,26-2,75	2,76-3,25	≥ 3,26

The value of mangrove community conditions showed that the sapling level and seedling level show that the *Rhizophora mucronata* has the highest value of community condition compared to other mangrove species (*Rhizophora stylosa*, *Bruguiera gymnorhitza*, *Ceriop stagal* and *Osbornia octodanta*). The condition of the community seen from the value of species density (Di), relative density of species (RDi), relative frequency of species (RFi), closure of species (Ci) and relative closure of species (RCi) and the importance value index (IVI) can describe the level of dominance of a mangrove species in its habit (Talib, 2008), and also describe the level of adjustment of a mangrove species to the habitat it grows (Bengen, 2002).

Table 2. Condition of mangrove community at the sapling level**.**

Variables	Mangrove species				
	Rhizophoramucronata (Rm)	*Rhizophora stylosa (Rs)*	*Bruguieragymnorhitza (Bg)*	*Ceriops tagal (Ct)*	*Osbornia Octodanta (Oo)*
Di (ind/ha)	10.98	8.82	5.67	2.79	1.98
RDI (%)	36.31	29.17	18.75	9.23	6.55
Fi	0.27	0.23	0.20	0.15	0.14
RFI (%)	26.53	20.41	20.41	15.31	14.29
Ci (m^2/ha)	6.77	2.09	1.06	0.27	0.14
RCI (%)	63.95	11.12	10.07	2.52	0.27
INP	126.79	71.84	49.28	25.90	23.35

Therefore, the community conditions of *Rhizophora mucronata* are relatively low if compared with the value of mangrove community in other places in Indonesia, the mangrove community condition. Where based on the results of research conducted by Baitanu (2015) in Eastern Amarasi District, Kupang Regency, precisely in the Menifo Nature Tourism Park, whose condition has not been disturbed or is still natural to find that the species density value of sapling level is 87-137 ind/ha, the relative density of species: 28-87%, relative frequency of species: 14.29-26.53% closure of species: 2-41 m^2/ha, relative closure of species: 26-81% and importance value index: 121-277. While from seedling level the value of species density: 311-511 ind/ha, relative density of species: 31-91%, relative frequency of species: 19.44-36.11%, closure of species: 5-24 m^2/ha, relative closure of species: 52-83% and importance value index: 62-121. Furthermore, the condition of this mangrove community when viewed based on the value of the Important Value Index of *Rizophora mucronata* mangroves on the coast of Dolulolong Village, Lembata Regency is also lower than reported by several researchers such as Parmadi *et al* (2016) who reported that the Important Value Index of the *Rizophora mucronata* mangrove species in the Kuala Idi Region, East Aceh Regency, for the sapling level of 123.26-165.89 and for the seedling level of 77.37-123.33, then Usman *et al.* (2013) also reported that Important Value Index of *Rizophora mucronata* on Dudepo Island District Anggrek, Gorontalo Utara Regency, for sapling level: 100-200 and seedling

level: 54.65-133.12.

The condition of an organism community in coastal is depends on their habitat condition (Santoso *et al.*, 2015b; Santoso *et al.*, 2015a; Al Ayubi *et al.*, 2019). Thus, the condition of mangrove community in a habitat has a close relationship with the quality of the environment as a place of life. Because if the condition of the habitat occupied by the mangrove is in a good or stable condition, the growth and life of the mangrove will increase to reach its maximum carrying capacity. Vice versa if the condition of the habitat occupied by mangroves has been disrupted, then the survival and growth of individual mangroves will be disrupted, which has an effect on the low or poor condition of community and impacts on the sustainability of coastal resources (Awn *et al.*, 2016; Utina *et al.*, 2019).

Table 3. Condition of seedling mangrove community.

Variables	Mangrove species				
	Rhizophora mucronata (Rm)	*Rhizophora Stylosa (Rs)*	*Bruguiera gymnorhitza (Bg)*	*Ceriops tagal (Ct)*	*Osbornia octodanta (Oo)*
Di (Ind/ha)	33.48	29.16	15.12	12.24	9.72
RDI (%)	50.54	44.02	22.83	18.48	14.67
Fi	0.27	0.23	0.20	0.15	0.14
RFI (%)	36.11	31.94	27.78	20.83	19.44
INP	86.65	75.97	50.60	39.31	34.12

Coastal is an area that is very vulnerable to various disturbances which for example is in the form of direct disposal of waste into the coastal area and also oil spills originating from anchored fishing boats in coastal areas and then will affect the composition of nutrients or nutrients that are made by plants in the coastal areas in carrying outgrowth and propagation (Awn *et al.,* 2016; Amtiran *et al.*, 2017). Conditions can also be seen in the coastal area of Dolulolong Village where there are domestic activities around the mangrove ecosystem, and also there are some areas in the mangrove ecosystem that appear to be used as fishing boat landing areas. All activities are affecting the structure of the substrate and henceforth it will effect on mangrove community especially at the level of saplings and seedlings on the coast of Dolulolong.

Condition of mangrove community

Estimation of the condition of the mangrove community structure on the coast of Dolulolong Village, Lembata Regency can be seen based on the results of the analysis of the diversity index value by referring to the Shanon-Winner Diversity. The diversity index values of the mangrove species on sapling and seedling level are presented in Table 4.

The details of the table above explain the value of the mangrove diversity index of the level of the sapling to 1.77 and the seedling level to 2.02. The diversity index values of the levels, saplings and seedlings as described above are low category. Related to the index value of mangrove diversity from the level of saplings and seedlings found in the coastal of Dolulolong, it can be seen that the pattern of distribution and domination of mangroves in the area is not balanced or the community is not uniform. This can be proven through the findings that show that the mangrove community of the *Rhizophora mucronata* species dominate the area more in this case the coastal area of Dolulolong Village, Lembata Regency.

The pattern of distribution and domination of mangrove community in a habitat is very closely related to the condition of the habitat or place of the life of a biota or plant that occupies it (Lignon *et al.*, 2011). If the habitat condition is in natural condition then the pattern of distribution and domination of a biota or a plant is in a stable or balanced state. However, if the pattern of spread of a biota or plant in a habitat is unstable or unbalanced, it will have an effect on the disruption of the community structure of the biota or plant (Kusuma and Suhendra, 2006; Sambu, 2014).

Table 4. Value of Mangrove Diversity Index.

Species of mangrove	Diversity Index (H´)	
	Sapling	Seedling
Rhizophora mucronata	0.825	0.983
Rhizophora stylosa	0.545	0.172
Bruguiera gymnorhitza	0.089	0.122
Ceriops tagal	0.258	0.745
Osbornia octodanta	0.055	0.239
∑	1.773	2.023

The unstable pattern of distribution and domination of mangroves or the unstable structure of mangrove community in the coast of Dolulolong is due to habitat conditions in this region. However, the disturbances or pressures give the effect to the low changing conditions of mangrove community, who exist in this region as a result of various activities from the mainland. The various activities such as the disposal of detergent waste from the laundry into the mangrove habitat, destruction of the mangrove forest such as mangrove cutting for wood burning, and opening of the area to anchor fishing boats. All of activities causes the low quality of the environment as a mangrove habitat in this region.

Conclusion

Based on the description of the results and the discussion above, it can be concluded that: 1) Species of mangroves found in the coast of Dolulolong consist of 5 species of mangroves namely *Rhizophora mucronata*, *Rhizophora stylosa*, *Brugiera* gymnorhitza, *Ceriops tagal* and *Osbornia octodanta*; 2) Condition of mangrove community both sapling and seedling level as seen from the value of species density (Di), relative density of species (RDi), frequency of species (Fi) and relative frequency of species (RFi), closure of species (Ci) and relative closure of species (RCi) and the importance value index (IVI) and the condition of the structure of the mangrove community as seen from the value of the diversity index on the coast of Dolulolong are in a very low category which indicates that the habitat conditions, community conditions and structure of the mangrove community in this region have experienced certain stresses or disturbances.

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