Journal of Coastal and Ocean Sciences
Volume 4 No. 2, May 2023: 60-65

e-issn: 2746-4512
p-issn: 2745-4355

Short Communication: Structure Community of Mangrove in Peunaga Rayeuk Area, Meurebo District, Aceh West

Eka Lisdayanti[1]*, Neneng Marlian[1], Malfajri Hutabarat[1], Levi Riyanti[1]
[1]Aquatic Resources Study Program, Faculty of Fisheries and Marine Sciences, Teuku Umar University
Jl. Alue Peunyareng, Ujong Tanoh Darat, Meureubo, Aceh Barat, Aceh 23681
Corresponding Author: ekalisdayanti@utu.ac.id

Received: 15 April 2023; Accepted: 30 May 2023

ABSTRACT

This study aims to determine the structure of the mangrove community on the coast of Peunaga Rayeuk, Meurebo District, and West Aceh District. The method used in this study was line transect, making transects/plots for each observation station with a size of 10x10 m^2 with 3 replications so that each observation station has an area of 30x10 m^2. This research was conducted in October 2022. There were 2 types of mangroves included in the observation station, namely *Rhizophora apiculata* and *Avicennia alba*, while the associated mangrove was of the type *Acrostichum speciosum*. In addition, there are also associated mangroves that are not included in the observation station but are located around the observation station, namely *Nypa fruticans*, *Hibiscus tiliaceus*, and *Pandanus odoratissima*. Stations 1 and 2 were dominated by sandy and muddy sand substrates, which respectively showed a diversity index of 0.054 and 0.149, a uniformity index of 0.078 and 0.215, and a dominance of 0.478 and 0.252. The most abundant species was *R.apiculata* with a relative density of 0.949 ind/ha, followed by *S.alba* of 0.051. Relative cover of *R.apiculata* and *S.alba* respectively with the range of 0.302 and 0.698. The results of this study concluded that over all the structure of the mangrove community on the coast of Peunaga Rayeuk is still classified as low, so it requires greater attention in the restoration and management of mangrove ecosystems.

Keywords: Community structure, Mangroves, Meurebo

1. INTRODUCTION

Mangroves are a group consisting mostly of tropical trees and shrubs that grow in the intertidal zone which is still influenced by tides and seasons. Mangroves are dominant and unique coastal vegetation that can adapt to tidal conditions of seas and estuaries, having a dense structure with a canopy covering the shores and estuaries of equatorial, tropical, and subtropical regions around the world. The role of mangroves in providing many ecosystem services including biodiversity and fisheries support, coastal protection, carbon sequestration, and nutrient provision makes communities dependent on the wealth of aquatic resources supported by mangrove habitats (Sippo et al., 2018). Mangroves provide natural coastal protection and break or reduce wave energy to dispel abrasion. Mangroves can be a natural sediment trap, which is a place rich in organic materials, so it becomes a breeding ground for fish and marine life because it has fertile waters. The results of the study (Kon et al., 2010) show that the physical structure of mangrove vegetation facilitates intertidal epifauna habitat, canopy cover has an important function in providing wet surface substrates and can be a food source.

Peunaga Rayeuk is one of the gampong located in Meurebo District, West Aceh Regency. The coastal area of Peunaga Rayeuk is one of the coastlines that suffered heavy damage due to the impact of tsunami waves in 2004 which impacted the ecosystem in the region. Coastal ecosystems that experience heavy damage are mangrove ecosystems which can also reduce ecosystem functions and the value of ecosystem services (Lewis et al., 2016). Mangrove mortality is thought to occur due to sea level rise; low sediment accretion is influenced by river flow (Gilman et al., 2008), sediment supply is essential to allow vertical accretion, thus allowing mangroves to offset sea level rise. The loss of mangrove areas caused by the tsunami event will change the hydrological system in mangrove forests by increasing the water salinity significantly.

Thus, causing larger species such as *Brugueira gymnorhiza* to face death due to changes in salinity. On the other hand, *R.stylosa* and *Sonneratia alba* have had better adaptation and dominance lately (Dharmawan, 2021). Identification of mangrove species post-tsunami is needed as information about colonization strength and species composition of mangroves in newly formed tidal habitats after subsidence and is very important for understanding the pattern of initial species composition after large-scale natural disturbances (Nehru & Balasubramanian, 2018).

The availability of information on mangrove diversity in Peunaga Rayeuk is rarely discussed and reported in the literature. This study was conducted to analyze the community structure of mangrove ecosystems in Peunaga Rayeuk so that it can assist in mangrove ecosystem management or replanting activities in these areas if needed.

2. RESEARCH METHODS

Methods

Data collection was carried out at 2 research stations, mangrove sampling using the transect quadrant method (Bengen, 2004). Transect withdrawal is carried out perpendicularly from sea to land along 50 m and a box plot is formed on every 3 repetitions measuring 10x10m^2. In each plot, measurements of the diameter of mangrove tree trunks were carried out using a cloth meter, data recording was adjusted to the category of mangrove growth, namely the tree category (trunk diameter >4cm or trunk circumference ≥ 16 cm) (Ashton & Macintosh, 2002). Measurements were made on all trees in each plot. Type identification is carried out based on references (Giesen et al., 2006). The data collected for the analysis of mangrove community structure are species composition, species distribution, and general environmental conditions of mangrove ecosystems (Dharmawan & Pramudji, 2017). The mangrove sampling results are then recorded on paper.

Data Analysis

The assessment of the mangrove community structure is carried out by calculating the value of the Important Value Index (INP) of each type of mangrove that has been identified. The important value index (INP) is the result of the sum of the relative density value of the type (RDi), the relative frequency value of the type (RFi), and the relative closing value of the type (RCi)

Type Density (Di)

Type density (Di) is the number of stands of the I type in a unit area. The determination of the density of the type can be calculated using the equation:

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

Relative Type Density (RDi)

Relative density (RDi) is the ratio between the number of i-type stands and the total number of stands of all types. Determination of relative density (RDi) using the equation:

$$RDi = \frac{ni}{\sum n} \times 100$$

Information:

RDi = Relative density

Nor = Number of types

$\sum n$ = Total number of stands of the entire type

Frequency Type (Fi)

The frequency of type (Fi) is the probability of finding type I in the observed plot, with the following equation:

$$Fi = \frac{Pi}{\sum P}$$

Information:

Be = Frequency of the i-th type

Pi = Number of tiles where the i-th type is found

$\sum n$ = Total number of sample tiles created

Relative Frequency Type (RFi)

Relative Frequency (RFi) is the ratio between the frequency of type I (Fi) and the number of frequencies for all types ($\sum F$)

$$RFi = \frac{Fi}{\sum F} \times 100$$

Information:

RFi = Type relative frequency

Be = Frequency type i

$\sum n$ = Number of frequencies for all types

Type Closure (Ci)

Type closure (Ci) is the area of type I cover within a unit area:

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

Information:
There = Type closure
$\sum BA$ = Trunk diameter at chest level
A = Total area sampling (m^2)

Relative Closure (Ci)

Relative Closure (RCi), which is the ratio between i-type closures and the total area of closures for all types, can be calculated using the equation:

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

Information:
RCi = Relative closure
There = Closure of the i-th type
C = Total closure for all types

Important Value Index (INP)

The Important Value Index (INP) is the sum of the relative values (RDi), relative frequency (RFi), and relative closure (RCi) of mangroves can be calculated using the equation:

$$INP= RDi + RFi + RCi$$

Information:
RDi = Relative density
RFi = Relative type frequency
RCi = Relative type closure

The role of a type of mangrove in the ecosystem can be illustrated from the results of the analysis of the important value index of a research area.

Mangrove Community Structure
Species diversity

The mangrove diversity index is calculated based on *the Shannon-Wiener* assessment index. This assessment is used to measure community abundance based on the number of specific types and the number of individuals of each species at a site. The greater the number of species, the more diverse the community (Shannon & Weaver, 1949). The equation used is as follows:

$$H' = -\sum(pi) \text{ (In pi)}$$

Description:
H' = Diversity index
N = Total number of individuals of the whole breed
Nor = Number of individuals of the I breed
pi = ni/N is the ratio between the number of types I and the total number of types of individuals.

Criteria for species diversity index values based on *Shannon-Wiener* (H') are as follows:

$H' \leq 1.0$ = Low level of diversity, high ecological pressure
$1,0 < H' < 3,0$ = Level Moderate diversity, moderate ecological pressure
$H' > 3,0$ = shows high diversity, low ecological pressure

An abundance of almost the same species indicates a community has high species diversity. Conversely, if the community has only a few types and only a few are dominant, then species diversity is categorized as low. (Soegianto, 1994)

Uniformity index

The uniformity of a study site is based on the similarity of the spread of the number of individuals of each type, by comparing the diversity index with its maximum value. The more uniform the distribution of individuals between species, the more the balance of the ecosystem increases. The uniformity index is determined according to the following equation:

$$H' = \frac{H'}{H'max}$$

$$H'max = \ln S$$

Description:
And = Uniformity index
H' = Diversity index
H'max = Maximum diversity index
S = Number of types

The range of uniformity indices is as follows:

$\leq 0 < E \; 0,5$ = Ecosystems are in a state of stress and low uniformity
$0,5 < E \leq 0,75$ = The ecosystem is in a state of less stability and moderate uniformity
$0,75 < E \leq 1,0$ = The ecosystem is in a stable condition and has high uniformity

Dominance Index

Dominance can mean that one or more species have a much larger role in the community and environment. Dominance can take the form of several individuals, body size or closure, productivity, or other activities. The high dominance value of an area indicates low diversity. The dominance index can be calculated according to the formula:

$$C= \frac{1}{N2}\sum_{i-1}^{s} ni2$$

Description:
C = Simpson dominance index
Nor = Number of individuals of the I breed
N = total number of individuals of the whole breed

The range of dominance indices is as follows:

0 < C ≤ 0,5	=	low dominance (no species that extremely dominates other species), stable environmental conditions, and no ecological pressure on biota in the location
0,5 < C ≤ 0,75	=	moderate dominance and fairly stable environmental conditions
0,75 < C ≤ 1,0	=	high dominance (some species dominate other species), unstable environmental conditions, and there is an ecological pressure

3. RESULT AND DISCUSSION

Mangrove vegetation contained in the observation station consists of types *R.apiculata* and *S.alba* and mangrove associations of the species *Acrostichum speciosum.* While the type *Nypa fruticans*, *Hibiscus tiliaceus*, and *Pandanus odoratissima* did not enter the observation station but was in the vicinity of observation stations 1 and 2. Mangroves contained in the station have the same distribution pattern, namely types *R. apiculata* found along the observation transect while the type *S.alba is* Only found on the outside of the transect close to the beach with sand substrate and tends not to get tidal influences. *R.apiculata* is a plant with a stilt root-type tree. It has fruit with a long round shape with a diameter of 1.3-1.7 cm with brownish green fruit pieces. It has relatively small leaves and tends to have a sharp tip. *S. alba* has thick, bright green leaves. It has a rounded leaf shape, with a leaf length of about 13 cm, a leaf width of 8 cm, and a rounded leaf tip. *S.alba* has white to brown stems. The density of mangrove species obtained in the coastal area of Peunaga Rayeuk is presented in the following table.

The density of mangrove species at the tree growth rate was obtained between 34-44 ind/ha, at the seedling level between 15-19 ind/ha, and the growth rate of saplings was obtained at 86-156 ind/ha. The highest and lowest densities are found at station 2, which are respectively found in the growth rate of saplings and the growth rate of seedlings. The Peunaga Rayeuk mangrove area was buried by sedimentary material from the sea and carried away by the tsunami, causing the area to become shallow because it contained sediment. Observation station 1 has a mud substrate that tends to be sandy, besides that at the time of observation this location tends to be continuously submerged in water. Whereas at station 2 the dominant type of substrate is a sand substrate and tends to be found in many associated mangroves such as *N.fruticans*, *H.tiliaceus*, and *P. odoratissima*.

Table 1. Mangrove density at various growth rates on the Peunaga Rayeuk Coast

Growth rate	Density at location (individual/ha)	
	Station 1	Station 2
Tree	44	34
Semaian (*sapling*)	19	15
Saplings (*seedlings*)	86	156

Analysis of the community structure of mangrove ecosystems of each type at 2 stations is presented in Table 2.

The important value index (INP) shows the role and structure of mangrove vegetation in a location. Based on the INP calculation analysis conducted (Table 3), the highest relative density of *R. apiculata* mangrove species is 0.949 but has a low relative closure compared to *S. alba* species of 0.698, the highest important value index is found in *R.apiculata* mangrove species of 1.917 and the lowest of *S. alba* species of 0.698.

Table 2. Community structure of Peunaga Rayeuk mangrove ecosystem, Meurebo District, West Aceh Regency

Types of Mangroves	Number of stands	Type density (Di) ind/ha	Relative density (RDi)	Frequency type (Fi)	Relative frequency (RFi)	Type closure (Ci)	Relative closure type (RCi)
R. apiculata	74	2466,7	0,94872	1	0,66667	2,01721	0,30194
Station 1	43						
Station 2	31						
S. alba	4	133,33	0,05128	0,5	0,33333	4,66355	0,69806
Station 1	1						
Station 2	3						

Table 3. Important value index (INP) for each type of mangrove

Types of mangroves	Relative density (RDi)	Relative frequency (RFi)	Relative closure (RCi)	Important value index (INP)
R. apiculata	0,94872	0,66667	0,30194	1,91733
S. alba	0,05128	0,33333	0,69806	0,69806

Overall, the results of the analysis of relative density, frequency, cover, and index of important values of types at each location (Tables 2 and 3). The community structure of mangrove ecosystems on the coast of Peunaga Cut, Meurebo District, West Aceh Regency is shown in the following Table 4.

Table 4. Community structure of mangrove ecosystems at each observation station

Station	Diversity (H')	Uniformity (E)	Dominance (C)
1	0,05424	0,07825	0,47796
2	0,14922	0,21528	0,25208

Result Observations show that the community structure of mangrove ecosystems at each observation station has different values. Assess the diversity of stations 1 and 2 based on criteria Shannon-Wiener enter the range of low levels of diversity, with high ecological pressure. Including uniformity and dominance which also shows a value of 0.5 and is still classified as low. This shows that mangroves are under threat from both natural and anthropogenic disturbances, from the data collected there are still logging activities in this location. In addition, mangrove growth in a unique environment that indirectly gets the influence of tides and is dominated by sandy substrate types causes mangrove growth to be inhibited. This is corroborated by research (Giri et al., 2014) results that reveal that the main causes of mangrove area cover loss in some countries include land use conversion, cutting down trees for firewood use, pollution, decreasing freshwater availability, flooding, reducing mud deposition, coastal erosion, and tsunamis. shows that between 1990 and 2010 mangrove cover reduction has occurred worldwide by 3% and the main causes are land conversion for coastal development, rice production, and aquaculture activities (UNEP, 2011).

4. CONCLUSIONS

Based on the results of research conducted on the coast of Peunaga Rayeuk, Meurebo District, West Aceh Regency, 3 types of mangroves *R.apiculata, S.alba,* and *A.speciosum were obtained.* Observations from the two stations were predominantly of *the R. apiculata type*, with an important value index (INP) of 1.917. Overall, the results also show that community structure is still classified as low.

REFERENCES

Ashton, E.C., & Macintosh, D.J. (2002). *Preliminary assessment of the plant diversity and community ecology of the Sematan mangrove forest , Sarawak , Malaysia*. *166*.

Bengen, D.G. (2004). *Ekosistem dan Sumberdaya Alam Pesisir dan Laut serta Prinsip Pengelolaannya*. Bogor : Pusat Kajian Sumberdaya Pesisir dan Laut, Institut Pertanian Bogor

Dharmawan, I.W.E. (2021). Mangrove Health Index Distribution on the Restored Post-Tsunami Mangrove Area in Biak Island, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *860*(1). https://doi.org/10.1088/1755-1315/860/1/012007

Dharmawan, I.W.E., & Pramudji. (2017). Panduan pemantauan komunitas mangrove. In *Critc Coremap Cti Lipi* (Issue 2).

Giesen, W., Wulffraat, S., Zieren, M., & Scholten, L. (2006). *Mangrove Guidebook*.

Gilman, E.L., Ellison, J., Duke, N.C., Field, C. (2008). Threats to Mangroves from Climate Change and Adaptation Options: A review. *Aquatic Botany*, 89(2), 237–250. https://doi.org/10.1016/j.aquabot.2007.12.009

Giri, C., Ochieng, E., Tieszen, L.L., Zhu, Z., Singh, A., Loveland, T., Masek, J., Duke, N. (2011). Status and Distribution of Mangrove Forests of the World using Earth Observation Satellite Data. *Global Ecology and Biogeography*, 20: 154-159

Kon, K., Kurokura, H., Tongnunui. (2010). Effect of the Physical Structure of Mangrove Vegetation on a Benthic Faunal Community. *Journal of Experimental Marine Biology and Ecology*, 282(2): 171-180. https://doi.org/10.1016/j.jembe.2009.11.015

Lewis, R.R., Milbrandt, E.C., Brown, B., Krauss, K.W., Rovai, A.S., Beever, J.W., Flynn, L.L. (2016). Stress in Mangrove Forests: Early Detection and Preemptive Rehabilitation are Essential for Future Successful Worldwide Mangrove Forest Management. *Marine Pollution Bulletin*, *109*(2), 764–771. https://doi.org/10.1016/j.marpolbul.2016.03.006

Nehru, P., & Balasubramanian, P. (2018). Mangrove Species Diversity and Composition in the Successional Habitats of Nicobar Islands, India: A Post-Tsunami and Subsidence Scenario. *Forest Ecology and Management*, 427: 70–77. https://doi.org/10.1016/j.foreco.2018.05.063

Shannon, C.E., & Weaver, W. (1949). *The Mathematical Theory of Communication*.

Sippo, J.Z., Lovelock, C.E., Santos, I.R., Sanders, C.J., Maher, D.T. (2018). Mangrove Mortality in a Changing Climate: An overview. *Estuarine, Coastal and Shelf Science*, 215:241–249. https://doi.org/10.1016/j.ecss.2018.10.011

Soegianto, A. (1994). *Ekologi kuantitatif : metode analisis populasi dan komunitas.* Surabaya: Usaha Nasional.

UNEP (2011). Keeping Track of Our Changing Environment: From Rio to Rio+20 (1992-2012). Division of Early Warning and Assessment (DEWA), United Nations Environment Programme (UNEP), Nairobi.