Mangrove Species Diversity in South Wara and Bara Sub-districts of Palopo City

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Abstract
Research on mangrove species diversity in Wara Selatan and bara sub-districts of Palopo City was conducted in April-November 2023. This study aims to determine the composition and diversity of mangrove species in Palopo City. The research used the plot method (combination of plots and transects) and the cruising method (exploration) in 2 sub-districts and 3 stations each. Transects were drawn perpendicular to the coastline, starting from the outermost vegetation (near the sea) to the final limit of the littoral area (land). The results of the identification of mangrove species obtained mangrove species composition of 4 species. Mangrove zonation varies greatly depending on the environmental conditions at each station. The front zone (near the sea is overgrown by mangroves Rhizophora sp. While the back zone (near the mainland) is overgrown by minor mangroves and mangrove associations. Analysis of ecological parameters includes density, diversity, uniformity, and dominance of mangrove species. The results of data analysis showed that the value of the species diversity index ranged from 1.00 to 2.05 (moderate species diversity); the species uniformity index ranged from 0.42 to 0.60 (moderate population uniformity); the highest dominance index in the Wara sub-district at station III was 0.82 (there is a dominating species) while in Bara sub-district the dominance index ranged from 0.36 to 0.50 (no dominating species).

Keywords: Mangrove; Mangrove Species; Mangrove Diversity

1. Introduction

Mangroves are essential for life in coastal areas. This vegetation plays a role in protecting the coastal area and maintaining the habitat of associated biota to maintain biodiversity. In addition, mangroves also have economic potential that can be obtained from three main sources: forest products, fisheries, and ecotourism [1].

Mangroves are spread across several countries with an area of about 19.9 million hectares, and Indonesia has the most extensive mangrove forests in the world. In addition, Indonesia has the highest level of mangrove diversity globally, with 202 mangrove species [2]. This high level of biodiversity makes mangrove forests a precious asset not only in terms of their ecological function but also in terms of their economic function [3]. However, Indonesia has currently lost about 40% of its mangrove area. Its strategic location in the coastal region makes mangrove ecosystems the object of various development activities so that mangrove ecosystems continue to experience changes in formation [4].

South Sulawesi is one of the provinces in Indonesia that suffered severe mangrove damage. In 2009, only about 12,820 hectares of mangrove areas remained, including mangrove forests that have been disturbed and converted into community aquaculture areas [5]. Damage to these mangroves will result in a decrease in the function and benefits of the mangrove forest. However, the most worrying thing about mangrove damage is the loss of mangrove species, which causes

a reduction in the diversity of species in the mangrove ecosystem. Data on mangrove species is needed to preserve mangrove species in South Sulawesi.

Palopo is a city in South Sulawesi, part of which is directly adjacent to the sea. The city has nine sub-districts and 48 urban villages. Wara Selatan and Bara are sub-districts in Palopo City with a mangrove ecosystem. However, there has been no data collection on what types of mangroves grow in the area, so the research is interested in identifying the types of mangroves in the sub-districts of South Wara and Bara.

2. Methodology

Location and Time

This research was conducted in the Wara Selatan and Bara sub-districts of Palopo City. The district has a fairly representative mangrove condition because the condition of the mangrove ecosystem is classified as unspoiled. This research was conducted in April-November 2023.

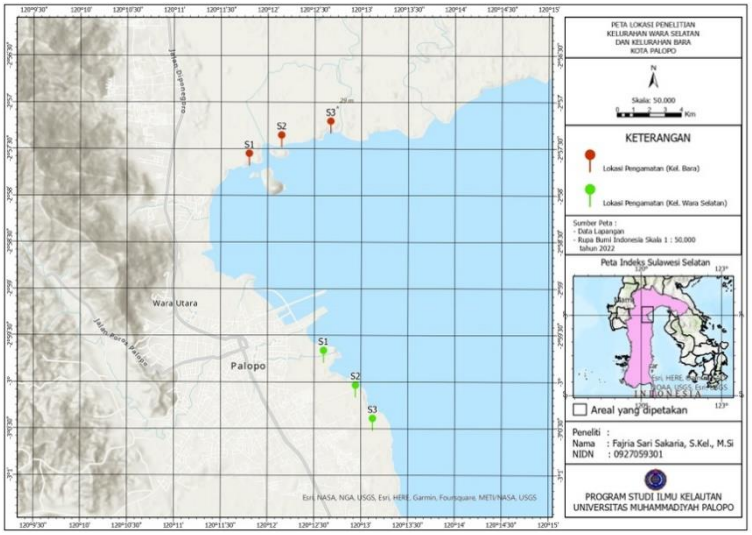

Figure 1 Research Location

Tools and Materials

The tools used were an image map, compass, global positioning system (GPS), roller meter, ruler, nylon rope, stakes, digital camera, thermometer, salinometer, pH meter, and mangrove identification book. The materials used were tally sheets, plastic samples, label paper, and mangrove species samples.

Working Methods

Based on preliminary data on the condition of mangroves, two sampling methods were used, namely the path method and the cruising method.

a. Plotted path method

The plot method combines the transect and plot method [6].

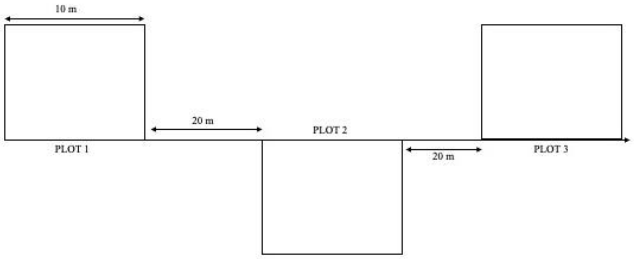

Figure 2 Striped Path Method (Combination of Transect and Plot)

The aim is to see the profile and ecology of mangrove vegetation based on zoning. The line is drawn perpendicular to the coastline, starting from the outermost vegetation (near the sea) to the final limit of the coastal area (land). The transect length was adjusted to the conditions of the research site, with a transect width of 10 m. Furthermore, a stratified plot size of 10x10 m each for trees was made [6]. The data recorded include mangrove species and the number of mangrove stands.

b. Exploration Method

The Explore method examines mangrove species not included in the transect area[6]. This method is intended to collect data on mangrove species from each cruising area so each location has a sample that can be used to compare with other regions. This sample area can be divided based on the needs and objectives of the research itself.

Data Analysis

Species Density

Species density is the number of stands of species i in a unit area (Bengen, 2002) with the formula :

$$Di = ni/A \text{ dan } DR = Di/\text{Total } Di \times 100\ \%$$

Where:

Di	: Density of species i (Individual/m2),
Ni	: Total number of stands of type i,
A	: Total area of sample observation (m2),
DRi	: Relative density of type i (%)and
∑n	: Total number of stands of all types

Diversity Index (H')

The diversity index describes the state of mangroves mathematically to facilitate observing the diversity of populations in a community. This calculation used the Shanon winner diversity index according to Sudarso and Yusril (2015), namely:

$$H' = -\sum_{i=1}^{n} pi \ln pi$$

Where:
H' : Species diversity index
Pi : Number of individuals of each species (1,2,3..n)
Pi =
ni : Number of individuals of each species
N : Total number of individuals
Ln : Natural logarithm
H' Value Criteria
H' > 3 : High diversity
1<H'>3 : Medium diversity
H' < 1 : Low diversity

Index of Uniformity (E)

The uniformity index determines the balance of the community, which is the number of individuals between species in a community. The uniformity index (E), according to Sudarso and Yusril (2015) is as follows:

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

Where:

E : Uniformity index

H' : Diversity Index

Max : Number of species

Criteria for uniformity index:

e > 0,4 : Small population uniformity

0,4 >e>0,6 : Medium population uniformity

E < 0.6 : high population uniformity

Dominance Index (C)

To know the dominance of certain species in a community, Odum's Simpson Dominance Index (1994) uses the following formula:

$$C = \sum_{(\frac{ni}{N})} 2$$

Where:

C : Dominance index

Ni : Number of individuals of each species

N : Total number of individuals

Criteria for Dominance Index:

C is close to 0 (C < 0.5) : No dominant species

C close to 1 (C>0.5) : There is a dominant species

3. Result and Discussion

Mangrove Species Composition

Based on the results of identifying mangrove vegetation in South Wara Subdistrict and Bara, the types of vegetation that make up the mangrove ecosystem at the research site were obtained (Table 1). Mangrove species found are the main constituent composition of mangrove ecosystems such as Bruguiera Sp, Rhizophora Sp, Avicennia Sp, and Sonneratia Sp.

Mangroves found are scattered at each station with a different number of species. The difference is very dependent on environmental factors. Tides that indirectly control the depth of the water table, salinity of water and soil related to species tolerance to salt content, soil type that determines the level of soil aeration high water table and drainage, supply and fresh flow, and light that affects the growth of seedlings of Rhizophora species < Avicennia and Sonneratia [8].

Table 1. Mangrove species composition in Palopo city (Wara Selatan and Bara sub-districts)

	District	Stasiun	Mangrove Type
1	South Wara	I	*Bruguiera* Sp
			Rhizophora Sp
			Avicennia Sp
			Sonneratia Sp
		II	*Rhizophora* Sp
			Avicennia Sp
			Sonneratia Sp
		III	*Rhizophora* Sp

			Avicennia Sp
			Sonneratia Sp
			Bruguiera Sp
		I	*Rhizophora* Sp
			Avicennia Sp
			Bruguiera Sp
2	Bara	II	*Rhizophora* Sp
			Avicennia Sp
			Sonneratia Sp
			Bruguiera Sp
		III	*Rhizophora* Sp
			Avicennia Sp

Density of species

In calculating the density value of mangrove species in the plot of 4 types, namely Bruguiera Sp, Rhizophora Sp, Avicennia Sp, and Sonneratia Sp. Overall, the density of mangrove species at the research site is evenly distributed and dominated by the type of Rhizophora Sp. Rhizophora genera grow well and are dominant at all research stations. This is due to Rhizophora's good form of adaptation to environmental conditions in Palopo City. Arief (2003) states that Rhizophora genera generally grow in soft substrate areas with a wide distribution. Furthermore, Bengen (2002) states that the typical life cycle of Rhizophora with seeds that can germinate while still on the mother plant is very supportive of the wide distribution process of this species in the mangrove ecosystem.

Index of Diversity, Diversity, and Dominance

Table 2. Mangrove Diversity, Uniformity, and Dominance index values at the research station

Location of Research	Indeks	Stasiun		
		I	II	III
Wara Selatan	Diversity	1,14	1,62	2,05
	Uniformy	0,53	0,45	0,42
	Dominance	0,37	0,71	0,82
Bara	Diversity	1,06	1,00	1,68
	Uniformy	0,51	0,57	0,60
	Dominance	0,36	0,46	0,50

Based on Table 2 above, the diversity index value (H') ranges from 1.00-2.05. Based on the criteria of Sudarso and Yusril (2015), the value is included in the moderate category (1<H'<3).

This indicates that the mangrove ecosystem has sufficient productivity, ecosystem conditions are pretty balanced, water conditions are still stable, and there is moderate ecological pressure.
The diversity value of a community is highly dependent on the number of species, and the number of individuals contained in the community will be high if the community is composed of many species and no species dominates. Conversely, if a community has a low species diversity value, if the community is composed of few species and there is a dominant species (Indriyanto, 2006). Furthermore, the uniformity index in the study ranged from 0.4 to 0.60. Based on the criteria of Sudarso and Yusril (2015), the value is classified as moderate. This shows that the species found at each research station tend to have uniformity, meaning that there is no particular species that dominates a station. If the uniformity index is small, then the diversity of species in the community is less, meaning that the number of individuals of each species is not the same, so there is a tendency to be dominated by certain species. Conversely, the greater the value of the uniformity index indicates that in the community there is no dominant species (Santana, 1991).
The Dominance Index value at each research station ranged from 0.37-0.82. The highest dominance index value was found in South Wara Sub-district station III (0.82). Based on the criteria for the dominance index value of Sudarso and Yusril (2015), station III has a dominant species, namely Rhizophora Sp which has a dominance value of 0.82 or has more than half the total number of individuals at station III. Meanwhile in Bara Sub-district, the dominance value ranges from 0.36-0.50. Based on the criteria of Sudarso and Yusril (2015), there are no species that dominate the community. This indicates that species in mangrove communities tend to be uniform and ecological conditions are still stable.

4. Conclusion

Based on the results of research on mangrove species diversity in Palopo City it can be concluded that there are 5 species found. The value of the species diversity index ranges from 1.00 to 2.05 (moderate species diversity); the species uniformity index ranges from 0.42 to 0.60 (moderate population uniformity); the highest dominance index in Wara sub-district at station III is 0.82 (there is a dominating species) while in Bara sub-district the dominance index ranges from 0.36 to 0.50 (no dominating species).

5. Acknowledgement

All praise and thanks are due to the presence of Allah SWT, who gave His grace and guidance so that this research could be completed well. This research aims to determine the composition and diversity of mangrove types in Palopo City. With the completion of this research, it is hoped that it can be an inclusive contribution to the development of knowledge and worship for writers and students, as well as exploring applications in the field of ecological expertise. The author accepts constructive criticism and suggestions for improving this manuscript. Hopefully, this article is useful for students and wider readers, especially those who need it.

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