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Composition and Zonation of Mangrove Vegetation in Ujung Pangkah, Gresik, Indonesia

Arofatul Syabina Mabruroh*, Nirmala Fitria Firdhausi, Saiful Bahri, Yuanita Rachmawati, Misbakhul Munir
UIN Sunan Ampel Surabaya, Indonesia
Corresponding e-mail: syabinamabruroh10@gmail.com
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Abstract *– Ujung Pangkah Gresik is a significant mangrove area with both ecological and economic functions. Ecologically, it prevents seawater intrusion and abrasion, while economically, it supports sectors like tourism, forestry, fisheries, and ecotourism. This research aims to identify mangrove species diversity and zoning patterns in Ujung Pangkah using survey methods to assess diversity, density, dominance, importance value, and zoning. Four species were found (Avicennia marina, Avicennia officinalis, Rhizophora stylosa, Ceriops tagal) with 454 individuals. The diversity value is moderate at 1.86. The highest and lowest densities were 0.52 and 0.01, respectively. Avicennia marina is the dominant species with an importance index of 273.69. The area has a mixed zoning pattern.*
Keywords: *Mangrove Diversity, Density, Dominance, Soning pattern, Ujung Pangkah Gresik*

INTRODUCTION

Mangroves are a terrestrial ecosystem that has certain characteristics such as diverse plant species, nutrient cycles in the ecosystem, and topographic forms. This ecosystem covers 2% of the total surface area of the earth, with Indonesia having the largest mangrove area in the world, around 3.7 million hectares (Rangkuti et al., 2022).

Mangroves have ecological functions such as preventing seawater intrusion and abrasion, as well as economic value in the economic, tourism, forestry, fisheries, and ecotourism sectors (Aurilia & Saputra, 2020; Harefa et al., 2020). This ecosystem is usually located in the coastal area of the estuary coast with a mangrove zone width of no more than 4 kilometers, except in estuaries and shallow and closed bays (Herison et al., 2024). The unique zoning of mangroves is influenced by various factors such as geomorphology and temperature, as well as environmental factors such as substrate, salinity, and water tides (Tefarani et al., 2019; Tihurua et al., 2020).

Mangroves are halophytic, capable of living in salt-rich environments, with special molecular, anatomical, morphological and physiological adaptations. Mangrove plants can be in the form of shrubs, palms, and ferns, divided into true mangroves and association mangroves (Djamaluddin, 2018). Mangrove ecosystems are especially important in coastal areas, where communities depend heavily on their wealth (Prasetyo et al., 2017). Mangroves have an economic function as a recreational area, a source of wood, a biological function as a habitat for marine creatures such as fish, shrimp, and crabs, as well as a physical function as a beach protector, abrasion preventer, and capture substances from the sea (Al Syauqi & Purwani, 2017; Nanlohy & Masniar, 2020).

The exploitation of mangroves for the economy causes damage that can be both natural and unnatural. The extent of natural damage, such as hurricanes, hurricanes, and dry climates, tends to have less impact than human-caused damage. Human damage, such as overuse of timber, pond construction, settlement construction, and industrial use, has a fairly high impact (Ketaren, 2023). These events significantly alter the physical and chemical character of mangrove habitats. As a result, the mangrove ecosystem has experienced a decline in quality and ecological function.

There are other studies being conducted (Paringsih et al., 2018) about the abundance of mangrove crabs and to evaluate the Important Value Index (IVI) in three zones, involve the community in conservation, and develop a strategy based on Planting Care Monitoring. The results show effective conservation in Cengkrong, becoming an example for the community in the conservation of mangrove forests and marine resources in the mangrove forest in Cengkrong.

In addition, research from (Prasetyo et al., 2017) using Landsat satellite imagery from 2006 to 2016 and field verification to identify damage to mangrove land in Ujung Pangkah Village, Gersik Regency, found that the total damage reached 589.03 hectares in the last 10 years. Then in the research (Dwiputra et al., 2020) found a decline in the area and density of mangrove vegetation in Central Java from 1989 to 2004, which was largely caused by human activities that converted mangrove land into ponds.

Ujung Pangkah Gresik, a vast mangrove area, faces an increase in human activities that have an impact on biota and mangrove ecosystems (Madyowati & Kusyairi, 2020). The area is also polluted with industrial waste, including heavy metals and hydrocarbons, which flows into the river (Wong et al., 2016). Excessive pond clearing causes damage to mangrove zoning and can lead to coastal abrasion and residential damage.

This research aims to identify the diversity of mangrove species and determine the zoning pattern in the Ujung Pangkah Gresik area, using parameters such as salinity, water pH, and soil substrate moisture. This research is important as a basis for determining mangrove ecosystem conservation policies.

In addition, it is also to find out the composition of mangrove types, the level of diversity, density, dominance, and the Important Value Index (IVI) of mangroves in the area. The results of the research are expected to provide useful information for academics in the development of mangrove ecological knowledge. This research can also provide guidance for the community and the government in the sustainable management of mangrove ecosystems in Ujung Pangkah Gresik and other regions in Indonesia.

MATERIALS AND METHODS

1. Research Location

This research is descriptive exploratory descriptive research that uses survey methods and direct data collection by indicating biological parameters, Biodiversity Index and Important Value Index and zoning of mangrove species in Ujung Pangkah, Gresik, East Java, Indonesia. The physical and chemical data taken included soil moisture, light intensity, pH, and salinity, with the aim of finding out the pattern of mangrove zoning in Ujung Pangkah District. This field research was carried out from November 2023 to December 2023 in the Banyulegi mangrove area, Banyuurip, Ujung Pangkah District, Gresik Regency, East Java. Data collection was carried out at 08.00-10.00 WIB.

Figure 1. Sampling location, Mangrove Ujung Pangkah, Gresik, East Java, Indonesia

Figure 1 above is the zoning of mangrove species in the location which is marked with a red sign as a sampling place at station 1, station 2 and station 3.

2. Materials

This research used various tools such as length measuring instruments, work maps, cameras, compasses, pH measuring instruments, mangrove identification books (Noor et al., 2006)), stationery, machetes, raffia ropes, GPS, thermometers, refractometers, and related literature (Djamaluddin, 2018; Herison & Romdania, 2020) Materials used include block millimeter paper, tally sheet, and plastic clips. These tools and materials are used for accurate measurement and data recording in the field. This combination ensures that the data obtained is precise and reliable for further analysis.

3. Data Analysis

Community Structure

Analyze the community structure by doing calculations by obtaining an important value index (IVI).

IVI = KR+FR+DR (for pole and tree levels)

IVI = KR+FR (for seedling and stake levels)

Information:

KR = Relative density

FR = Relative frequency

DR = Dominasi relative

Domination (D)

$$\frac{\textit{Area of the base of a species}}{\textit{Sample plot area}}$$

D Relative (DR)

$$\frac{\textit{D from a type of species}}{\textit{D total all type of species}} \times 100\%$$

Type Density (D_i)

$$\frac{\textit{Number total individuals species}}{\textit{Area of observation}}$$

Density Relative (KR)

$$\frac{\textit{Density of a species}}{\textit{Density of all species}} \times 100\%$$

Frequency Type (F)

$$\frac{\textit{Number of plots where a species was found}}{\textit{Number of all plots observations}}$$

Relative Frequency (FR)

$$\frac{\textit{Frequency of a type of species}}{\textit{Frequency all types of species}} \times 100\%$$

Species Diversity

The data on the diversity of association mangrove species is known using the Shannon-Wienner Diversity Index (H').

$$H' = -\sum_{i=1}^{S} (\text{pi})(ln\ pi)$$

Where $(p_i = \frac{n_i}{N})$ H' is the Shannon-Wienner Diversity Index, S is the number of species, ni is the number of individuals in a species, ln is the natural logarithme, and N is the total number of individuals of a given species. This index is used to measure the diversity of species in an ecosystem. This formula integrates the proportion of each species to the total individual. The results provide an overview of the diversity and distribution of species in the ecosystem studied.

Mangrove Zoning Pattern

Analysis of the mangrove zoning pattern which is divided into open area zones, then central area zones, then areas that have brackish water rivers and even lead to freshwater rivers, coupled with land area zones that then have fresh water (Noor et al., 2006).

RESULT AND DISCUSSION

1. Composition of Mangrove Vegetation Types

Based on observations for 2 months in the Banyulegi mangrove, Banyuurip Village, Ujung Pangkah District, Gresik Regency, East Java, this location has sparse vegetation with few mangrove species. There are 454 mangrove individuals scattered in the pile and pole level. At this location, 4 species of mangroves were found. A list of the number of species and individuals can be seen in Table 1.

Table 1. Mangrove species that have been identified during the observation.

Scientific Name	Local Name	Station			Total Number of Poles and Piles
		1	2	3	
Avicennia marina	Api-api	180	17	32	229
Avicennia officinalis	Api-api	25	4	-	29
Rhizophora stylosa	Bakau	-	94	24	118
Ceriops tagal	Bakau tanjang	-	15	63	78
Number of individuals		205	130	119	454

The mangrove species that have been identified in Banyulegi, Banyuurip Village, Ujung Pangkah District, Gresik Regency, East Java, are divided into three observation stations. At station 1, there are 229 individuals *Avicennia marina* and *Avicennia officinalis* of a total of 205 individuals of all species. Station 2 has 4 species of mangroves, namely *Avicennia marina*, *Avicennia officinalis*, *Rhizophora stylosa*, and *Ceriops tagal*, with a total of 130 individuals. At station 3, 119 individuals from three mangrove species were found, namely *Avicennia marina*, *Rhizophora stylosa*, and *Ceriops tagal*. Station 2 has the highest number of species due to the salinity and soil pH that support mangrove growth (Kresnasari & Gitarama, 2021; Yanti et al., 2022).

2. Mangrove diversity

The results of data analysis showed that the diversity of mangroves in Banyulegi, Banyuurip, Ujung Pangkah District, Gresik Regency, East Java, varied at each station. The highest diversity index was found at station 2 with a value of 1.86, while the lowest was at station 1 with a value of 0.09.

Table 2. Mangrove species that have been identified during the observation.

Station	Diversity Index (H')	Level
1	0,09	Low
2	1,86	Medium
3	1,45	Medium

Based on Table 2 above, it shows that the criteria for the diversity of Shannon-Wienner species, the diversity of mangroves in Banyulegi, Banyuurip, Ujung Pangkah District, Gresik Regency, East Java is classified as low to medium (Odum, 1993). Station 1 has an H' value of 0.09, indicating low diversity. Station 2 with an H' value of 1.86 is classified as medium diversity, better than station 1. Station 3 has an H' value of 1.45, also classified as medium diversity. Of the three stations, station 1 has the lowest diversity value, while stations 2 and 3 are classified as moderate.

In addition, through Table 2 above, in Banyulegi, Banyuurip, Ujung Pangkah District, Gresik Regency, it shows that the diversity of mangroves is diverse. Station 1 has a salinity of 10‰, a pH of 7.5, and dry soil. Station 2 has a salinity of 0‰, pH 7, moist soil. Station 3 has a salinity of 5‰, pH 7, moist soil. Diversity is highest at station 2, lowest at station 1.

Based on the results of the pole level density analysis in Table 3, *Avicennia marina* memiliki nilai kerapatan tertinggi di stasiun 1 dengan 0,34 dan kerapatan relatif 91,07%. Di stasiun 2, *Rhizophora stylosa* It has the highest density value of 0.18 and a relative density of 63.28%. Station 3 shows *Ceriops tagal* with a density value of 0.19 and a relative density of 52.25%. The total type density at all stations is 1.8 with a relative density of 300.13%. The density of mangrove species in Banyulegi is uneven, with the density value at each station less than 1.

Table 3 shows the stake level density, with *Avicennia marina* Station 1 has the highest density of 1.04 and a relative density of 83.87%. *Rhizophora stylosa* dominates station 2 with a density of 0.52 and a relative density of 90.69%. Station 3 is also dominated by *Rhizophora stylosa* with a density of 0.17 and a relative density of 54.16%. The highest relative density in the Banyulegi region is dominated by *Avicennia marina*, shows good natural growth and density varies due to environmental factors and human activities.

Furthermore, based on the results of the dominance analysis in Table 3, *Avicennia marina* dominates station 1 with a value of D=205.78 and a relative dominance of 91.56%. In station 2, *Rhizophora stylosa* dominated with a value of D=57.56 and a relative dominance of 51.9%, while in station 3, *Ceriops tagal* dominated with a value of D=62.76 and a relative dominance of 46.69%. *Avicennia marina* is the most dominant in the Banyulegi region, Banyuurip, due to the supportive environmental conditions of station 1, such as high salinity and good pH. This shows that *Avicennia marina* is able to adapt and survive in extreme environmental conditions.

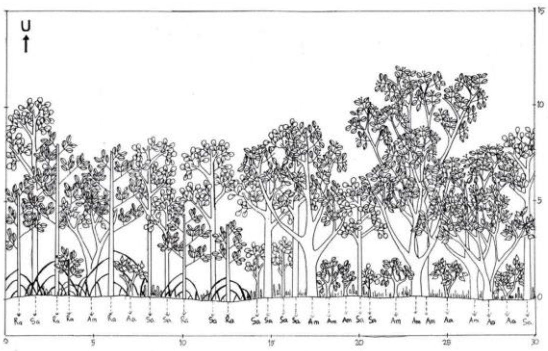
Table 3. Results of Density (K), Dominance (D), and Important Value Index (IVI).

Station	Spesies	Pole Density		Pile Density		D	DR	IVI
		K	KR	K	KR			
1	*Avicennia marina*	0,34	91,07	1,04	83,87	205,78	91,56	273,69
1	*Avicennia officinalis*	0,03	8,98	0,2	16,12	19	8,45	26,31
2	*Avicennia marina*	0,04	16,09	0,04	6,97	29,64	26,78	58,91
2	*Avicennia officinalis*	0,01	3,48	0,01	2,35	6,06	5,47	12,36
2	*Ceriops tagal*	0,05	17,24	0,52	90,69	17,62	15,89	50,37
2	*Rhizophora stylosa*	0,18	63,28	0,08	25	57,56	51,9	178,36
3	*Avicennia marina*	0,08	23,42	0,06	20,83	41,67	31,01	77,87
3	*Ceriops tagal*	0,19	52,25	0,17	54,16	62,76	46,69	151,2
3	*Rhizophora stylosa*	0,9	24,32	2,12	299,99	29,96	22,29	70,98
	Total	**1,8**	**300,13**	**1,04**	**83,87**	**470,05**	**300,04**	**900,05**

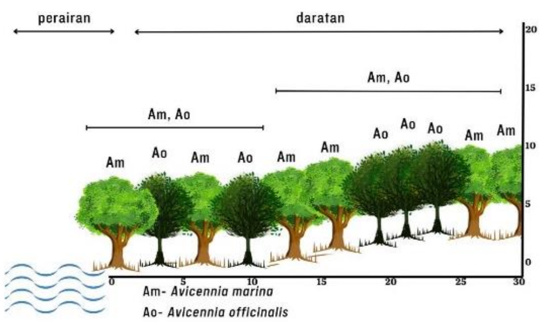
Shown in Table 3, reveals that in Banyulegi, Banyuurip, Ujung Pangkah, Gresik Regency, Avicennia marina has the highest important index value (IVI) at station 1 with 273.69, while Avicennia officinalis has the lowest at station 2 with 12.36. Rhizophora stylosa dominates at station 2 (IVI 178.36) and station 3 (IVI 108.33). The high IVI of Avicennia marina indicates its significant influence, adapting well to high salinity and mud substrates. Environmental factors like substrate, sunlight, and tides impact IVI variation among species, highlighting Avicennia marina's adaptability compared to Avicennia officinalis.

3. Zoning Pattern

Zoning in mangrove forests is influenced by plant adaptability to environmental changes, leading to distinct boundaries and varying compositions (Bachri & Abdullah, 2020). Factors like topography and soil characteristics shape these patterns, reflecting ecological responses that can be simple or complex. Species composition changes with distance from the ocean, as seen in Banyulegi, Banyuurip, Ujung Pangkah, Gresik Regency, East Java.



(A) (Rahim & Baderan, 2017)



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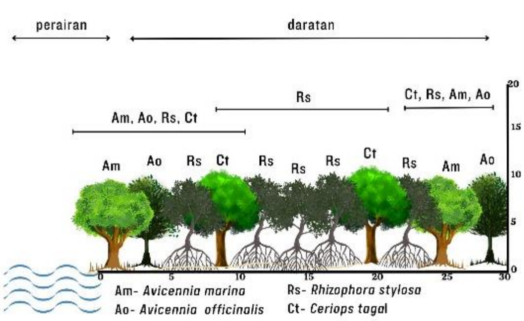

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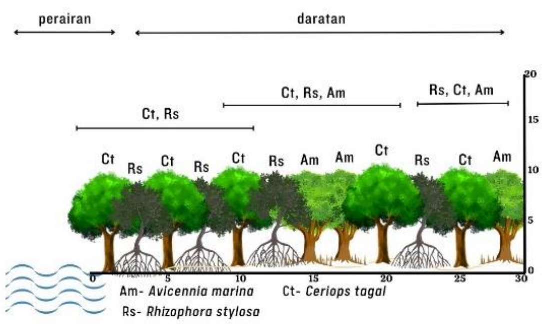

(D)

Figure 2. (A) Mangrove forest zoning pattern in good condition, (B) Station 1 zoning pattern, (C) Station 2 zoning pattern, (D) Station 1 zoning pattern.

Based on the comparison of zoning patterns in Figure 2 above, the location of mangrove zoning patterns in Banyulegi, Banyuurip, Ujung Pangkah, Gresik, East Java is different from other areas and shows simple mixed zoning. Environmental factors such as substrate, salinity, and tides affect the diversity of zoning patterns between stations. At station 1, the front and rear zones are dominated by *Avicennia marina* and *Avicennia officinalis.* Station 2 has four species with different patterns in each zone, including *Rhizophora stylosa* and *Ceriops tagal.* Station 3 shows zoning differences with *Ceriops tagal*, *Rhizophora stylosa*, and *Avicennia marina* dominating in various zones.

CONCLUSION

Research in the mangrove area of Banyulegi, Banyuurip, Ujung Pangkah District, Gresik, East Java found four species of mangroves: *Avicennia marina*, *Avicennia officinalis*, *Rhizophora stylosa*, and *Ceriops tagal.* The value of mangrove diversity is classified as moderate with the highest density in *Avicennia marina* and *Rhizophora stylosa*. *Avicennia marina* dominates with the highest important value index at the pole level and *Rhizophora stylosa* at the stake level. The zoning pattern in the area is a simple mixed zoning. It is recommended to conduct periodic research and monitoring related to changes in zoning and mangrove diversity.

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REFERENCES

Al Syauqi, A., & Purwani, K. (2017). Inventarisasi Tumbuhan Mangrove di Kampus Institut Teknologi Sepuluh Nopember. *Jurnal Sains Dan Seni ITS*, *6*(2), E110–E114.

Aurilia, M. F., & Saputra, D. R. (2020). Analisis fungsi ekologis mangrove sebagai pencegahan pencemaran air tanah dangkal akibat intrusi air laut. *Jurnal Pengelolaan Lingkungan Berkelanjutan (Journal of Environmental Sustainability Management)*, 424–437.

Bachri, S., & Abdullah, V. (2020). Komposisi dan Pola Zonasi Hutan Mangrove Di Desa Labuhan Bontong Kecamatan Tarano Kabupaten Sumbawa. *PROSIDING SEMINAR NASIONAL IPPeMas*, *1*(1), 288–295.

Djamaluddin, R. (2018). *Mangrove-biologi, ekologi, rehabilitasi, dan konservasi*. Unsrat Press.

Dwiputra, M. A., Mustofa, A., & Prasetyo, B. A. (2020). Aplikasi sistem informasi geografis untuk kajian perencanaan rehabilitasi hutan mangrove di Kecamatan Punduh Pedada, Lampung. *Journal of Science and Applicative Technology*, *4*(2), 67–74.

Harefa, M. S., Pangaribuan, B. J. T., Amri, S., & Andre, K. (2020). Analisis konservasi ekosistem hutan mangrove daerah pesisir Kampung Nipah Kecamatan Perbaungan. *Jurnal Georafflesia: Artikel Ilmiah Pendidikan Geografi*, *5*(2), 112–123.

Herison, A., Bengen, D. G., Putra, A. D., Romdania, Y., & Arief, F. D. (2024). Effects of Avicennia Marina Mangrove Sedimentation on Wave Attenuation. *Jurnal Teknologi*, *86*(2), 9–15.

Herison, A., & Romdania, Y. (2020). Mangrove for civil engineering (mangrove ecosystem for development). *Universitas Lampung, Bandar Lampung*.

Ketaren, D. G. K. (2023). Peranan kawasan mangrove dalam penurunan emisi gas rumah kaca di Indonesia. *Jurnal Kelautan Dan Perikanan Terapan (JKPT)*, *1*, 73–79.

Madyowati, S. O., & Kusyairi, A. (2020). Keanekaragaman komunitas makrobenthos pada ekosistem mangrove di Desa Banyuurip Kecamatan Ujung Pangkah Kabupaten Gresik. *Journal of Fisheries and Marine Research*, *4*(1), 116–124.

Nanlohy, L. H., & Masniar, M. (2020). Manfaat Ekosistem Mangrove Dalam Meningkatkan Kualitas Lingkungan Masyarakat Pesisir. *Abdimas: Papua Journal of Community Service*, *2*(1), 1–4.

Noor, Y. R., Khazali, M., & Suryadiputra, I. N. N. (2006). *Panduan pengenalan mangrove di Indonesia*. Ditjen PHKA.

Paringsih, N. C., Setyono, P., & Sunarto, S. (2018). Konservasi Mangrove Berbasis TRM (Tanam Rawat Monitoring) untuk Menjaga Sumberdaya Laut di Cengkrong, Trenggalek. *Bioeksperimen: Jurnal Penelitian Biologi*, *4*(2), 22–34.

Prasetyo, A., Santoso, N., & Prasetyo, L. B. (2017). Kerusakan Ekosistem Mangrove Di Kecamatan Ujung Pangkah Kabupaten Gresik Provinsi Jawa Timur Degradation of Mangrove Ecosystem in Ujung Pangkah Subdistrict Gresik District East Java Province. *Journal of Tropical Silviculture*, *8*(2), 130–133.

Rahim, S., & Baderan, D. W. K. (2017). *Hutan mangrove dan pemanfaatannya*. Deepublish.

Rangkuti, A. M., Cordova, M. R., Rahmawati, A., & Adimu, H. E. (2022). *Ekosistem pesisir & laut Indonesia*. Bumi Aksara.

Tefarani, R., Martuti, N. K. T., & Ngabekti, S. (2019). Keanekaragaman spesies mangrove dan zonasi di wilayah Kelurahan Mangunharjo Kecamatan Tugu Kota Semarang. *Life Science*, *8*(1), 41–53.

Tihurua, E. F., Agustiani, E. L., & Rahmawati, K. (2020). Karakter anatomi daun sebagai bentuk adaptasi tumbuhan penyusun zonasi mangrove di Banggai Kepulauan, Provinsi Sulawesi Tengah. *Jurnal Kelautan Tropis*, *23*(2), 255–264.

Wong, L. S., Voon, B. W. N., Teo, S. C., & Balakrishnan, A. (2016). Spectrometry analysis on cyanobacteria for heavy metals detection in aquatic environment. *Ecology, Environment and Conservation*, *22*(3), 1107–1111.