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Suitability and carrying capacity of mangrove ecotourism area of Ekasoghi Beach, Sumenep Regency, East Java, Indonesia

Achmad Sonhaji¹, Slamet Subari², Akhmad Farid^{3*}

¹⁻³ Magister Program Pengelolaan Sumber Daya Alam, Universitas Trunojoyo Madura, Indonesia

* Corresponding Author: Akhmad Farid

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Abstract

Having a total diversity of mangrove species of about 51%, there are a total of 89 species of mangroves in the world. The purpose of this study was to determine the structure of the mangrove community, the tourism suitability index and the carrying capacity of the ecotourism area. This research was conducted in Beach of Ekasoghi Village, Sumenep Regency. Found 6 mangrove species, namely *Sonneratia alba*, *Sonneratia caseolaris*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Avicennia alba* and *Lumnitzera racemosa*. The IVI for trees, saplings and seedlings is included in the high category because the IVI values are 300, for saplings 200 and for seedlings 200. Having a moderate dominance index level is found at stations 1 and 10, stations 2 to 9 are low dominance indexes. The IKW analysis which has a value of 82% is at stations 5 and 6, station 1 is 62%, station 2 is 72%, stations 3 and 4 are 69%, stations 7 and 8 are 69% and stations 9 and 10 are 62%. means categorized (conditionally appropriate). Analysis of the carrying capacity of this area provides 56 people per day while for a trip as many as 7 people. Analysis of the carrying capacity of utilization with a percentage of 10% results obtained as many as 6 people per day. This is intended so that the tourist area is maintained its ecology, beauty and sustainability to be used as ecotourism.

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Keywords: Mangrove ecotourism, community structure, suitability, carrying capacity, beach of Ekasoghi mangroves, Sumenep Regency

1. Introduction

Having a total diversity of mangrove species around 51%, the total types of mangroves in the world amounted to 89 types. Mangrove ecosystems are transitional ecosystems between terrestrial ecosystems and marine ecosystems. Coastal and coastal areas have strategic significance because they are areas of interaction or transition (interface) between terrestrial and marine ecosystems that have unique properties and characteristics and contain considerable biological production and other environmental services.

The wealth of resources owned by the region attracts various parties to use it directly because sectorally it contributes greatly to economic activities such as fisheries, forestry, industry, tourism and others. Mangroves are spread in several countries of the world with an area of about 19.9 million hectares, Indonesia is one of the countries that has the largest mangrove forest in the world. In addition, Indonesia has the highest level of mangrove diversity in the world, with 202 types of mangroves, which dominate mangroves that grow and develop in tidal areas of muddy beaches (Mukhlisi, 2018)^[9].

Six types of mangroves were found, namely *Sonneratia alba*, *Sonneratia caseolaris*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Avicennia alba* and *Lumnitzera racemosa*. The INP level of trees, stakes, and seedlings is included in the high category because of its Important Value Index (INP) value of 300, saplings 200 and seedlings 200. Having a medium dominance index level is found at stations 1 and 10, stations 2 to 9 are low dominance indexes. Travel Suitability Index (IKW) analysis which has a value of 82% is at stations 5 and 6, station 1 at 62%, station 2 at 72%, station 3 and 4 at 69%, stations 7 and 8 at 69% and stations 9 and 10 at 62% which means categorized (according to conditional).

Aanalysis of the carrying capacity of this area provides 56 people per day while for per trip as many as 7 people. Analysis of the carrying capacity of utilization with a percentage of 10%, results were obtained as many as 6 people per day. This is so that the tourist area is maintained ecologically, beautiful and sustainable to be made ecotourism. The purpose of this study is to determine the structure of mangrove communities, tourism suitability index and the

carrying capacity of ecotourism areas.

2. Research method

This research will be carried out in January – February 2023 at Ekasoghi Beach, Saronggi District, Sumenep Regency. The sampling location is divided into 10 stations. Research method using transect Stratified Random Sampling.

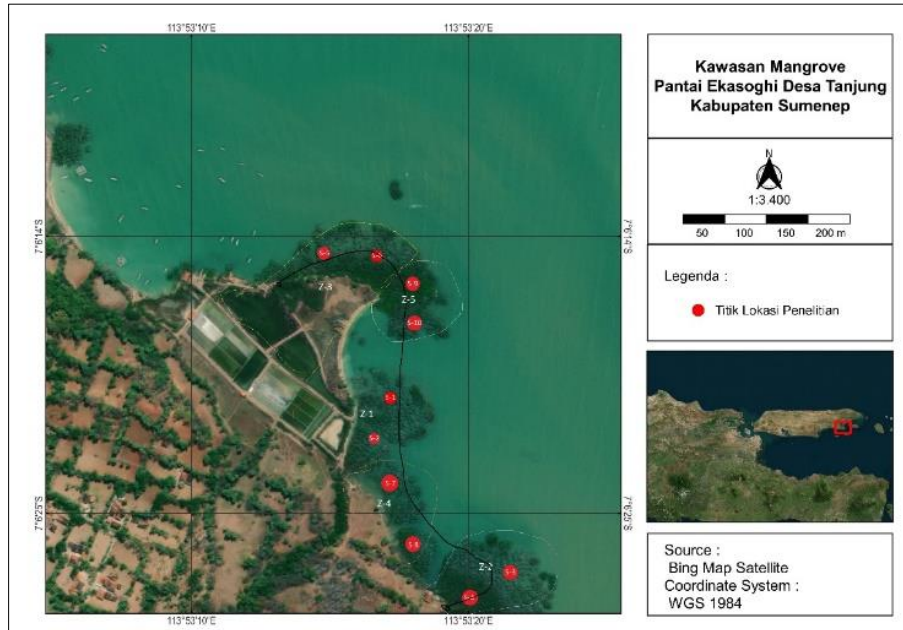


Fig 1: Research location map (Source: google earth & Arcgis, 2023)

2.1. Data analysis

Data collection using observation. Documentation and calculation of mangrove community structure, marine ecotourism suitability analysis and carrying capacity analysis.

2.1.1. Mangrove community structure

Type frequency: $KM = \frac{\sum \text{Individual of a type to } i}{\text{The are of the entire compartment}}$

Relative frequency: $KR = \frac{\text{Density of a type to } i}{\text{Density of all types}} 100\%$

Type frequency: $FM = \frac{\sum \text{Plot of a type to } i}{\sum \text{Entire tile}}$

Relative frequency: $FR = \frac{\text{Frequency of a type to } i}{\text{Frequency of all types}} 100\%$

Dominance: $DM = \frac{\text{Area of a type } i}{\text{Area of the entire plot}}$

Information:

Area of area = $\frac{1}{4} \mu d^2$

$\mu = \text{Constanta (3.14)}$

$d = \text{Tree diameter}$

Relative dominance: $FR = \frac{\text{Dominance of a type to } i}{\text{Dominance of the whole breed}} 100\%$

The calculation of the Important Value Index of mangroves for tree and pole levels uses the following formula (Odum,

1993) [11]:

$INP = KR + FR + DR$

The calculation of the Important Value Index (INP) of the stake and seedling levels uses the following formula (Odum, 1993) [11]:

$INP = KR + FR$

Information:

INP = Important value index

KR = Relative density

FR = Relative frequency

DR = Relative closure

The mangrove diversity index can be calculated using Shannon-Wiener. The more mangrove species found, the more diverse the mangrove community, according to (Odum, 1993) [11]:

$H' = -\sum \frac{ni}{N} \ln \frac{ni}{N}$

Information:

$H' = \text{Diversity index}$

$N = \text{Total number of individuals of the whole breed}$

$ni = \text{Number of individuals of type to } i$

The Diversity Index categories are as follows:

Low level of diversity, high ecological pressure: $H' < 1,0$

Moderate level of diversity, moderate ecological pressure: $1,0 < H' < 3,322$

High level of diversity, low ecological pressure: $H' > 3,322$

Indeks Mangrove dominance aims to find out some or many species that dominate in the area (Odum, 1993) ^[11].

0-0,5 = Low
 0,5-0,75 = Medium
 0,75-1,0 = High

$$C = \sum \left(\frac{n_i}{N} \right)$$

Information:

C = Dominance index

N = Total number of individuals of the whole breed

n_i = Number of individuals of the i-th breed

Dominance Index Criteria according to

2.1.2. Marine ecotourism suitability analysis

The data collection method used is the Tourism Conformity Analysis method. According to the tourism suitability analysis, the mangrove category uses a matrix containing parameters, scores, and weights to determine whether or not the area is suitable as an ecotourism area. Mangrove category tourism suitability matrix.

Table 1: Ecotourism suitability matrix

Parameter	Weight	Category	Score
Mangrove Thickness (m)	5	>500	3
		>200-500	2
		>50-200	1
		1	0
Mangrove density (100m ²)	3	>15-20	3
		>10-15; >20	2
		>5-10	1
		1	0
Types of Mangroves	3	>5	3
		3-5	2
		2-1	1
		0	0
Biota Objects	1	Fish, shrimp, crabs, mollusks, reptiles and birds	3
		Fish, shrimp, crabs and mollusks.	2
		Fish and mollusks	1
		(One of the aquatic biota)	0
Tide (m)	1	0-1	3
		>1-2	2
		>2-5	1
		>5	0

Information:

Maximum value = 39

Appropriate = 75-100%

Conditional Compliant = 50-<50%

Not Compliant = <50%

Tourism Suitability Index (IKW) according to (Yulianda *et al.*, 2018) ^[16] can use the formula as follows:

$$IKW = \left(\frac{N_i}{N_{max}} \right) \times 100\%$$

Information:

IKW = Tourism Suitability Index (%)

N_i = Value of the i-th parameter (weight x score)

N_{max} = Maximum value of a tourist kategori

The parameters of the assessment of the tourism suitability index (IKW) analysis include:

Mangrove thickness

The thickness of mangroves is measured directly using satellite imagery. Measurements are made from the outermost line towards the direction of the sea perpendicular to the land. So that thick mangrove vegetation can be seen. This measurement is done per station.

Mangrove density: According to (Odum, 1993) ^[11] the

formula for calculating the density of mangrove species is:

$$KM = \frac{\sum \text{Individual of a type to } i}{\text{Area of the entire plot}}$$

Types of mangrove

Determining the type of mangrove is done by observing mangrove parts such as roots, leaves, flowers, and fruits. The parts are observed and identified according to their type. Identify mangrove species using mangrove identification books or other references related to mangrove species.

Biota objects

The determination of biota objects is determined by being observed directly in the field. The biota found were photographed and identified according to their type. This identification is adapted to references to biota objects. The observed biota objects are adjusted to the mangrove category ecotourism suitability measurement matrix, and biota object data is taken per research station.

Tide

Tidal data is measured by searching for information in BMKG online Surabaya. Tidal data measured from January to December 2022. The data will be presented in graphic form. So it's easy to read.

2.1.3. Regional carrying capacity analysis

Table 2: Ecological potential of tourists (K) and area (Lt)

Types of Activities	Number of Visitors (People)	Area (Lt)	Information
Mangrove Ecotourism	1	50 m	Calculated track length for each person within 50 m

Source: (Yulianda, 2007) ^[15]

Table 3: Time needed (Wp) and total time 1 day (Wt)

Types of Activities	Time required Wp (Hours)	Total time 1 Day – Wt (Hours)
Mangrove ecotourism	2	8

Source: (Yulianda, 2007) ^[15]

According to (Yulianda, 2007) ^[15] the analysis of the carrying capacity of the area uses the following formula:

$$DDK = K \times \left(\frac{Lp}{Lt}\right) \times \left(\frac{Wt}{Wp}\right)$$

Information:

DDK = Regional Carrying Capacity

K = Ecological potential of tourists per unit area (people)

Lp = Area utilized

Lt = Area of ecotourism activity type

Wt = Total time in 1 day

Wp = Total time type of ecotourism activity per person

2.1.4. Utilization carrying capacity analysis

According to (Yulianda, 2007) ^[15] the analysis of the carrying capacity of utilization uses the following formula:

$$DDP = DDK \times 0,1$$

Information:

DDP = Utilization Carrying Capacity

DDK = Regional Carrying Capacity

3. Results and discussion

3.1. Aquatic environmental conditions

Measurement of the mangrove aquatic environment in Ekasoghi Village, Sumenep District, Sumenep Regency can be seen from Temperature, pH and Salinity.

Table 4: Aquatic environmental conditions

Stations & Value	Parameter	Quality standart	Source
1. 28,9	Temperature (°C)	28-32	KepMen LH No.51, 2004
2. 29,4			
3. 31,3			
4. 30,3			
5. 29,3			
6. 29,6			
7. 29,8			
8. 29,5			
9. 28,6			
10. 29,3			
1. 7,20	pH	7-8,5	KepMen LH No.51, 2004
2. 7,06			
3. 7,32			
4. 6,96			
5. 7,09			
6. 7,13			
7. 7,40			
8. 7,37			
9. 6,97			
10. 7,22			
1. 29	Salinity	33-34	KepMen LH No.51, 2004
2. 15			
3. 30			
4. 30			
5. 12			
6. 10			
7. 0,5			
8. 0,5			
9. 25			
10. 27			

In the condition of the mangrove aquatic environment, there are different temperature parameter values for each station. The highest temperature in this study was at station 3 zone 2 which was valued at 31.3 °C. In this area there is more

sunlight 746 than other stations. The lowest temperature is found at station 9 zone 5 with a value of 28.6 °C, this is because the zone 5 area is not close to sea water so that the temperature is low besides that the area does not have too

much hot sunlight. As it is according to (Indrawan & Handayani, 2022) ^[6] that said, the temperature difference between stations is due to the intensity of sunlight that leads directly to the mangrove area. Each station in the area is in accordance with the quality standards of KepMen LH No. 51 of 2004 which states that the quality standards for mangrove waters temperature are around 28-32 °C.

At station 7 zone 4 the highest pH value is 7.40. The lowest pH values were at station 4 zone 2 with a value of 6.96 and at station 9 zone 5 with a value of 6.97. It can be said that the pH value in the area means that it is in the quality standard value, because the pH value is in the mangrove water quality standard. Mangrove naturally lives in acidic waters.

According to (Bedono *et al.*, 2016) ^[2] The decrease in pH value due to falling mangrove litter is overhauled by microorganisms, so that the pH becomes acidic.

The highest salinity values are at stations 3 and 4 with a value of 30 ppt, the lowest is at stations 7 and 8 zone 4 with a value of 0.5 ppt. In the 10 stations with 5 zones, none of them are in accordance with the quality standards of KepMen LH No. 51 of 2004. This is due to the inundation of sea water found in mangrove areas. As conveyed (Jasin & Jansen, 2019) ^[7] Seawater inundation that occurs due to tides and uneven distribution of water into mangrove forests can cause stagnant water, so that the salinity value found in the area is high.

3.2. Mangrove community structure

Table 5: Types of mangrove in Ekasoghi Village

Stasion	Species	Category		
		Tree	Stake	Seedling
1	<i>Sonneratia alba</i>	15	11	3
	<i>Sonneratia caseolaris</i>	-	-	-
	<i>Rhizophora apiculata</i>	1	-	1
	<i>Rhizophora mucronata</i>	-	3	-
	<i>Avicennia alba</i>	5	-	-
	<i>Lumnitzera racemosa</i>	--	-	-
	Total	21	14	4
2	<i>Sonneratia alba</i>	10	5	6
	<i>Sonneratia caseolaris</i>	2	1	1
	<i>Rhizophora apiculata</i>	3	4	4
	<i>Rhizophora mucronata</i>	2	3	3
	<i>Avicennia alba</i>	7	5	5
	<i>Lumnitzera racemosa</i>	4	2	2
	Total	28	20	21
3	<i>Sonneratia alba</i>	9	7	5
	<i>Sonneratia caseolaris</i>	3	3	2
	<i>Rhizophora apiculata</i>	6	5	4
	<i>Rhizophora mucronata</i>	2	1	1
	<i>Avicennia alba</i>	10	6	4
	<i>Lumnitzera racemosa</i>	3	1	2
	Total	33	23	18
4	<i>Sonneratia alba</i>	7	3	1
	<i>Sonneratia caseolaris</i>	4	3	1
	<i>Rhizophora apiculata</i>	4	3	1
	<i>Rhizophora mucronata</i>	7	4	2
	<i>Rhizophora mucronata</i>	15	9	4
	<i>Avicennia alba</i>	3	3	2
	<i>Lumnitzera racemosa</i>			
	Total	39	25	11
5	<i>Sonneratia alba</i>	13	8	4
	<i>Sonneratia caseolaris</i>	4	2	1
	<i>Rhizophora apiculata</i>	4	4	5
	<i>Rhizophora mucronat</i>	4	2	1
	<i>Avicennia alba</i>	7	6	5
	<i>Lumnitzera racemosa</i>	4	2	2
	Total	36	24	18
6	<i>Sonneratia alba</i>	19	14	5
	<i>Sonneratia caseolaris</i>	3	3	2
	<i>Rhizophora apiculata</i>	4	1	-
	<i>Rhizophora mucronata</i>	6	5	2
	<i>Avicennia alba</i>	11	8	4
	<i>Lumnitzera racemosa</i>	4	3	1
	Total	47	34	14
7	<i>Sonneratia alba</i>	5	3	3
	<i>Sonneratia caseolaris</i>	18	10	5
	<i>Rhizophora apiculata</i>	7	5	2
	<i>Rhizophora mucronata</i>	3	2	1

	<i>Avicennia alba</i>	2	1	-
	<i>Lumnitzera racemosa</i>	2	1	1
	Total	37	22	12
8	<i>Sonneratia alba</i>	4	2	1
	<i>Sonneratia caseolaris</i>	10	4	3
	<i>Rhizophora apiculata</i>	7	5	1
	<i>Rhizophora mucronata</i>	3	3	1
	<i>Avicennia alba</i>	2	1	1
	<i>Lumnitzera racemosa</i>	2	1	1
	Total	28	16	8
	9	<i>Sonneratia alba</i>	-	-
<i>Sonneratia caseolaris</i>		12	-	-
<i>Rhizophora apiculata</i>		1	6	3
<i>Rhizophora mucronata</i>		2	4	2
<i>Avicennia alba</i>		1	2	1
<i>Lumnitzera racemosa</i>		-	-	-
Total		16	12	6
10	<i>Sonneratia alba</i>	-	-	-
	<i>Sonneratia caseolaris</i>	19	15	9
	<i>Rhizophora apiculata</i>	3	2	1
	<i>Rhizophora mucronata</i>	3	2	1
	<i>Avicennia alba</i>	1	2	1
	<i>Lumnitzera racemosa</i>	-	-	-
	Total	26	21	12

Source: Field Data, (2023)

The number of mangrove species at each station is not the same or different. According to (Khairunnisa *et al.*, 2020) [8] one of them is caused by man's own actions. Which makes mangrove areas as residential areas, pond land and bridge construction areas, as well as a lot of mangrove tree cutting

for firewood and charcoal. Likewise, in Ekasoghi Village, Saronggi District, many mangroves are also used as residential areas, ponds, and logged by irresponsible individuals.

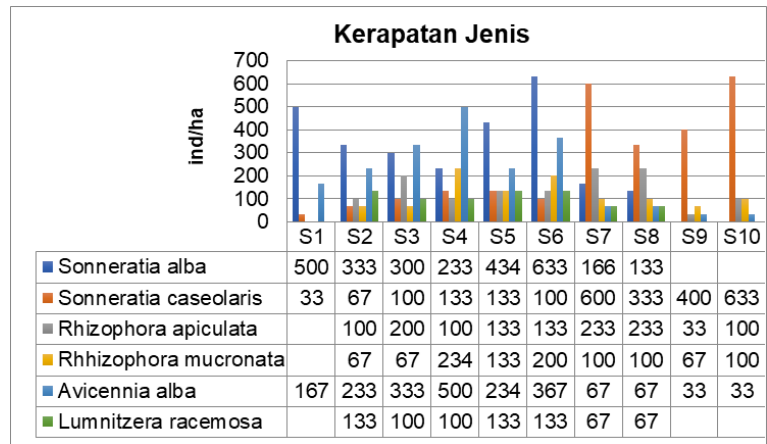


Fig 2: Tree-level species density graph

The density value at the highest tree level is at station 6 with a density value of 1566 ind/ha, indicating that conditions are classified as very dense. In addition, those that have mangrove conditions that are located at stations 1, 9 and 10 each have a density value between them, namely station 1 of 700 ind / ha, station 9 of 533 ind / ha and station 10 of 866 ind / ha.

According to (Gazali *et al.*, 2019) [5], The increase in density value is influenced by the number of mangroves found at each station and the low density due to the lack of trees and

the distance between trees from one another is relatively tenuous caused by the incompatibility of the type of substrate with the type of mangrove, the closure of mangroves by plastic waste carried by tidal flows so that mangrove growth is not good. According to KepMen LH No. 201 of 2004, states that the density of trees >1500 means very dense, density >1000-<1500 means medium and density <1000 has a rare meaning. The medium to very dense density category indicates good / beautiful forest conditions.

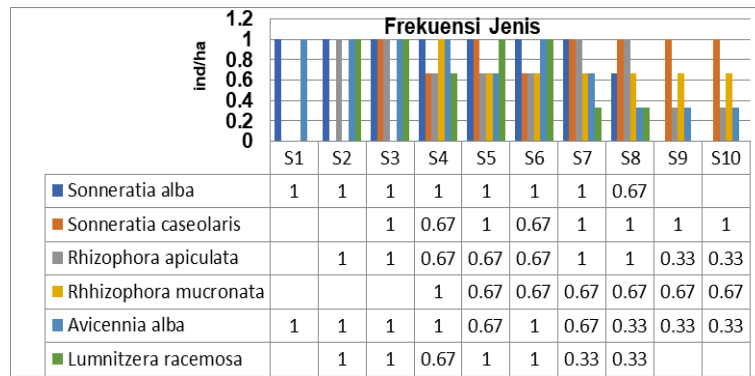


Fig 3: Tree level species frequency graph

The highest frequency of tree-level species is at stations 4, 5 and 6 with the same g-salty value of 5.01 ind/ha. The lowest type of frequency is at station 1 with a value of 2. According to (Musalima *et al.*, 2021) ^[10] The frequency rate is influenced

by the value of the plot where the mangrove species are found. The more the number of squares found mangrove species, the higher the frequency value of mangrove presence.

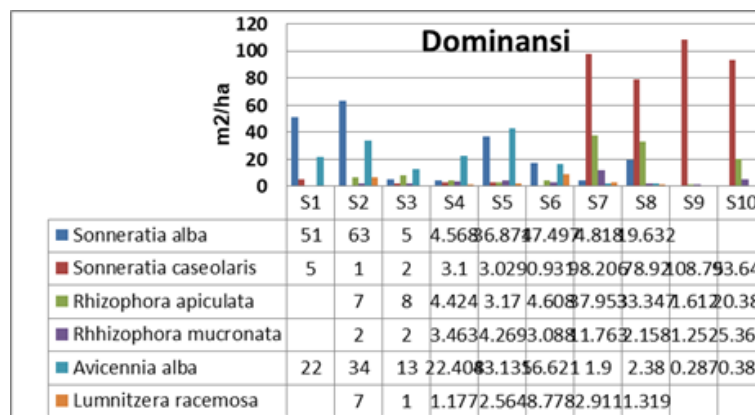


Fig 4: Tree level dominance chart

The dominance at each station is different. According to (Budiarti *et al.*, 2019) ^[3] The dominance of mangrove species is different from each type in an area, if the larger trunk size will expand its dominance. Jenis which has a relatively low

dominance value means that it reflects n K inability to tolerate environmental conditions, therefore the availability of organic matter is a supporting factor for mangrove growth.

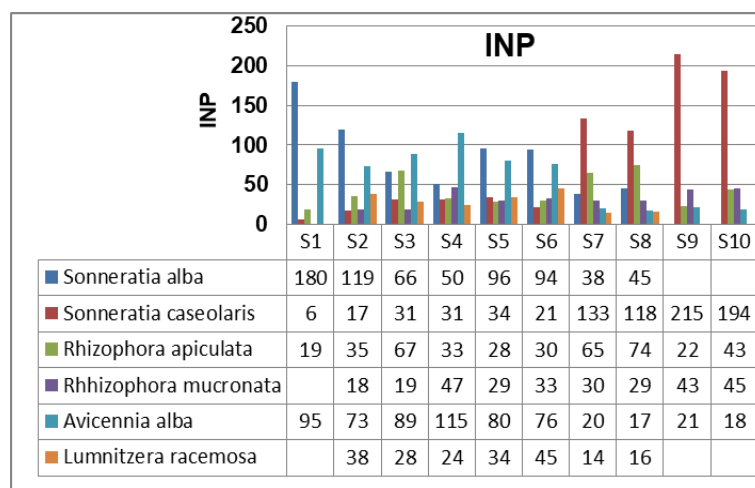


Fig 5: Tree level importance index graph

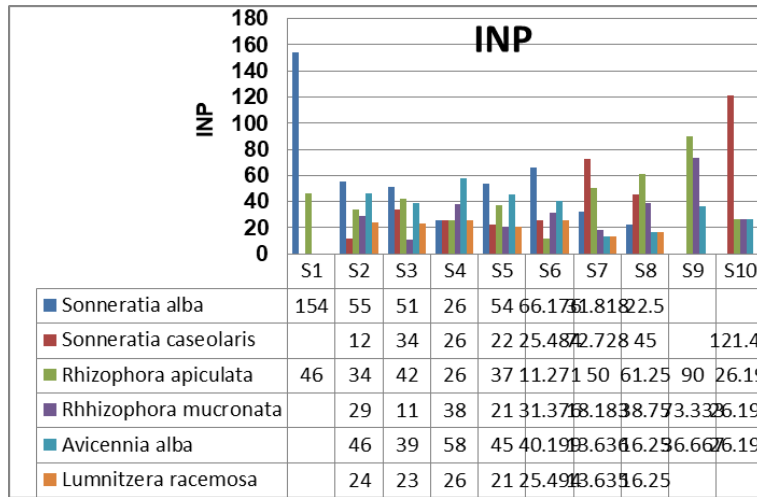


Fig 6. Graph of stake level significant value index

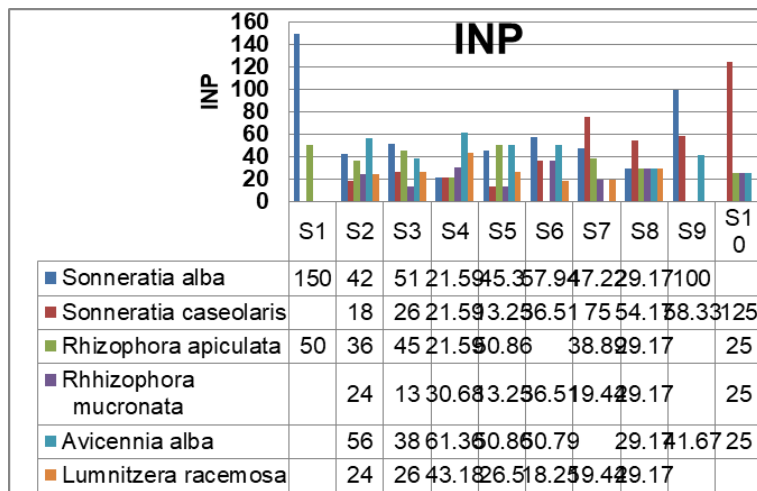


Fig 7: Graph of important value index of Seedling Level

The important Value Index is the sum result of the sum of Relative Density, Relative Frequency and Relative Dominance. Important values indicate the importance of a plant species affecting or not the plant in the community and ecosystem. According to (Putra *et al.*, 2020) [13] mangrove species that have a greater INP value than other species in one environment will be easier to adapt, compete, and also have reproductive abilities.

Table 6: Diversity index table

Station	Diversity index (H')	Level of Diversity
1	0.83	Low
2	1.66	Medium
3	1.65	Medium
4	1.67	Medium
5	1.67	Medium
6	1.55	Medium
7	1.47	Medium
8	1.65	Medium
9	1.32	Medium
10	0.88	Low

Source: Field Data, (2023)

Of the ten stations, the diversity is included in the category of moderate diversity, sufficient productivity, fairly balanced ecosystem conditions and moderate ecological pressure. This species diversity can be influenced by various factors

including environmental stability, habitat, competition, productivity and also the food chain. According to (Ely *et al.*, 2021) [4] That environmental conditions are increasingly mature and stable can be seen from the high value of diversity.

Table 7: Dominance index table

Stasiun	Dominance index (C)	Dominance level
1	0.58	Medium
2	0.21	Low
3	0.21	Low
4	0.22	Low
5	0.21	Low
6	0.25	Low
7	0.29	Low
8	0.22	Low
9	0.28	Low
10	0.56	Medium

According to (Asman *et al.*, 2020) [1] defines the magnitude of the species diversity index, that is, if $H' > 3$ then species diversity is high or abundant, if the value of $H' < 3$ then species diversity is medium and if the value of $H' < 1$ then species diversity is little or low. The highest dominance value is at station 1 which has a dominance index value of 0.58. However, the level of dominance is low at station 2 to station 9 with different dominance index values including stations 2,

3 and 5 having the same value of 0.21. Stations 4 and 8 have the same value of 0.22. Furthermore, station 5 has a dominance index value of 0.25. The next low dominance index value is at station 9 with a value of 0.28. Overall, the

dominance index in Ekasoghi village found a low level of dominance. This means low diversity, very low productivity as an indication of severe pressure and unstable ecosystems.

3.3. Mangrove ecotourism parameters

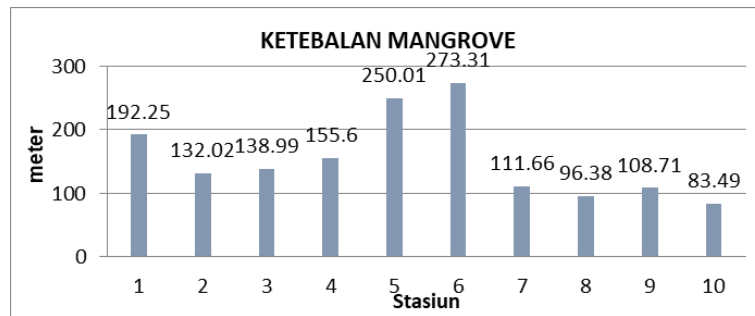


Fig 8: Mangrove thickness chart

The condition of thick mangroves can be a special attraction for tourists in terms of aesthetics. The thicker the mangroves, the more interested tourists or visitors are (Yulianda, 2007). There needs to be development related to the bridge, this will

make it easier for visitors or tourists to explore and enjoy the mangrove tourist area in Ekasoghi Village, Saronggi District, Sumenep Regency.

Table 8: Mangrove density found

Station	Species	Sum Tree (Ni)	Plot area 10x10 (A)	Density (m2/Ind)
1	<i>Sonneratia alba</i>	15	100	15
	<i>Rhizophora apiculata</i>	1	100	1
	<i>Avicennia alba</i>	5	100	5
	Total			21
2	<i>Sonneratia alba</i>	10	100	10
	<i>Sonneratia caseolaris</i>	2	100	2
	<i>Rhizophora apiculata</i>	3	100	3
	<i>Rhizophora mucronata</i>	2	100	2
	<i>Avicennia alba</i>	7	100	7
	<i>Lumnitzera racemosa</i>	4	100	4
	Total			28
3	<i>Sonneratia alba</i>	9	100	9
	<i>Sonneratia caseolaris</i>	3	100	3
	<i>Rhizophora apiculata</i>	6	100	6
	<i>Rhizophora mucronata</i>	2	100	2
	<i>Avicennia alba</i>	10	100	10
	<i>Lumnitzera racemosa</i>	3	100	3
	Total			33
4	<i>Sonneratia alba</i>	7	100	7
	<i>Sonneratia caseolaris</i>	4	100	4
	<i>Rhizophora apiculata</i>	3	100	3
	<i>Rhizophora mucronata</i>	7	100	7
	<i>Avicennia alba</i>	15	100	15
	<i>Lumnitzera racemosa</i>	3	100	3
	Total			39
5	<i>Sonneratia alba</i>	13	100	13
	<i>Sonneratia caseolaris</i>	4	100	4
	<i>Rhizophora apiculata</i>	4	100	4
	<i>Rhizophora mucronata</i>	4	100	4
	<i>Avicennia alba</i>	7	100	7
	<i>Lumnitzera racemosa</i>	4	100	4
	Total			36
6	<i>Sonneratia alba</i>	19	100	19
	<i>Sonneratia caseolaris</i>	3	100	3
	<i>Rhizophora apiculata</i>	4	100	4
	<i>Rhizophora mucronata</i>	6	100	6
	<i>Avicennia alba</i>	11	100	11
	<i>Lumnitzera racemosa</i>	4	100	4
	Total			47

7	<i>Sonneratia alba</i>	5	100	5
	<i>Sonneratia caseolaris</i>	18	100	18
	<i>Rhizophora apiculata</i>	7	100	7
	<i>Rhizophora mucronata</i>	3	100	3
	<i>Avicennia alba</i>	2	100	2
	<i>Lumnitzera racemosa</i>	2	100	2
	Total			37
8	<i>Sonneratia alba</i>	4	100	4
	<i>Sonneratia caseolaris</i>	10	100	10
	<i>Rhizophora apiculata</i>	7	100	7
	<i>Rhizophora mucronata</i>	3	100	3
	<i>Avicennia alba</i>	2	100	2
	<i>Lumnitzera racemosa</i>	2	100	2
	Total			28
9	<i>Sonneratia caseolaris</i>	12	100	12
	<i>Rhizophora apiculata</i>	1	100	1
	<i>Rhizophora mucronata</i>	2	100	2
	<i>Avicennia alba</i>	1	100	1
	Total			16
10	<i>Sonneratia caseolaris</i>	19	100	19
	<i>Rhizophora apiculata</i>	3	100	3
	<i>Rhizophora mucronata</i>	3	100	3
	<i>Avicennia alba</i>	1	100	1
	Total			26

Table 9: Types of mangroves found

Station	Species	Value	Sum
1	<i>Sonneratia alba</i>	15	
	<i>Sonneratia caseolaris</i>	-	
	<i>Rhizophora apiculata</i>	1	
	<i>Rhizophora mucronata</i>	-	21
	<i>Avicennia alba</i>	5	
	<i>Lumnitzera racemosa</i>	-	
2	<i>Sonneratia alba</i>	10	
	<i>Sonneratia caseolaris</i>	2	
	<i>Rhizophora apiculata</i>	3	
	<i>Rhizophora mucronata</i>	2	
	<i>Avicennia alba</i>	7	
	<i>Lumnitzera racemosa</i>	4	28
3	<i>Sonneratia alba</i>	9	
	<i>Sonneratia caseolaris</i>	3	
	<i>Rhizophora apiculata</i>	6	
	<i>Rhizophora mucronata</i>	2	
	<i>Avicennia alba</i>	10	33
	<i>Lumnitzera racemosa</i>	3	
4	<i>Sonneratia alba</i>	7	
	<i>Sonneratia caseolaris</i>	4	
	<i>Rhizophora apiculata</i>	3	
	<i>Rhizophora mucronata</i>	7	
	<i>Avicennia alba</i>	15	39
	<i>Lumnitzera racemosa</i>	3	
5	<i>Sonneratia alba</i>	13	
	<i>Sonneratia caseolaris</i>	4	
	<i>Rhizophora apiculata</i>	4	
	<i>Rhizophora mucronata</i>	4	
	<i>Avicennia alba</i>	7	
	<i>Lumnitzera racemosa</i>	4	36
6	<i>Sonneratia alba</i>	19	
	<i>Sonneratia caseolaris</i>	3	
	<i>Rhizophora apiculata</i>	4	
	<i>Rhizophora mucronata</i>	6	
	<i>Avicennia alba</i>	11	
	<i>Lumnitzera racemosa</i>	4	47
7	<i>Sonneratia alba</i>	5	
	<i>Sonneratia caseolaris</i>	18	
	<i>Rhizophora apiculata</i>	7	

	<i>Rhizophora mucronata</i>	3	
	<i>Avicennia alba</i>	2	37
	<i>Lumnitzera racemosa</i>	2	
8	<i>Sonneratia alba</i>	4	
	<i>Sonneratia caseolaris</i>	10	
	<i>Rhizophora apiculata</i>	7	
	<i>Rhizophora mucronata</i>	3	
	<i>Avicennia alba</i>	2	
	<i>Lumnitzera racemosa</i>	2	28
9	<i>Sonneratia alba</i>	-	
	<i>Sonneratia caseolaris</i>	12	
	<i>Rhizophora apiculata</i>	1	
	<i>Rhizophora mucronata</i>	2	
	<i>Avicennia alba</i>	1	
10	<i>Lumnitzera racemosa</i>	-	16
	<i>Sonneratia alba</i>	-	
	<i>Sonneratia caseolaris</i>	19	
	<i>Rhizophora apiculata</i>	3	
	<i>Rhizophora mucronata</i>	3	
	<i>Avicennia alba</i>	1	
	<i>Lumnitzera racemosa</i>	-	26

According to (Yulianda *et al.*, 2018) ^[16] in the marine ecotourism compatibility matrix of the mangrove category, mangrove species have a weight of 3. Stations 2, 3, 4, 5, 6, 7 and 8 have 6 mangrove species each. thus stations 2 to 8 each get a score of 3, this is because each station 2 to 8 has more than 5 (>5) mangrove species. Stations 9 and 10 have the same types of mangroves including *Sonneratia caseolaris*, *Rhizophora apiculata*, *Rhizophora mucronata*, and *Avicennia alba*, so stations 9 and 10 get a score of 2 referring

to the journal (Yulianda *et al.*, 2018) ^[16] the category of mangrove types is 3-5 then get a score of 2. The last station is at station 1 which gets a score of 2 because 3 species of mangrove species were found. According to (Prastomo *et al.*, 2017) ^[12] in mangrove ecosystems usually when dominated by mangrove species from the genera *Rhizophora*, *Sonneratia* and *Avicennia*. Usually this is because the mangrove genus can adapt to muddy soils, warm waters, high salt content

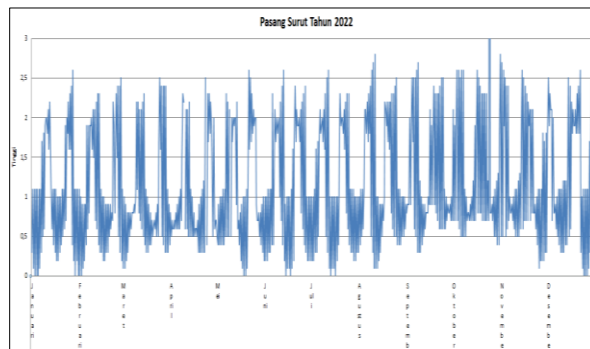


Fig 9: Tide chart of Ekasoghi Village seawater (BMKG Surabaya Data)

The low tides show that the highest tides are in February, March, June, August, September, October and November with a height of 2.8 m. While the lowest tides occur in January, February, April, May, June, July and December with a height of 0 m. This shows that the height of the tides in

Ekasoghi Village On average, it is 1.2 m high. The tidal value is in accordance with the criteria of the marine ecotourism matrix in the mangrove category and has a score of 2. The tides in Ekasoghi Village are a type of low tide that leanstowards double daily (Putriningtias *et al.*, 2019).

3.4. Mangrove ecotourism suitability index

Table 10: Marine ecotourism suitability value for the mangrove category in station 1

Parameter	Weight	Result	Station 1	
			Score	Ni
Thickness (m)	5	192.25	1	5
Species density (100 m2)	3	21	3	9
Types of mangrove	3	3	2	6
Biota Objects	1	Ikan, kepiting, Moluska burung	2	2
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)			24	
IKW				62%
Conformity Class				Sesuai Bersyarat

Source: Field Data, (2023)

Table 11: Marine ecotourism suitability value for the mangrove category in station 2

Parameter	Weight	Result	Station 2	
			Score	Ni
Thickness (m)	5	132.02	1	5
Species density (100 m2)	3	28	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	Ikan, kepiting, moluska, burung	3	3
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				28
IKW				72%
Conformity Class				

Source: Field Data, (2023)

Table 12: Marine ecotourism suitability value for the mangrove category in station 3

Parameter	Weight	Result	Station 3	
			Score	Ni
Thickness (m)	5	138.99	1	5
Species density (100 m2)	3	33	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	kepiting, moluska, ikan, burung	2	2
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				27
IKW				69%
Conformity Class				Sesuai bersyarat

Source: Field Data, (2023)

Table 13: Marine ecotourism suitability value for the mangrove category in station 4

Parameter	Weight	Result	Station 4	
			Score	Ni
Thickness (m)	5	155.6	1	5
Species density (100 m2)	3	28	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	Ikan, kepiting, moluska, burung	1	1
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				27
IKW				69%
Conformity Class				Sesuai bersyarat

Source: Field Data, (2023)

Table 14: Marine ecotourism suitability value for the mangrove category in station 5

Parameter	Weight	Result	Station 5	
			Score	Ni
Thickness (m)	5	250.01	2	10
Species density (100 m2)	3	36	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	moluska, udang, ikan, burung	2	2
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				32
IKW				82%
Conformity Class				Sesuai

Source: Field Data, (2023)

Table 15: Marine ecotourism suitability value for the mangrove category in station 6

Parameter	Weight	Result	Station 6	
			Score	Ni
Thickness (m)	5	273.31	2	10
Species density (100 m2)	3	47	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	Moluska, reptile, ikan, burung	2	2
Tide (m)	1		2	2
TOTAL ($\sum Ni$)				32
IKW				82%
Conformity Class				Sesuai

Source: Field Data, (2023)

Table 16: Marine ecotourism suitability value for the mangrove category in station 7

Parameter	Weight	Result	Station 7	
			Score	Ni
Thickness (m)	5	111.66	1	5
Species density (100 m ²)	3	37	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	ikan, udang, burung, kepiting	2	2
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				27
IKW				69%
Conformity Class				Sesuai bersyarat

Source: Field Data, (2023)

Table 17: Marine ecotourism suitability value for the mangrove category in station 8

Parameter	Weight	Result	Station 8	
			Score	Ni
Thickness (m)	5	96.38	1	5
Species density (100 m ²)	3	28	3	9
Types of mangrove	3	6	3	9
Biota Objects	1	ikan, udang, burung, kepiting	2	2
Tide (m)	1	1.2	2	2
TOTAL ($\sum Ni$)				27
IKW				69%
Conformity Class				Sesuai Bersyarat

Source: Field Data, (2023)

Table 18: Marine ecotourism suitability value for the mangrove category in station 9

Parameter	Weight	Result	Station 9	
			Score	Ni
Thickness (m)	5	108.71	1	5
Species density (100 m ²)	3	16	3	9
Types of mangrove	3	4	2	6
Biota Objects	1	ikan, kepiting, moluska, reptil, burung	2	2
Tide (m)	1	1.2	2	
TOTAL ($\sum Ni$)				24
IKW				62%
Conformity Class				Sesuai Bersyarat

Source: Field Data, (2023)

Table 19: Marine ecotourism suitability value for the mangrove category in station 10

Parameter	Weight	Result	Station 10	
			Score	Ni
Thickness (m)	5	83.49	1	5
Species density (100 m ²)	3	26	3	9
Types of mangrove	3	4	2	6
Biota Objects	1	ikan, kepiting, moluska, reptil, burung	2	2
Tide (m)	1	1.2		2
TOTAL ($\sum Ni$)				24
IKW				62%
Conformity Class				Sesuai bersyarat

Source: Field Data, (2023)

The value of the category marine suitability index in mangroves that has been presented in a meaningful table, namely in table 10 in zones 3, stations 5 and 6 has a category class that matches the IKW value of 82%, meaning that the area is suitable or suitable and can be used as a tourist area for thick mangrove ecosystems, this is useful as a habitat for biota, this is in line with the journal (Prastomo *et al.*, 2017) ^[12] High mangrove thickness will affect organic matter and high abundance of macrobenthos and plankton. So that after calculating with the tourism suitability index (IKW) formula, the mangrove area of Ekasoghi Village is suitable and

feasible to be used as an ecotourism area because each parameter has reached the desired tourism suitability index (IKW) value of >75% (Yulianda *et al.*, 2018) ^[16].

3.5. Regional carrying capacity analysis

The mangrove tourism area is 50 m long, the time provided for mangrove ecotourism in 1 day for 8 hours, the time spent by tourists while visiting mangrove ecotourism for 2 hours per day, the three parameters are for 1 person as in the matrix that has been determined by the area carrying capacity matrix (DDK). The area of the entire mangrove area used for ecotourism is 14.6 ha. The length of the track used is 699.27

m. Visitors or tourists who visit mangrove ecotourism in Ekasoghi Village per day are a maximum of 56 people per day. As for per trip, the maximum visitors or tourists can only visit and visit mangrove ecotourism a maximum of 7 people per trip.

Table 20: The carrying capacity value of mangrove category monitoring capacity per day

Lt (m)	Lp	Wt	Wp	DDK
50	699,27	8	2	56

Table 21: Mangrove category monitoring capacity value per trip

DDK	Wt	Result
56	8	7

3.6. Utilization carrying capacity analysis

After calculating the carrying capacity of the area (DDK) then of course to perfect, then calculate the carrying capacity of utilization (DDP) by considering the percentage of area for a conservation area of 10% in Ekasoghi Village. The results obtained for the carrying capacity of utilization in Ekasoghi Village are 6 people per day.

Table 22: Utilization carrying capacity value

DDK	0,1	Result
56	0,1	6

4. Conclusion

Based on the results of research in Ekasoghi Village, Saronggi District, Kabipaten, Sumenep found that there are 6 types of mangroves, namely *Sonneratia alba*, *Sonneratia caseolaris*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Avicennia alba* and *Lumnitzera racemosa*. The INP value on trees 300, sapling 200 and seedling 20 indicates that INP is in the high category. The diversity index of stations 1 to 10 has a moderate level of diversity. The IKW analysis at stations 1 and 2 is included in the conditional corresponding class with a value of 62% and 72%, stations 3 and 4 are included in the conditional corresponding class with both having a value of 69%, but stations 5 and 6 have a corresponding class with the same value of 82%, stations 7 and 8 have a value of 69% which means conditional and stations 9 and 10 are included in the conditional corresponding class with a value of 62%. Carrying capacity shows that the ability of an area to provide space for the use of an area is 56 people per day, while for per trip as many as 7 people per trip. The carrying capacity of utilization gets results as much as 6 people per day.

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