

# Ecological Parameters and Tourism Suitability of Mangrove Ecosystems in Bontang Mangrove Park Saleba, East Kalimantan

Yosua Novianto\* | Muhammad Yasser | Irma Suryana

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Mulawarman University  
Jl. Gunung Tabur No. 1. Kampus Gn. Kelua Samarinda 75123

\*E-mail: yosuadianan@gmail.com

## ARTICLE INFO

### Research Article

#### Article history:

Received March 9, 2025

Received in revised form July 23, 2025

Accepted August 19, 2025

DOI: <https://doi.org/10.30872/0n77n925>

**Keywords:** bakau, forest, wetland, tropical, Borneo



## ABSTRACT

*This study evaluates the suitability of mangrove ecotourism in Bontang Mangrove Park (BMP) Saleba, East Kalimantan, by integrating ecological parameters with social insights. Key indicators such as mangrove thickness, density, species diversity, and biota associations were analyzed alongside tidal dynamics and community perceptions. Using the Importance Value Index (IVI) and Tourism Suitability Index (IKW), results show that BMP Saleba's mangrove ecosystem is classified as "very suitable" for ecotourism, with *Rhizophora mucronata* dominating across growth stages and supporting high biodiversity. Dense vegetation, stable tidal conditions, and favorable substrate characteristics further reinforce ecological resilience. Combined with community recognition of mangroves as ecological and cultural assets, these findings highlight BMP Saleba's readiness for sustainable ecotourism development, contributing to conservation strategies and local economic opportunities.*

## INTRODUCTION

Ecotourism has emerged as a sustainable alternative to conventional tourism, emphasizing conservation, education, and community involvement. Unlike mass tourism, which often exploits natural resources, ecotourism seeks to preserve ecosystems while providing meaningful experiences for visitors. According to Fandeli (2000), ecotourism integrates environmental awareness with recreational activities, ensuring that tourism development contributes to long-term ecological balance. In coastal and mangrove ecosystems, this approach is particularly relevant, as these habitats are highly sensitive to human disturbance yet offer unique opportunities for education, biodiversity appreciation, and climate resilience.

Mangrove forests are among the most productive ecosystems in the tropics, serving as nurseries for marine life, buffers against coastal erosion, and carbon sinks that mitigate climate change. Their ecological functions make them valuable not only for conservation but also for ecotourism development. In Indonesia, mangrove areas have increasingly been recognized for their potential to support community-based tourism initiatives that combine environmental protection with local economic benefits. The presence of diverse mangrove species, associated fauna, and distinctive landscapes provides an attractive foundation for ecotourism activities such as guided tours, environmental education, and cultural experiences.

Bontang Mangrove Park (BMP) Saleba, located within Kutai National Park in East Kalimantan Province, represents one such ecotourism initiative. The park is situated in a coastal city where mangrove ecosystems dominate the shoreline, offering both ecological and recreational value. Previous studies, such as Harjanto et al. (2019), documented significant mangrove expansion in the area, with land cover increasing by 30% between 2002 and 2018. This ecological recovery highlights the potential of BMP Saleba

as a model for ecotourism development. However, despite these promising trends, there has been limited research assessing the current suitability of the park for ecotourism based on ecological indices and community perspectives.

This study aims to fill that gap by analyzing the suitability of mangrove ecotourism in BMP Saleba through ecological parameters. Key indicators such as mangrove thickness, density, species dominance, and biota associations are examined alongside community perceptions and physical water conditions. The analysis employs the Importance Value Index (IVI) and the Tourism Suitability Index (IKW) to evaluate ecological resilience and tourism potential. By integrating ecological data with social insights, this research provides a comprehensive understanding of BMP Saleba's readiness for ecotourism development, contributing to both conservation strategies and sustainable tourism planning in East Kalimantan.

## METHODOLOGY

### Study Location

The study was conducted in the mangrove ecosystem of Bontang Mangrove Park (BMP) Saleba, located in North Bontang District, Bontang, East Kalimantan Province (Figure 1). The research was carried out from June to August 2023.

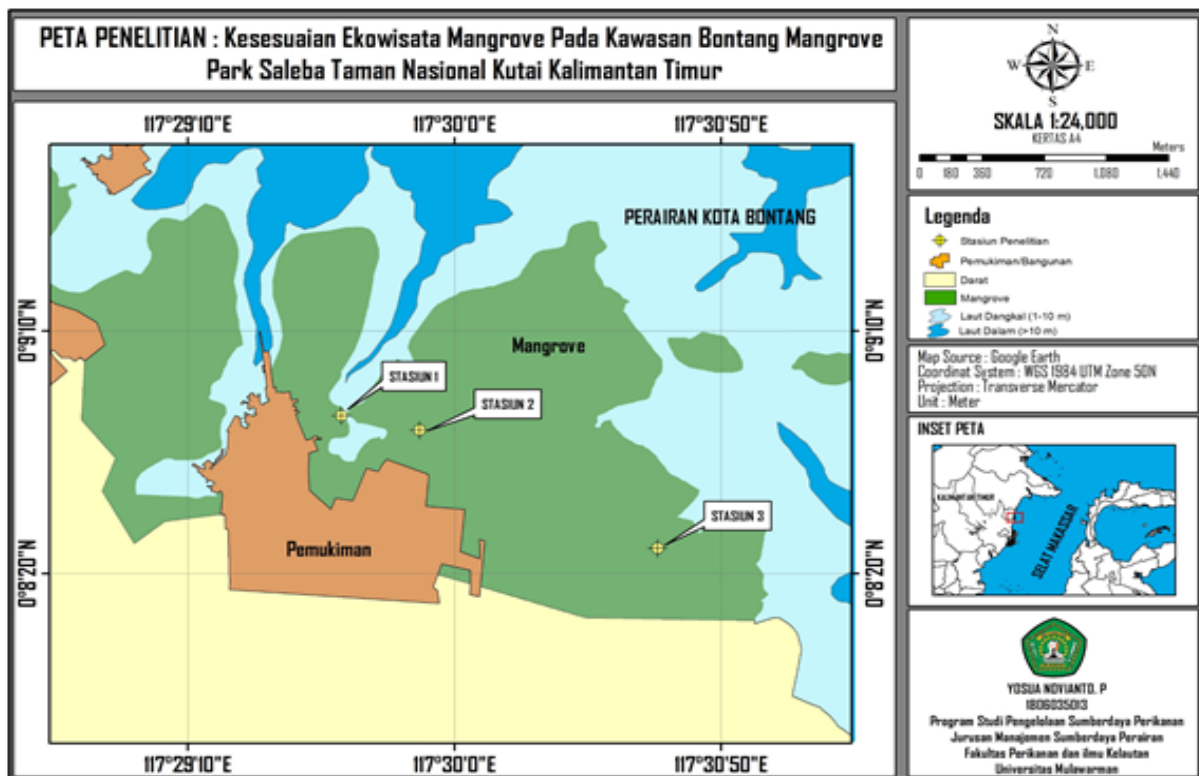


Figure 1. Study area map

## Data Analysis

### *Tourism suitability index*

Tourism suitability analysis can be calculated using the tourism suitability index formula by adding up each parameter that has been calculated and adding up the score and weight multiplication of 5 parameters including mangrove thickness, mangrove density, mangrove type, sea tides, and biota objects.

$$IKW = \sum_{i=1}^n (B_i \times S_i)$$

Where:

n = The number of conformity parameters,

B<sub>i</sub> = The weight of the i-th parameter, and

S<sub>i</sub> = The score of the i-th parameter.

IKW categories as follows;

IKW ≥ 2.5 = Very appropriate

2.0 ≤ IKW < 2.5 = Appropriate

1 ≤ IKW < 2.0 = Not appropriate

IKW < 1 = Very inappropriate

Source: Yulianda (2019)

Mangrove vegetation analysis uses formulas from (English et al., 1994) such as; species density, Species Relative Density, Species Frequency (F<sub>i</sub>), Species Relative Frequency (RF), Species Dominance (C<sub>i</sub>), Species Relative Dominance (RC<sub>i</sub>), Important Value Index (INP).

#### a). Density (D<sub>i</sub>)

Species density (D<sub>i</sub>) is the number of stands of species i in a unit area, determination of species density can be calculated using the formula (English et al., 1994):

$$D_i = \frac{N_i}{A}$$

Description:

D<sub>i</sub> = Density of species- i

N<sub>i</sub> = Total number of stands of species- i

A = Total area of sampling

#### b). Relative density of species (RD<sub>i</sub>)

Relative density (RD<sub>i</sub>) is the comparison between the number of species of stand type i with the total straight stands of the species, determination of relative density (RD<sub>i</sub>) using the formula (English et al., 1994):

$$RD_i = \frac{N_i}{\sum n} \times 100\%$$

Description:

RD<sub>i</sub> = Relative Density (%)

N<sub>i</sub> = Number of Individuals of species- i (ind)

∑n = Total number of individuals (ind)

c). Frequency ( $F_i$ )

Frequency ( $F_i$ ) is the probability of finding a species  $i$  in all sample plots created (English et al., 1994):

$$F_i = \frac{P_i}{\sum P}$$

Description:

$F_i$  = Frequency of  $i$ -th type

$p_i$  = Number of sample plots created

$\sum p$  = Total number of sample plots created

d). Relative Frequency ( $RF_i$ )

Relative frequency ( $RF_i$ ) is the ratio between the frequency of a species ( $F_i$ ) and the total frequency of all species ( $\sum$ ) (English et al., 1994). To calculate the relative frequency, use the formula:

$$RF_i = \frac{F_i}{\sum F} \times 100\%$$

Description:

$RF_i$  = Relative Frequency (%)

$F_i$  = Frequency of the  $i$ -th type (ind)

$\sum F$  = sum of frequencies of all types (ind)

e). Type closure ( $C_i$ )

Type closure ( $C_i$ ) is the area of type  $i$  closure in an area (English et al., 1994):

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

Information:

$C_i$  = Area of Closure of Type  $i$

$BA$  =  $\pi DBH^2/4$

$\Pi$  = 3.1416

$DBH$  = Tree diameter of the  $i$ -th type

$A$  = Total area of sampling area (plot)

f). Relative Coverage ( $RC_i$ )

Relative cover ( $RC_i$ ) is the comparison between the area of cover of type  $i$  ( $C_i$ ) and the total area of cover for all types ( $\sum C$ ) (English et al., 1994). To calculate  $RC_i$ , the following formula is used:

$$RC_i = \frac{C_i}{\sum C} \times 100$$

$RC_i$  = Relative Coverage (%)

$C_i$  = Area of cover of type  $i$

$\sum$  = Total area of cover of all types

g). Relative density is the ratio between the number of individuals of a species and the total number of individuals of all species, aimed at determining the percentage density of each species in the total number of all species (Odum, 1998)

$$RD_i = (N_i/\Sigma n) \times 100\%$$

Description:

RD<sub>i</sub> = Relative density

N<sub>i</sub> = Total number of stands of species i

Σn = Total number of individuals of all species

## RESULT

### Mangrove Thickness

The measurement of mangrove thickness was measured using Landsat satellite imagery in ArcGis at each station which was measured vertically from the front zone of the mangrove to the back zone of the mangrove. The results of mangrove thickness at each station in the BMP Saleba Area, TNK, East Kalimantan are obtained in the following table.

Table 1. Results of mangrove thickness measurements at each station

Station	Thickness (m)	Average thickness	Weight	Score	Category
I	1.290				
II	1.820	1.223	0,380	3	> 500 m
III	560				

Based on the graphic images and tables of research results for the parameters of mangrove vegetation thickness in the BMP Saleba area of Kutai National Park, East Kalimantan at station 1 with a thickness of 1,290 m, station 2 with a thickness of 1,820 m, station 3 with a thickness of 560 m, it is included in the very suitable category when viewed in the Yulianda formula (2019).

### Mangrove Density

Mangrove density is one of the indicators to see a parameter to predict the density of mangrove species in a certain area so that answers are obtained to the potential prediction in the form of information on the abundance of mangrove species (Table 2).

Table 2. Mangrove density in the Bontang Mangrove Park area

Types of mangroves	Station 1			Station 2			Station 3		
	N <sub>i</sub>	K ind/ha	K ind/m	N <sub>i</sub>	K ind/ha	K ind/m	N <sub>i</sub>	K ind/ha	K ind/m
<i>R. mucronata</i>	30	1000	10	20	667	6.6	27	900	9
<i>R. apiculata</i>	20	667	6.6	10	333	3.3	18	600	6
<i>S. alba</i>	5	167	1.6	5	167	1.6	10	333	3.3
<i>A. marina</i>	3	100	1	2	67	0.6	5	167	1.6
<i>B. gymnorhiza</i>	7	233	2.3	5	167	1.6	15	500	5
<i>L. litorea</i>	0	0	0	1	33	0.3	0	0	0
<i>A. aurerium</i>	0	0	0	1	33	0.3	0	0	0
<i>A. lanata</i>	0	0	0	1	33	0.3	0	0	0
<b>Total</b>	<b>65</b>	<b>2167</b>	<b>21.5</b>	<b>45</b>	<b>1500</b>	<b>14.6</b>	<b>75</b>	<b>2500</b>	<b>24.9</b>

In the density results shown in table 3 above, it was obtained that stations III and I had higher densities compared to station II. The results obtained for density I were a total density of 2167ind/ha and with a density of 21.6 ind/m<sup>2</sup>, then for station II it had a density of 1500 ind/ha and with a density of 14.6ind/m<sup>2</sup>,

and for station III it had a density of 2500 ind/ha and with a density of 24.9 ind/m<sup>2</sup>. So that it refers to the Decree of the Minister of State for the Environment No. 201 of 2004 concerning standard criteria and guidelines for determining mangrove damage. In the BMP Saleba Area, observations of stations I, II, and III obtained the results of the mangrove density criteria (ha) which were very dense.

### Types of Mangroves

The types of mangroves found in the Bontang Mangrove Park ecotourism area of Kutai National Park have a variety of types with 14 types of mangroves in the Bontang Mangrove Park ecotourism area.

The results of the observations found that there were 8 types of mangroves from 5 families in the BMP Saleba Area, Kutai National Park, Bontang (2023). The diversity of mangrove types in an area can affect the diversity of biota associated with an ecosystem so that it becomes a potential that will be favored by tourists, because they can enjoy the beautiful natural beauty in the form of expanses of mangrove forests, cool air so that it can increase insight into the environment and the importance of mangrove ecosystems in the structure of coastal ecosystems (Sadik, et al. 2017).

According to Noor et al. (2012) mangroves are nursery grounds, feeding grounds and spawning grounds for shrimp, crabs and other marine biota. And mangroves are one of the places for bird and mammal species to take shelter and breed in them. Observations conducted in the Bontang mangrove park area, at stations I, II, and III, found fauna directly in the BMP Saleba Area or indirectly. In the observation conducted in the Bontang mangrove park area, 6 types of biota/animals were found, including types/species of crustaceans, reptiles, molluscs, animals, and pisces.

### Sea Tides

Sea tides are periodic changes in the high and low sea levels caused by the gravitational pull between the earth, moon and sun. Secondary data taken from sealevel.monitoring.big.go.id where researchers want to see sea level fluctuations in the Bontang Mangrove Park area. Reference data for tides (sea tides) from BIG (Geospatial Information Agency) for the Bontang area in 31 days with a daily data recording interval. The following is a picture of a graph of sea tides in the city of Bontang in 31 days.

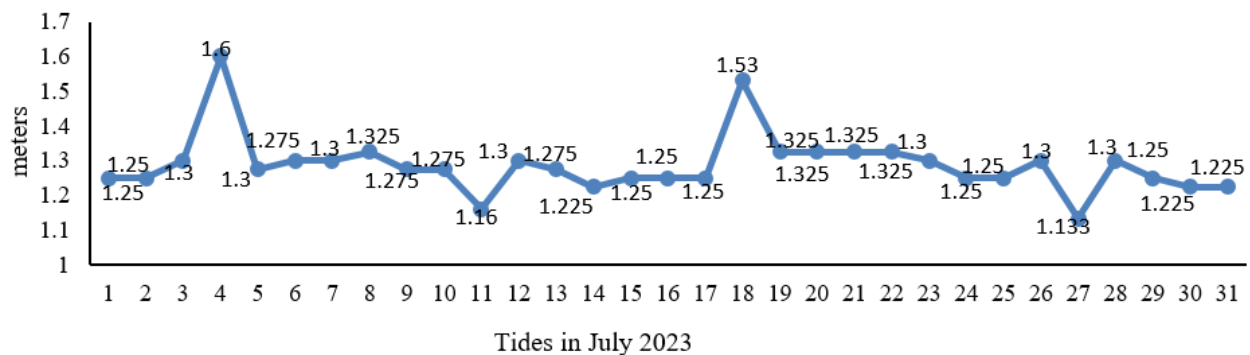


Figure 2. Tidal graph in the BMP area

The tidal data above is for the Bontang City area in 31 days with the highest tide of 1.6 m and the lowest ebb of 1.13 m with an average tidal height of 1.3 m. The duration of the tide has a major effect on changes in the salinity of the Aksornkoae mangrove area (1993). Water salinity increases during high tide, and decreases during low tide. This can limit the zone and distribution of mangrove species, especially horizontal distribution (Kusmana et al., 2008). Where Indonesia generally has a mixed semi-diurnal tides type, namely with 2 highest high tides and 2 lowest low tides in a day with different height positions (Bengen & Dutton, 2004).

### 1. Density (Di)

In the Di value for ha units in the seedling category, the mangrove type *Rhizophora mucronata* is the type with the highest Di/ha at each station. Where the Di value at station 3 obtained the highest value with a value of 33333 Di/ha while the lowest type was at station 2 for the *Achrostichum aurerium* type with a value of 1667 Di/ha. In the sapling category, the *Rhizophora mucronata* type was the type with the highest Di/ha at each station 1,2, and 3.

### 2. KR (Relative density)

In the relative density value of the seedling category for the highest relative density is in the *Rhizophora mucronata* type with a density value of 52.23% at station 1 The category for *Rhizophora mucronata* type saplings has the highest value of 40% at station 2 and the lowest is in the *Lumnitzera littorea* type at station 2, and the *Achrostichum aurerium* type at station 2 with a value of 2%. The tree category for the *Rhizophora mucronata* type has the highest relative density value of 46.15% at station 1 and for the *Lumnitzera littorea* type *Achrostichum aurerium* station, and *Avicenia lanata* has the lowest value of 2.22% at station 2.

### 3. Fi (Frequency)

The highest frequency value of the seedling category is in the *Rhizophora mucronata* and *Rhizophora apiculata* types with a value of 1 at stations 1 and 3 for the *Rhizophora mucronata* type and station 3 for the *Rhizophora apiculata* type. The sapling category for the *Rhizophora mucronata* species has the highest frequency (Fi) value with a value of 1 at station 3 and the *Rhizophora apiculata* species at stations 1 and 3 with the highest value of 3. The tree category for the *Rhizophora mucronata* species at station 1, *Rhizophora apiculata* at stations 1 and 3, and *Bruguiera gymnorrhiza* at station 3 has the highest Fi value of 1.

### 4. FR (Relative frequency)

In the relative frequency value for the seedling category, the *Rhizophora mucronata* type is the mangrove type with the highest relative density value of 29.94% for station 1 and station 3 with a value of 24.95%, followed by the *Rhizophora apiculata* type with a value of 24.95% at station 3 The *Rhizophora apiculata* type sapling category has the highest value of 33.33% at station 1 and the lowest is in the *Bruguiera gymnorrhiza* type, the *Lumnitzera littorea* type station 2 and the *Achrostichum aurerium* type station 2 with a value of 9%. The tree categories of *Rhizophora mucronate* and *Rhizophora apiculata* are the types of mangrove with the highest relative density value of 30.03%.

### 5. D (Dominance) and DR (Relative dominance)

For the dominance of the type of *Rhizophora mucronata* is the type with the highest dominance value in the category of sapling and tree levels where the dominance value of saplings at each station for the type of *Rhizophora mucronate* with an average dominance value of 0.54 while for the dominance of the tree level the average value is 0.81 so that it is a type of mangrove with the highest dominance. In the relative dominance for the category of sapling and tree levels, the highest type is in *Rhizophora Mucronate* with an average value for the sapling level at each station of 42.38% while for the category of tree level it is 53.87%

### 6. INP (importance value index)

The highest INP value results in the seedling, sapling and tree type level categories are in the *Rhizophora mucronata* mangrove species with the highest important value index value in the seedling category with an average value for each station of 69.16, then for the sapling level category the average value for each station is 96.28 while for the tree level category the average value for each station is 120.39

Based on these results for station 3, the density is influenced by the thickness and depth of the mud at station 3 near the Bontang Kuala area so that according to (Poedjirahajoe, et al, 2017 in Daulay et al, 2023), the thickness of the mud is closely related to the duration of inundation and current speed, structure and density of mangroves. Thick mud in mangrove forests indicates better forest growth and density, thick mud is also an indicator that influences the ease of mangrove roots in finding nutrients because mangrove roots can penetrate downwards more easily (Susanto, 2020 in Daulay et al., 2023).

## DISCUSSION

The findings of this research highlight that the mangrove ecosystem in BMP Saleba demonstrates strong ecological resilience, particularly in terms of thickness and density. Stations I and II showed mangrove thickness exceeding 1,200 m, while station III, though thinner at 560 m, still falls into the “very suitable” category according to Yulianda’s (2019) criteria. Similarly, mangrove density across all stations was classified as “very dense” under the Minister of Environment Decree No. 201/2004, with station III recording the highest density at 2,500 ind/ha. These results suggest that BMP Saleba possesses a robust mangrove structure capable of supporting ecotourism activities without compromising ecological stability. The dense vegetation also indicates a healthy regeneration process, which is essential for long-term sustainability.

Beyond structural parameters, species composition and dominance play a crucial role in shaping the ecological and tourism potential of BMP Saleba. The dominance of *Rhizophora mucronata* across seedling, sapling, and tree categories, with the highest Importance Value Index (INP) reaching 120.39, reflects its ecological significance in stabilizing the ecosystem. The presence of diverse mangrove species, including *Sonneratia alba*, *Avicennia marina*, and *Bruguiera gymnorrhiza*, enhances habitat heterogeneity and supports associated fauna such as crustaceans, mollusks, reptiles, and fish. This biodiversity not only strengthens ecosystem functions but also enriches the visitor experience by offering opportunities for environmental education and wildlife observation. Thus, species diversity and dominance contribute to both ecological resilience and tourism attractiveness.

The integration of ecological parameters with tidal dynamics and community perceptions further underscores BMP Saleba’s readiness for ecotourism development. Tidal fluctuations averaging 1.3 m influence salinity and species distribution, yet the mangrove community remains stable, indicating adaptability to local hydrological conditions. Thick mud layers at station III, for instance, support better root penetration and nutrient absorption, reinforcing mangrove growth. When combined with community insights that value mangroves as nursery grounds and cultural assets, the ecological data provide a strong foundation for sustainable tourism planning. Therefore, BMP Saleba can be positioned as a model for ecotourism that balances conservation with economic benefits, ensuring that tourism activities contribute to long-term ecosystem health and local livelihoods.

## CONCLUSION

Mangrove thickness and density in BMP Saleba indicate strong ecological resilience. Stations I and II recorded thickness above 1,200 m, while station III, though thinner, still met the “very suitable” category. Density levels across all stations were classified as “very dense,” with station III reaching 2,500 ind/ha. These results confirm that the mangrove ecosystem is structurally robust and capable of supporting ecotourism activities.

Species composition further strengthens this potential. *Rhizophora mucronata* dominated across seedling, sapling, and tree categories, with the highest Importance Value Index (INP) values. The presence of diverse species such as *Sonneratia alba* and *Avicennia marina* enhances habitat variety and supports associated fauna, enriching both ecological functions and visitor experiences.

Tidal dynamics and substrate conditions also contribute to ecosystem stability. Average tidal height of 1.3 m reflects adaptability of mangrove species to local hydrology, while thick mud layers at station III promote nutrient absorption and root growth. Combined with community perceptions valuing mangroves as ecological and cultural assets, BMP Saleba shows strong readiness for sustainable ecotourism development.

## REFERENCES

- Aksornkoe, S. 1993. Ecology and management of mangroves. IUCN Bangkok, Thailand. 176pp.
- Ardian, H., Yasser, M., & Kusumaningrum, W. (2023). Kesesuaian ekowisata mangrove di kawasan taman mangrove berbasis pantai di Bontang Kalimantan Timur: Kesesuaian ekowisata mangrove dikawasan taman mangrove berbasis pantai Bontang Kalimantan Timur. *Ilmu Perikanan Tropis Nusantara*, 2 (1), 50-58.
- Bengen, DG, & Dutton IM, (2004). “*Interaction :Mangroves, Fisheries and Forestry Management in Indonesia*”, vol 7 No. 2 hal 63 - 67.
- Daulay, A. P., Sari, R., & Girsang, S.R. M. (2023). Pemanfaatan Hutan Mangrove untuk Silvofishery Di Desa Pasar Rawa Kecamatan Gebang Kabupaten Langkat, Sumatera Utara. *Jurnal Hutan Lestari*, 11(3), 688-699.
- English, S., C. Wilkinson & V. Baker. 1994. *Survei Manual for Tropical Marine Resources*. Australian Institute of Marine Science, Townsville, Australia, 368 hal.
- Fandeli, C. (2000). Pengertian dan konsep dasar ekowisata. *Yogyakarta, Fakultas Kehutanan UGM*.
- Ghufran, M. dan Kordi, K.M. 2012. Ekosistem Mangrove: Potensi, Fungsi, dan Pengelolaan. Jakarta: Rineka Cipta.
- Harjanto, E., Rayadin, Y., Aipassa, M. I., & Ruslim, Y. (2019). Pengembangan Bontang Mangrove Park Sebagai Model Perlindungan Ekosistem Mangrove di Taman Nasional Kutai dan Dampaknya terhadap Perubahan Tutupan Lahan. *Jurnal Penelitian Ekosistem Dipterokarpa*, 5(1), 21-30.
- Kementerian Lingkungan Hidup. 2004. Keputusan Menteri Negara Lingkungan Hidup No. 201 tentang Kriteria Baku dan Pedoman Penentuan Kerusakan Mangrove, Jakarta.
- Laporan Kinerja Instansi Pemerintah (LKjIP), Kota Bontang Tahun 2020. 16\_LKjIP\_kota Bontang\_2020\_diupload pada 6 September 2023 pukul 21.21 Wita.
- Poedjirahajoe, E., Marsono, D., & Wardhani, F. K. (2017). Penggunaan principal Component Analysis dalam Distribusi Spasial Vegetasi Mangrove di Pantai Utara Pematang. *Jurnal Ilmu Kehutanan*, 11(1), 29. <https://doi.org/10.22146/jik.24885>
- Syahrial, S., Saleky, D., Samad, APA, dan Tasabaramo, IA (2020). Ekologi Perairan Pulau Serang Banten: Kondisi Umum Hutan Mangrove. *Jurnal Sumber Daya Perairan Indo-Pasifik*, 4(1), 53-68.
- Sunandar, A.P., Saputra, D., Azzahra, M.P., Saraswati., Rahmawati, F., Nurhalizah, S. & Handziko, R.C. (2018). Struktur komunitas dan persebaran mangrove sejati di Gisik Pantai Pasirmendit, Yogyakarta. *Prosiding Seminar Nasional Jurusan Pendidikan Biologi: Universitas Negeri Yogyakarta*.
- Susanto, D. (2020). Perbedaan Habitat Mangrove Pada Umur 9,10, 12 Tahun di Desa Bedono, Kabupaten Demak, Jawa Tengah. *Journal of Forest Science Avicennia*, 3(1),11-20. <https://doi.org/10.22219/avicennia.v3i1.11354>
- Supriharyono. (2007). Konservasi Ekosistem Sumberdaya Hayati di Wilayah Pesisir dan Laut Tropis. Pustaka Pelajar. Yogyakarta.
- Yulianda, F. (2019). *Ekowisata Perairan: Suatu Konsep Kesesuaian dan Daya Dukung Wisata Bahari dan Wisata Air Tawar*. Bogor, Indonesia: IPB Press.