

Macrozoobenthos diversity at Istana Amal Beach, Penajam Paser Utara Regency, East Kalimantan

Mariana Afna Zabila* | Adnan | Irma Suryana

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Mulawarman University
Jl. Gunung Tabur No. 1. Kampus Gn. Kelua Samarinda 76123

*E-mail: marianaafnazabila@gmail.com

ARTICLE INFO

Research Article

Article history:

Received September 10, 2024

Received in revised form January 25, 2025

Accepted March 4, 2025

DOI: <https://doi.org/10.30872/9z85tx28>

Keywords: benthic, ecology, ocean, Borneo



ABSTRACT

Istana Amal Beach, located in Penajam Paser Utara, East Kalimantan, is one of the region's ecotourism destinations. One of the key indicators of environmental quality in this area is the presence of macrozoobenthos. This study, conducted in December 2023, aimed to identify the types of macrozoobenthos present, calculate the diversity, evenness, and dominance indices, and assess the physical and chemical parameters of the water at Istana Amal Beach. A purposive sampling method was applied at two stations, selected based on different activity types in the area. The results revealed the presence of macrozoobenthos from two classes: Gastropoda and Bivalvia, comprising a total of 16 species. The ecological index values indicated a moderate diversity ($H' = 2.2$), high evenness ($E = 0.8$), and low dominance ($D = 0.1$), suggesting a relatively balanced ecosystem. Water quality measurements at both sampling points showed a salinity of 30 ppt, pH averaging 7.65, temperature of 30°C, and dissolved oxygen levels averaging 5.2 mg/L. The substrate at the site was identified as having a sandy texture.

INTRODUCTION

Coastal waters possess significant potential in terms of natural (biological) resources. However, with the continuous increase in development activities and population growth, the pressure on coastal aquatic environments is also intensifying (Bachtiar et al., 2004). One of the natural resources found in coastal ecosystems is macrozoobenthos. Macrozoobenthos are aquatic organisms that inhabit the bottom of water bodies, characterized by relatively slow movement and long lifespans. These attributes allow them to respond effectively to changes in water quality. Moreover, they play a crucial role in the food chain, with their existence dependent on the populations of lower trophic-level organisms (Noortningsih et al., 2008).

Certain biological traits of macrozoobenthos make them advantageous as biological indicators, including their sedentary nature. Therefore, changes in the quality of their aquatic environment directly influence their composition and abundance. Macrozoobenthos serve as key biological components for monitoring aquatic ecosystems impacted by ecological changes (Asra, 2009). These benthic organisms dwell on the seabed, where they dig, crawl, or remain sessile, often spending part or all of their life cycle in the aquatic environment. They also function as decomposers during the decomposition and mineralization of organic materials. The diversity of macrozoobenthos can be influenced by habitat substrate and water quality. As invertebrates that inhabit sediments or substrates, their abundance and diversity are determined by varying environmental tolerances and sensitivity to environmental changes.

The characteristics of the bottom substrate play a vital role in the development and distribution of these organisms (Sidik et al., 2016).

Istana Amal Beach is located in Penajam Paser Utara Regency, East Kalimantan. This area has substantial potential as a coastal tourism destination. However, data on macrozoobenthos in the Istana Amal coastal area remains unavailable due to limited research and information, particularly regarding macrozoobenthic species. Therefore, a study on macrozoobenthos in Istana Amal Beach, Penajam Paser Utara, is necessary. This gap in knowledge has prompted the researcher to investigate the diversity of macrozoobenthos at Istana Amal Beach, Penajam Paser Utara Regency, East Kalimantan.

METHODOLOGY

The research was conducted in December 2023, with direct sampling carried out at Istana Amal Beach, Penajam Paser Utara Regency, East Kalimantan. The sampling activities included macrozoobenthos collection, environmental parameter (water quality) measurements, and substrate sampling. Identification and analysis were performed at the Biodiversity Laboratory and the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University.

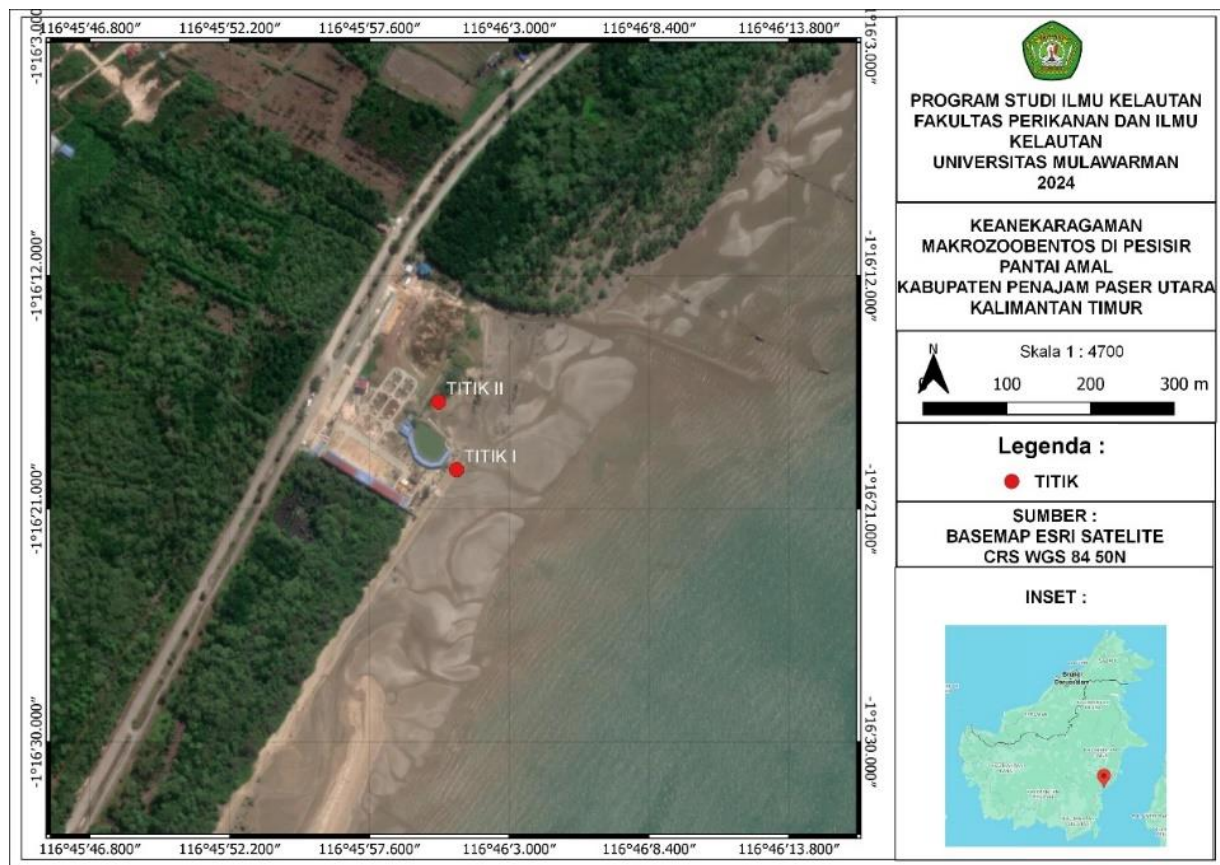


Figure 1. Research location map at Istana Amal Beach, Penajam Paser Utara

The tools used in this study included stationery, a camera, a 1×1 m transect quadrat, sample bags, labeling paper, a refractometer, a thermometer, a pH meter, and a DO titration set. The materials used comprised water samples, macrozoobenthos samples, and substrate samples. Sampling points were

determined during the lowest tide using a purposive sampling method. GPS (Global Positioning System) was used to record the coordinates of each sampling site.

Samples were collected at two locations along Istana Amal Beach, Penajam Paser Utara, East Kalimantan. Macrozoobenthos samples were collected using 1 m × 1 m quadrat plots placed from the shoreline toward the sea. Samples were taken using a hand shovel to a depth of approximately 10 cm and sieved through a 1 mm mesh screen. The macrozoobenthos specimens were then cleaned, placed into labeled plastic bags according to the sampling plots, and preserved in 70% ethanol and distilled water (aquadest). The samples were subsequently transported to the laboratory for analysis.

Biodiversity Index (H')

$$H' = -\sum (P_i \ln P_i)$$

Where:

H' = Shannon-Wiener diversity index
 P_i = Proportion of individuals of species i (n_i/N)
 n_i = Number of individuals of species i
 N = Total number of individuals
 $\ln$ = Natural logarithm

Evenness Index (E)

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

Where:

E = Species evenness index
 H' = Shannon-Wiener diversity index
 S = Total number of species

Dominance Index (C)

$$C = \sum \left[\frac{n_i}{N} \right]^2$$

Where:

C = Species dominance index
 n_i = Number of individuals of species i
 N = Total number of individuals

RESULT AND DISCUSSION

Physico-chemical parameters of coastal waters

Measurements of environmental physico-chemical parameters included dissolved oxygen (DO), pH, salinity, and temperature. The results of these measurements are presented in the following table:

Table 1. Physico-chemical parameters of coastal waters

Physico-chemical parameter	Sampling Point 1	Sampling Point 2	Water Quality Standards (KepMen LH, 2004)
Salinity (ppt)	30	30	33–34
pH	7.6	7.7	7–8.5
Temperature (°C)	30	30	28–32
Dissolved Oxygen (mg/L)	5.36	5.04	>5

Based on the temperature measurements at Istana Amal Beach, both sampling points recorded a temperature of 30°C. This temperature range supports the survival of macrozoobenthos. According to Sukarno (1988), the temperature range of 25–36°C is considered tolerable for macrozoobenthic organisms.

The salinity at both sampling points was recorded at 30‰, showing no significant variation between sites. This level of salinity is suitable for macrozoobenthos. According to Government Regulation No. 22 of 2021 on marine water quality standards for aquatic biota, the maximum acceptable salinity for macrozoobenthos is 34‰. Mudjiman (1981), as cited in Izzah et al. (2016), also notes that a salinity range of 15–45‰ is considered optimal for macrozoobenthic organisms. The values observed at both sites fall within these acceptable limits.

The pH values at both locations ranged from 7.6 to 7.7, which are within the normal range for aquatic life. pH is a limiting factor for organisms inhabiting aquatic ecosystems. Nontji (2005) states that pH is an important parameter influencing aquatic productivity, and a pH range of 7–9 is suitable for the growth and development of macrozoobenthos (Harahap et al., 2018).

Dissolved oxygen (DO) levels were measured at 5.36 mg/L at Station 1 and 5.04 mg/L at Station 2. These values comply with the marine water quality standard outlined in Government Regulation No. 22 of 2021, which states that DO levels should exceed 5 mg/L. According to Fikri (2014), macrozoobenthos require dissolved oxygen concentrations in the range of 1–3 mg/L. Thus, the DO levels observed in this study are sufficient to support macrozoobenthic life.

Table 2. Sediment fraction percentage at each sampling station

Station	Clay (%)	Silt (%)	Sand (%)	Sediment Texture
1	5.68	3.06	91.26	Sand
2	5.78	5.06	89.15	Sand

Based on the data presented in the table above, the sediment composition at both research sites is dominated by sand. This type of sediment texture is favorable for macrozoobenthos. According to Lind (1979), as cited in Suparkan (2017), sandy substrates are among the most preferred habitats for macrozoobenthic organisms.

Macrozoobenthos abundance

Based on the diagram above, the macrozoobenthos abundance data obtained from Stations 1 and 2 indicate that the macrozoobenthos found in this study belong to two classes: Gastropoda and Bivalvia,

comprising a total of 16 species from 9 families. The Gastropoda species identified include: *Polinices peselephanti*, *Cerithidea cingulata*, *Batillaria attramentaria*, *Turritella communis*, *Nerita lineata*, *Conus raulsilvai*, *Laevistrombus canarium*, *Turritella terebra*, *Murex trapa*, *Bufonaria rana*, *Vexillum exaratum*, *Telescopium telescopium*, and *Acrosterigma cygnorum*.

Additionally, three species from three different Bivalvia families were recorded: *Dosinia japonica*, *Macra stultorum*, and *Placamen chloroticum*. Station 1 is located within a tourism zone, while Station 2 is located within a mangrove area of Istana Amal Beach, Penajam Paser Utara. The species composition found in this study aligns with the general description of macrozoobenthic communities, which are organisms that inhabit the bottom sediments of aquatic ecosystems. These animals typically burrow or attach themselves to substrates (Nybakken, 1992).

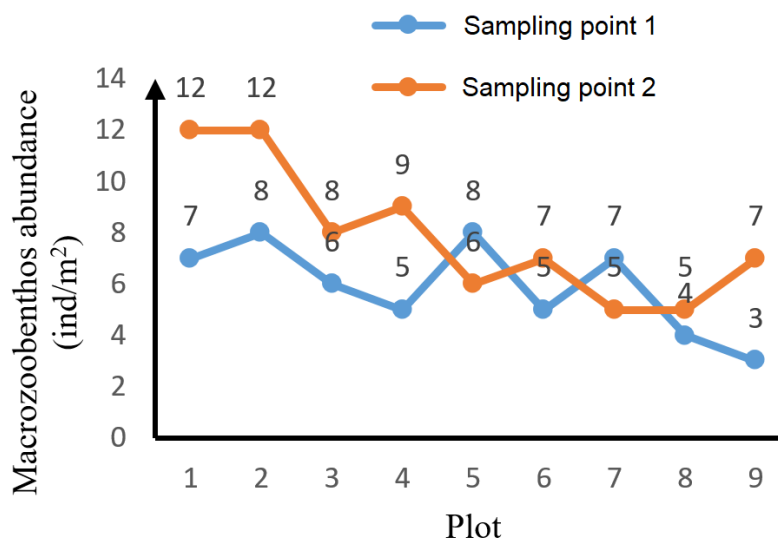


Figure 2. Macrozoobenthos abundance (individuals/m²)

Diversity Index (H'), Evenness Index (E), and Dominance Index (C)

Based on the calculated Shannon-Wiener diversity index (H'), the diversity value at Station 1 was 2.35, and at Station 2, it was 2.21. These results indicate that the macrozoobenthos diversity at both locations falls within the moderate diversity category, suggesting that the productivity levels are reasonably good. According to the Shannon-Wiener index criteria, an H' value of less than 3 is considered to reflect low to moderate diversity. Suparkan (2017) explains that macrozoobenthos diversity reflects species variability; the greater the number of species, the higher the diversity. Conversely, a lower number of species corresponds to lower diversity levels.

The evenness index (E) at both Station 1 and Station 2 was 0.92, indicating a stable community structure. According to Beisel et al., (2003), an evenness index within the range $0.00 < E < 1.00$ suggests a stable community. The closer the E value is to 1, the more evenly individuals are distributed among species. Lower evenness values indicate unequal species distribution and potential dominance by one or more species.

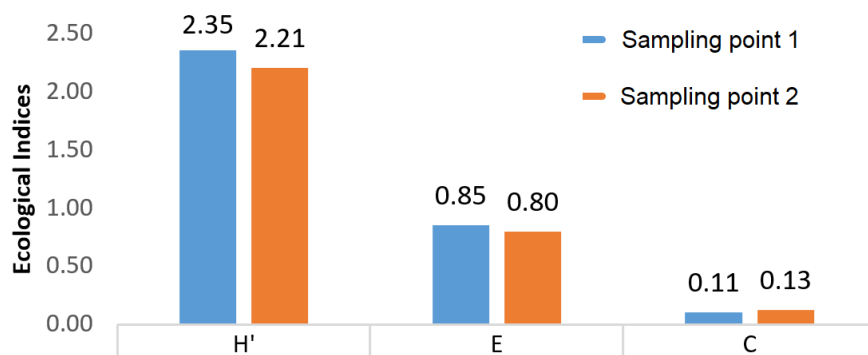


Figure 3. Ecological indices of macrozoobenthos

The dominance index (C) for both sampling points was 1.19. This value falls within the high dominance category, indicating that one or more species were dominant in both locations. According to dominance index criteria, a value of $0.00 < C < 0.50$ signifies low dominance, while a value between $0.50 < C < 0.75$ reflects high dominance. The results thus suggest that the macrozoobenthos community in this study was dominated by certain species.

CONCLUSION

The calculated values of the Shannon-Wiener diversity index (H') at the two sampling sites ranged from 2.35 to 2.21, indicating moderate diversity. The evenness index (E) ranged from 0.80 to 0.85, reflecting high evenness and suggesting a stable environmental condition. Meanwhile, the dominance index (C) ranged from 0.11 to 0.13, indicating low dominance, meaning that while some species were more abundant, no single species overwhelmingly dominated the community.

The results of the water quality parameter measurements at Istana Amal Beach showed that salinity at both sampling points was 30 ppt, pH ranged from 7.6 to 7.7, temperature was 30°C, and dissolved oxygen (DO) ranged from 5.04 to 5.36 mg/L. These values indicate that the water conditions at Istana Amal Beach are still suitable for the survival of macrozoobenthic organisms.

The substrate type at Istana Amal Beach exhibited a sandy sediment texture at both observation points (Station 1 and Station 2), which is considered favorable for macrozoobenthos.

REFERENCES

- Asra, R. (2009). Makrozoobentos Sebagai Indikator Biologi Dari Kualitas Air Di Sungai Kumpeh Dan Danau Arang-Arang Kabupaten Muaro Jambi, Jambi. *Biospecies*, 2(1), 23–25.
- Bachtar, T., Radjasa, O. K., & Sabdono, A. (2004). Natural Biodegradation of Coprostanol in an Experimental System of Three Environmental Conditions Of Jakarta Waters, Indonesia. *Journal of Coastal Development*, 8(1), 17–25.
- Beisel, J. N., Usseglio-Polatera, P., Bachmann, V., & Moreteau, J. C. (2003). A comparative analysis of evenness index sensitivity. *International Review of Hydrobiology: A Journal Covering all Aspects of Limnology and Marine Biology*, 88(1), 3–15.
- Fikri, N. (2014). Keanekaragaman Dan Kelimpahan Makrozoobentos Di Pantai Kartika Jaya Kecamatan Patebon Kabupaten Kendal. *Universitas Muhammadiyah Surakarta*, 1–12.

- Noortningsih, Jalip, I. S., & Handayani, S. (2008). Keanekaragaman Makrozoobenthos, Meiofauna Dan Foraminifera Di Pantai Pasir Putih Barat Dan Muara Sungai Cikamal Pangandaran, Jawa Barat. *Vis Vitalis*, 01(1), 34–42. Retrieved from <http://journal.unas.ac.id/index.php/visvitalis/article/view/54>
- Nybakken, J.W. (1992). *Biologi Laut Suatu Pendekatan Ekologis*. Jakarta: PT. Gramedia.unifi, & Harahap, Z. A (2014). *Komunitas makrozoobenthos Sebagai Indikator Kualitas Perairan Kecamatan Pantai Labu Kabupaten Deli Serdang*. Medan: Universitas Sumatera Utara
- Suparkan, Z. *Keanekaragaman Makrozoobentos Epifauna di Wisata Panta Akkarena dan Tanjung Bayang Makassar*. [Skripsi]. Fakultas Sains dan Teknologi, Universitas Islam Negeri Alauddin. Makassar.
- Sidik, R. Y., Dewiyanti, I., & Octavina, C. (2016). Struktur Komunitas Makrozoobentos Dibeberapa Muara Sungai Kecamatan Susoh Kabupaten Aceh Barat Daya. *Jurnal Ilmiah Mahasiswa Kelautan Dan Perikanan Unsyiah*, 1(2), 287–296.