



Diversity of plankton species in different ecosystems on Beras Basah Island, Bontang, East Kalimantan

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How to cite:

Fadila, M.I., Anjasmara, A. S., Rizal, D. R., Rusdi, R., & Reynalta, R. (2026). Diversity of plankton species in different ecosystems on Beras Basah Island, Bontang, East Kalimantan. *Bioeksperimen: Jurnal Penelitian Biologi*, 12(1), 183–190. <https://doi.org/10.23917/bioeksperimen.v12i1.15978>.

Article info	Abstract
<p>Article History: Received: 29 Jan 2026, Revised: 26 March 2026, Available Online: 31 March 2026</p> <p>Keywords: Beras Basah Island, Bontang, Plankton</p> <p>©2026 Bioeksperimen. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 (CC-BY-NC) International (https://creativecommons.org/licenses/by-nc/4.0/).</p>	<p>Beras Basah Island, located in the coastal waters of Bontang City, East Kalimantan, is a marine conservation area characterized by diverse coastal ecosystems, including marine waters, coral reefs, and seagrass bed. These ecosystems support various aquatic organisms, including plankton communities that play a key role in marine food webs. This study aimed to examine the composition, abundance, and diversity of plankton across three different ecosystems around Beras Basah Island. Sampling was conducted in May 2025 using a purposive sampling method at three stations representing marine waters, coral reefs, and seagrass bed. Plankton samples were collected using a 20 µm mesh plankton net and preserved with Lugol's solution. The data were analyzed to determine plankton abundance, Shannon–Wiener diversity index (H'), and evenness index (E). A total of 13 plankton species were identified, consisting of 10 phytoplankton species (Bacillariophyceae and Dinophyceae) and 3 zooplankton species (Ciliata and Crustacea). The Shannon–Wiener diversity index ranged from 2.17 to 2.30, indicating moderate diversity, while evenness values ranged from 0.94 to 0.98, suggesting a relatively uniform distribution of individuals among species. Phytoplankton dominated the plankton community across all ecosystems, with the highest abundance recorded in the seagrass bed (1732 individuals L⁻¹). These findings indicate that plankton communities are relatively consistent across different coastal ecosystems in the waters of Beras Basah Island.</p>

Introduction

Beras Basah Island is located in the outer waters of Bontang City and has been designated as a marine conservation area under the Decree of the Mayor of Bontang No. 112 of 2011 concerning the reservation of coastal and marine conservation areas in the coastal and marine waters of Bontang City. Under this decree, Beras Basah Island is classified as a limited-use zone intended for sustainable activities while maintaining the integrity of coastal ecosystems. The establishment of coastal conservation areas represents an important strategy for preserving the stability of marine ecosystems that are increasingly vulnerable to anthropogenic pressures and environmental change ([Rosdiani et al., 2025](#)).

This area has high ecological value, supported by the presence of various important ecosystems, such as coral reefs and seagrass bed. These ecosystems play a crucial role in sustaining aquatic productivity and biodiversity, including plankton communities as fundamental components of the aquatic food web ([Padang, 2023](#)). The abundance and diversity of plankton are strongly influenced by the physico-chemical conditions of the waters and the relatively undisturbed habitat. The environmental conditions of Beras Basah Island



remain relatively well preserved, making the area an important marine tourism destination as well as a key fishing ground for coastal communities in Bontang City ([Ramadhani et al., 2023](#); [Rosdiani et al., 2025](#)).

The high ecological value and increasing utilization of the Beras Basah Island area, continuous monitoring of water quality is required to ensure the sustainability of coastal ecosystem functions. One commonly applied approach for assessing ecological water conditions is the analysis of plankton community structure. Plankton, comprising phytoplankton and zooplankton, are microscopic organisms that drift in the water column and respond rapidly to environmental changes ([Cloern & Jassby, 2010](#)). Their sensitivity to variations in physico-chemical parameters makes plankton widely used as bioindicators in water quality assessment ([Padang, 2023](#)).

Changes in plankton composition, abundance, and diversity can reflect ecosystem disturbances caused by both natural factors and anthropogenic activities, such as nutrient enrichment and coastal tourism pressure ([Paerl et al., 2014](#); [Glibert et al., 2018](#)). Therefore, plankton studies are not only essential for understanding aquatic ecosystem dynamics but also provide a scientific basis for coastal management and policy decision-making. Several studies related to plankton communities have previously been conducted in the waters of Bontang City. For instance, [Fadilah et al. \(2022\)](#) investigated plankton community characteristics in seagrass bed in the waters of Tihi-Tihi Village, while [Haviludin et al. \(2023\)](#) examined plankton diversity and abundance as bioindicators of environmental quality in the coastal waters of Bontang. [Mahrezky et al. \(2023\)](#), the characteristics of plankton in natural coral reef ecosystems and artificial coral reefs in Tihik-Tihik Village, Bontang City. These studies demonstrate the importance of plankton as ecological indicators for assessing water quality in coastal ecosystems. However, most previous studies in the region have focused on single ecosystem types or specific locations, and comparative studies examining plankton diversity across multiple coastal ecosystems within the same conservation area remain limited.

Therefore, this study aims to analyze the diversity and community structure of plankton across three study sites representing different coastal ecosystems at Beras Basah Island, namely the marine waters, coral reef ecosystem, and seagrass bed surrounding the island. By comparing plankton communities among these ecosystems, this research is expected to provide baseline ecological information on plankton diversity in the Beras Basah Island conservation area. The findings of this study may contribute to strengthening scientific knowledge of plankton biodiversity in the coastal waters of Bontang City and support sustainable management strategies for marine conservation areas.

Materials and methods

This research was conducted in May 2025 in the coastal waters of Beras Basah Island, Bontang, East Kalimantan. Sampling stations were determined using a purposive sampling method based on ecosystem types to obtain representative data on plankton species diversity corresponding to the characteristics of each ecosystem. The study area was divided into three observation stations, namely marine waters, coral reefs, and seagrass bed, as illustrated in Figure 1.

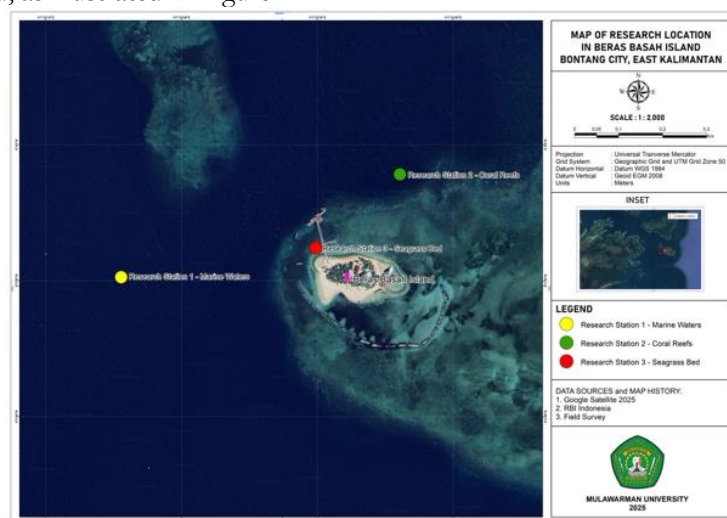


Figure 1. Research Location Map

1. Tools and Materials

The equipment used for plankton sampling included a 5 L bucket, a plankton net with a 20 μm mesh size, and 250 mL sample bottles. Water quality parameters were measured using a thermometer, refractometer, and pH indikator strips. The materials used for preservation and storage of plankton and water samples included Lugol's solution, permanent markers, labels, and a cooler bag.

2. Sampling Procedure

Plankton samples were collected at each sampling station in two replicates. Approximately 75 L of seawater was collected using a water bucket and filtered through a plankton net with a mesh size of 20 μm to concentrate the plankton. The concentrated samples were then transferred into 250 mL sample bottles and preserved with Lugol's solution (approximately 3–5 drops) to prevent cell degradation and maintain structural integrity. Plankton identification and analysis, as well as physico-chemical parameters, were conducted at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University.

3. Data Analysis

Plankton abundance was calculated and expressed as individuals per liter. Community structure was analyzed using ecological indices, including the Shannon–Wiener diversity index (H') and evenness index (E). Prior to statistical analysis, the normality of the data was evaluated. As the data did not meet the assumption of normal distribution, differences in plankton abundance among sampling stations were tested using the non-parametric Kruskal–Wallis test at a significance level of 95% ($p < 0.05$).

Results and discussion

1. Results

The results of the study conducted in three different ecosystems in the waters of Beras Basah Island showed a relatively similar plankton species diversity. A total of 13 plankton species were identified across all observation sites, with individual abundances ranging from 1574 to 1732 individuals per liter. The plankton community was dominated by phytoplankton, comprising 10 species belonging to two classes, namely *Bacillariophyceae* and *Dinophyceae*. In addition, zooplankton were also recorded, consisting of only three species belonging to the classes *Ciliata* and *Crustacea*. Detailed information on plankton species composition in each ecosystem of Beras Basah Island is presented in Table 1.

Table 1. Composition of Plankton Species in Beras Basah Island

No	Plankton	Number of Individuals		
		Marine Waters	Coral Reef	Seagrass
Phytoplankton				
Bacillariophyceae				
1	<i>Bacteriastrum hyalinum</i>	157	0	189
2	<i>Biddulphia mobiliensis</i>	126	189	126
3	<i>Coccinodiscus</i> sp.	126	157	157
4	<i>Ditylum sol</i>	157	63	189
5	<i>Rhizosolenia bergonii</i>	0	126	0
6	<i>Pleurosigma</i> sp.	157	157	189
7	<i>Thalassionema nitzschiodes</i>	63	252	126
8	<i>Thalassiotrix frauenfeldii</i>	157	63	252
Dinophyceae				
9	<i>Ceratium funca</i>	189	315	189
10	<i>Ceratium tripos</i>	189	189	126
Zooplankton				
Ciliata				
11	<i>Tintinnopsis directa</i>	0	63	0
Crustacea				
12	<i>Acartia clausi</i>	126	0	189
13	<i>Acartia amorii</i>	189	0	0
Number of individuals/Liter		1636	1574	1732
Shannon-Wiener Diversity Indeks (H')		2.30	2.17	2.28
Evenness Index (E)		0.96	0.94	0.98

Plankton analysis was conducted at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University (with minor revisions).



The Shannon–Wiener diversity index (H') of plankton across the three ecosystems in the waters of Beras Basah Island ranged from 2.17 to 2.30. The highest value was recorded in the marine waters, while the lowest was observed in the coral reefs. The Evenness Index (E) ranged from 0.94 to 0.98 across all sampling stations. The highest evenness value was found in the seagrass bed, whereas the lowest value was recorded in the coral reef. The values of diversity and evenness indices were comparable among the three ecosystems.

Based on the measurement results of several physico-chemical parameters of the waters at three different sampling stations around Beras Basah Island, the environmental conditions were relatively uniform. This condition indicates that there were no significant differences among the sampling stations in terms of the characteristics of the aquatic environment. The detailed results of the physico-chemical parameter measurements at each sampling station are presented in Table 2.

Table 2 Physico-Chemical Parameters in three different sampling stations around Beras Basah Island

Parameter	Unit	Research Station			Water Quality Standard *
		Marine Waters	Coral Reefs	Seagrass	
Physical					
Temperature	$^{\circ}\text{C}$	43	42	43	28-30
Chemical					
Salinity	ppt	30	25	28	33
pH	-	7.9	8.1	8.1	7 – 8,5
Nitrate (NO_3^-)	Mg/L^{-1}	0.018	0.019	0.022	0.006
Ortophosphate (PO_4^{3-})	Mg/L^{-1}	0.018	0.005	0.018	0.015

*The physico-chemical parameters were measured and analyzed at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University. Water quality standards are based on Government Regulation No. 22 of 2021, Appendix VIII (Marine water quality standards for marine biota).

Measurements of physico-chemical parameters across the three ecosystems showed relatively similar values. Water temperature ranged from 42 to 43 $^{\circ}\text{C}$, salinity ranged from 25 to 30 ppt, and pH ranged from 7.9 to 8.1. Nutrient concentrations were relatively low, with nitrate values ranging from 0.018 to 0.022 mg L^{-1} and phosphate ranging from 0.005 to 0.018 mg L^{-1} . The Kruskal–Wallis test indicated that there was no significant difference in plankton abundance among the three ecosystems ($p > 0.05$), suggesting that the observed variations in abundance values were not statistically different.

2. Discussion

Based on the results of this study, phytoplankton were found to be more dominant than zooplankton. This finding is consistent with [Nontji \(2008\)](#), who stated that these two phytoplankton classes are commonly found in marine waters. In addition, [Padang \(2023\)](#) reported that these classes have a wide distribution across various aquatic environments. Similar patterns have also been reported in several marine waters, where phytoplankton generally dominate over zooplankton. This dominance is closely related to the role of phytoplankton as the base of the marine food web and their rapid response to changes in nutrient availability in aquatic ecosystems ([Fadhilah et al., 2022](#)). The high abundance of phytoplankton is attributed to their function as primary producers that directly utilize light and nutrients for photosynthesis ([Maya et al. 2021](#)). Consequently, phytoplankton tend to dominate the structure of plankton communities in various marine environments.

Pleurosigma sp. was found at all research stations. This phytoplankton species is considered cosmopolitan, indicating a high level of ecological tolerance to various environmental conditions ([Padang, 2023](#)). The presence of this species across different coastal ecosystems is often associated with its ability to adapt to fluctuations in physico-chemical water parameters, such as water transparency, salinity, and nutrient availability ([Wang et al., 2019](#); [Haviludin et al., 2023](#)). In contrast, *Rhizosolenia bergonii* was only recorded in the coral reef ecosystem. [Padang \(2023\)](#) reported that *Rhizosolenia* is a plankton genus commonly found in marine waters, as it belongs to the oceanic plankton group. Similar findings have been reported by [Reynalta et al. \(2025\)](#), who documented the occurrence of the genus *Rhizosolenia* in marine



environments. In the present study, the limited occurrence of *Rhizosolenia bergonii* in the coral reef ecosystem may be temporal in nature, possibly influenced by water currents and the relatively close proximity between research stations.

Dinophyceae, particularly *Ceratium furca* and *Ceratium tripos*, were evenly distributed across all ecosystems, with relatively high abundances recorded in the coral reef ecosystem. Dinoflagellates of the genus *Ceratium* are known to exhibit diel vertical migration and high tolerance to variations in light intensity, enabling them to persist in waters with diverse environmental conditions (Glibert *et al.*, 2018). The high abundance of *Ceratium furca* in the coral reef ecosystem is presumed to be associated with relatively stable water conditions and moderate nutrient availability, which represent optimal conditions for dinoflagellate growth (Maharezky *et al.*, 2023).

In contrast, zooplankton were found in relatively low abundances. This condition is influenced by the timing of sampling, which was conducted during the daytime. Jimny *et al.* (2023) explained that most zooplankton tend to migrate away from the surface toward deeper water layers through diel vertical migration in order to avoid high light intensity and predation pressure. During feeding activities, zooplankton may migrate to depths of up to 200 meters. The limited distribution of zooplankton species, such as *Tintinnopsis directa*, which was only found in the coral reef ecosystem, as well as *Acartia clausi* and *Acartia omorii*, which were recorded in marine waters and seagrass bed, indicates the influence of micro-environmental factors such as currents, turbulence, and habitat structure on zooplankton distribution (Kiorboe, 2018; Maharezky *et al.*, 2023).

Plankton species diversity across the three ecosystems in the waters of Beras Basah Island showed Shannon–Wiener (H') values ranging from 2.17 to 2.30 (Figure 2). An index value of around two is classified as indicating moderate species diversity. This condition suggests that the waters of Beras Basah Island remain relatively stable, with environmental pressures that have not yet resulted in the dominance of one or two plankton species (Magurran, 1988). Moderate diversity levels are generally found in productive waters that still maintain good environmental carrying capacity to support the structure of plankton communities (Wang *et al.*, 2019; Padang, 2003).

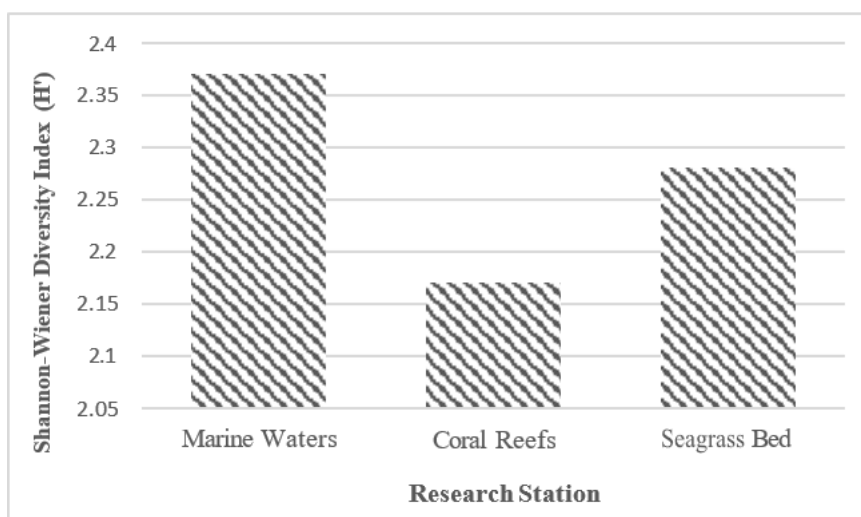


Figure 2. Shannon-Wiener Diversity Index

Evenness index values at all research stations were relatively similar, ranging from 0.94 to 0.98 (Figure 3). Evenness index values greater than 0.6 indicate a uniform distribution of plankton species across the research stations (Magurran, 1988). This suggests that higher evenness values reflect a more equitable distribution of individuals among the observed plankton species at the study sites.

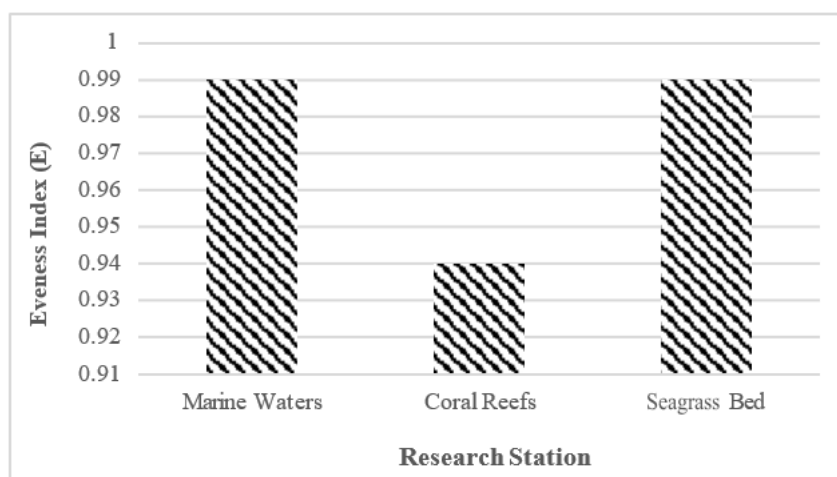


Figure 3. Evenness Index

Variations in the diversity and evenness index values in a water body, according to [Maya et al. \(2021\)](#), are influenced by physical water factors as well as differences in nutrient availability and nutrient utilization by each organism. The temperature measurements at each sampling station, including the sea, coral reef, and seagrass bed, showed relatively similar values ranging from 42 - 43 °C. The relatively high temperature values were likely influenced by the time of sampling, which was conducted during the daytime, resulting in increased water temperatures. According to [Nontji \(2008\)](#), marine waters temperature is strongly influenced by solar radiation, weather conditions, and the timing of data collection, with temperatures generally being higher during the daytime. Furthermore, [Effendi \(2003\)](#) stated that fluctuations in water temperature are a physical factor that is highly sensitive to environmental changes and directly influence the biological processes of aquatic organisms. This finding is consistent with [Reynalta et al. \(2025\)](#), who reported that daytime sampling resulted in plankton diversity and abundance patterns that were comparable to those observed in the present study.

The results of the acidity (pH) measurements at all research stations showed relatively stable values ranging from 7.0 to 8.1. These conditions indicate that the waters remain within the optimal range for marine organisms and comply with the water quality standards for marine biota specified in Appendix VIII of Government Regulation No. 22 of 2021. These values are also consistent with the range suitable for plankton growth and abundance reported by [Reynalta \(2025\)](#), which is between 6.2 and 8.6. Despite these favorable chemical conditions, the low diversity of zooplankton observed in this study is likely influenced by the sampling time, which was conducted during the daytime. The relatively high water temperature during the sampling period may act as a limiting factor affecting the vertical distribution of zooplankton.

The in situ measurements of salinity showed values ranging from 25 - 30 ppt, which are relatively lower than the national marine waters quality standards. Based on the field measurements, the salinity levels at the research site ranged between 25 and 30 ppt. Although these values are below the marine water quality standard threshold for marine biota as stipulated in Government Regulation No. 22 of 2021, ecologically they remain within the tolerance range of plankton. As stated by [Padang \(2023\)](#), planktonic organisms in marine waters are generally still able to survive and distribute in environments with salinity levels above 20 ppt.

The nitrate concentration at all sampling stations ranged from 0.018 to 0.022 mg/L Physco, indicating values well below the maximum threshold of 0.06 mg/L as stipulated in Appendix VIII of Government Regulation No. 22 of 2021. This condition suggests that the waters are in a relatively stable oligotrophic state and remain within a safe tolerance range for plankton growth ([Padang, 2023](#)). As one of the limiting nutrients in aquatic ecosystems, the availability of nitrate at measurable concentrations plays a crucial role in regulating plankton diversity and abundance, considering its function as a primary component in the synthesis of proteins and chlorophyll in phytoplankton. Adequate nitrate availability in the waters supports primary productivity, increases phytoplankton abundance, and indirectly supports zooplankton populations through trophic interactions within aquatic ecosystems. However, excessive nitrate concentrations resulting from domestic waste discharge may lead to eutrophication, which can trigger algal blooms and reduce plankton diversity ([Paerl et al., 2014](#); [Glibert et al., 2018](#)).



The orthophosphate concentration at the research site ranged from 0.005 to 0.018 mg/L. The concentrations recorded at the marine and seagrass stations were 0.018 mg/L, exceeding the seawater quality standard for marine biota of 0.015 mg/L as stipulated in Government Regulation No. 22 of 2021. Orthophosphate is the most essential form of dissolved inorganic phosphorus for primary productivity, as it can be directly absorbed by phytoplankton for photosynthesis and cellular metabolic processes (Hamuna et al., 2018). The relatively high orthophosphate concentration at these stations is likely influenced by anthropogenic activities around the coastal area of Beras Basah Island as well as the decomposition of organic matter accumulated on the seagrass bed. According to Padang (2023), elevated phosphate levels in coastal waters are often triggered by land-based run off that transports nutrients derived from human activities. Despite the relatively high phosphate concentration, the availability of nitrate during the daytime remained relatively low (0.018–0.022 mg/L), which may act as a limiting factor preventing the occurrence of massive algal blooms. The orthophosphate concentration exceeding the established threshold may contribute to the total phytoplankton abundance observed in this study, where the average range of 1547 – 1732 ind/L. This finding is consistent with the study of Reynalta et al. (2025), which reported that optimal phosphate availability can stimulate the growth of diatoms from the class Bacillariophyceae. In the present study, this group was identified as the most dominant phytoplankton group across all sampling stations.

Overall, the environmental conditions observed during this study suggest that the waters surrounding Beras Basah Island remain relatively suitable for supporting marine life. The relatively clear water conditions, stable pH, and moderate salinity provide favorable habitats for plankton communities and other aquatic organisms inhabiting marine waters, coral reef, and seagrass bed. The Kruskal-Wallis test results revealed that the different ecosystems (marine waters, coral reefs, and seagrass bed) did not significantly influence plankton abundance. This is presumably due to the relatively close proximity between stations and the influence of tidal currents, which facilitate water mixing. The homogeneous environmental conditions, particularly in pH and salinity, support a uniform distribution of plankton throughout this conservation area, suggesting that no single ecosystem is extremely superior in supporting plankton populations compared to others.

Conclusion

Beras Basah Island is dominated by the class *Bacillariophyceae*, with *Pleurosigma* sp. and *Biddulphia* sp. being prevalent across all ecosystem types. The highest plankton abundance was recorded in the seagrass bed (1732 Ind/L); however, based on the Kruskal-Wallis statistical test, there was no significant difference in abundance among the three stations ($p > 0.05$). The diversity index (H') falls into the moderate category (2.17–2.30) with a high evenness index (E) (0.94–0.98), indicating a stable ecosystem and uniform species distribution. Although the water temperature was relatively high (42–43 °C), other physico-chemical parameters still support the plankton community as primary producers in Beras Basah Island.

Author Statements

Acknowledgements and funding statements: The authors would like to thank the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University, for providing the analytical instruments and supporting the laboratory analysis. Special appreciation is extended to the "Healing in Bontang" team for their field trip assistance during the research at Beras Basah Island.

Competing of interest: The authors declare no competing interests

Author's contributions: Conceptualization and methodology were performed by Rismawaty Rusdi and Ricko Reynalta. Data collection was conducted by Aang Setyawan Anjasmara and Daisy Rahma Rizal. Data analysis and manuscript preparation were carried out by Muhammad Imam Fadila. All authors contributed to the review and editing of the manuscript and approved the final version.

Generative AI: Generative artificial intelligence tools (ChatGPT and Gemini) were utilized to support the development of the manuscript outline and to enhance language clarity. The authors are fully responsible for all scientific content, data interpretation, and conclusions.



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