JPPIPA 11(12) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Abundance and Diversity of Plankton as Bioindicators of Coastal Paddy-Field Water Quality in Batang Regency, Indonesia

Ari Handriatni[1], Heri Ariadi[2*], Farchan Mushaf Al Ramadhani[1], Ubad Badrudin[1], Syakiroh Jazilah[1], Rohmatul Amin[3], M. Akmal Faza[3], Samsul Ma'arif[3], Candra Dwi Pradana[3], Anandya Hadiprasetya[3]

[1] Department of Agrotechnology, Faculty of Agriculture, Universitas Pekalongan, Pekalongan, Indonesia.
[2] Department of Aquaculture, Faculty of Fisheries, Universitas Pekalongan, Pekalongan, Indonesia.
[3] Bachelor Degree at Department of Agrotechnology, Faculty of Agriculture, Universitas Pekalongan, Pekalongan, Indonesia.

Received: August 16, 2025
Revised: October 8, 2025
Accepted: December 23, 2025
Published: December 31, 2025

Corresponding Author:
Heri Ariadi
ander.kjavi11@gmail.com

DOI: 10.29303/jppipa.v11i12.12550

Abstract: This investigation evaluated spatial and temporal variations in plankton abundance and community structure to determine their effectiveness as bioindicators of water quality in coastal rice-field ecosystems of Batang Regency, Central Java. Plankton samples were collected from five sampling stations using 80 mL film vials and subsequently identified through laboratory-based taxonomic analysis. Key physicochemical factors were measured ex situ, and the analyses evaluated plankton abundance, Shannon–Wiener diversity index (H'), evenness (e), dominance (C), and saprobic index. Results demonstrated relatively low plankton abundance, with Bacillariophyceae (40%), particularly Chaetoceros sp., representing the principal taxonomic group, followed by Chlorella sp. Moderate diversity levels (H' = 1.45–2.85), high evenness (e > 0.6), and low dominance (C < 0.5) indicated a community structure with stable ecological dynamics. Most water quality parameters conformed to Indonesian water-quality criteria, characterized by a salinity of 0.5 g/L, temperatures of 23–24 °C, and dissolved-oxygen concentrations above 4.0 mg/L. However, the saprobic index revealed light to moderate pollution at stations near settlements and downstream river segments, likely influenced by domestic wastewater, agricultural runoff, and seawater intrusion. Overall, the ecosystem remained supportive of primary productivity, emphasizing the significance of plankton as sensitive indicators for monitoring coastal agricultural environments.

Keywords: Ecosystem; Fertilizer; Pollution; Runoff; Water quality

Introduction

The coastal zone of Batang Regency functions as an active agro-industrial region that has been utilized for agricultural production for many years. Besides supporting agricultural activities, the area also hosts tourism, port operations, and aquaculture, thereby increasing the vulnerability of its agricultural landscapes to various forms of environmental pollution (Ariadi et al., 2025). Such pollution is driven by the increasing intensity of human activities and the associated runoff of waste (Feng et al., 2025). Another negative impact of intensive agro-industrial activities in the coastal region of Batang is the risk of environmental quality degradation due to excessive pollutant loads (Yasmeen et al., 2024).

The agricultural sector in Batang Regency has functioned as productive agro-industrial area for decades. Major cultivated commodities include paddy, maize, soybean, cassava, and peanuts (Escobar et al., 2020). Despite its productivity, the coastal region of Batang is highly vulnerable to the impacts of climate change, which manifest in erosion, land subsidence, degradation of soil quality, and seasonal flooding (Sahara et al., 2025). These cumulative effects have significant implications for the sustainability of

How to Cite:
Handriatni, A., Ariadi, H., Al Ramadhani, F. M., Badrudin, U., Jazilah, S., Amin, R., … Hadiprasetya, A. (2025). Abundance and Diversity of Plankton as Bioindicators of Coastal Paddy-Field Water Quality in Batang Regency, Indonesia. *Jurnal Penelitian Pendidikan IPA*, *11*(12), 723–732. https://doi.org/10.29303/jppipa.v11i12.12550

agricultural practices in the coastal zone (Kuncheva et al., 2025).

Ecological challenges in Batang's coastal agricultural zones are expected to become increasingly complex if left unmanaged. Intensifying human activities, coupled with expanding land use, threaten the environmental sanitation of agricultural areas (Rosenqvist et al., 2022). Major agricultural impacts include declining crop yields, environmental degradation, abnormal growth patterns of cultivated crops, and increased plant disease prevalence (Espinoza & Escobal, 2025). Pollution impacts on paddy field environments in Batang Regency can be assessed through physical, chemical, and biological analyses. Biological analysis can be conducted by examining the dominance of microorganisms as environmental bioindicators (Chadda-Harmer et al., 2025).

Among microorganisms, plankton serve as reliable bioindicators of the fertility status of wet agricultural lands (Xu et al., 2016). Plankton are widely recognized as indicators for assessing the fertility of paddy field waters (Frau et al., 2021). Their presence influences the primary productivity of paddy field waters, which determines their suitability as cultivation media (Berman et al., 2022). In unpolluted paddy waters, a balanced ratio of plankton species can be observed (Lyu et al., 2025). Conversely, polluted waters are often characterized by plankton diversity dominated by a few species. Plankton abundance and the presence of specific taxa can thus serve as indicators of aquatic soil fertility in relation to environmental change (Chang et al., 2024).

Based on this background, the objectives of this study were to examine the abundance and diversity of plankton as bioindicators in coastal paddy fields of Batang Regency, both temporally and spatially. In addition, the study aimed to assess water quality conditions and pollution levels in paddy field waters using the saprobic index. This research is important because plankton are sensitive bioindicators capable of detecting changes in water quality in coastal rice paddy ecosystems that are vulnerable to seawater intrusion, agricultural runoff, and domestic waste (Ariadi et al., 2025). Through analyses of abundance, diversity, and saprobic indices, this research provides a scientific understanding of ecological conditions and the level of pollution present in the study area. The results contribute to the development of aquatic ecology and environmental management, while providing a scientific basis for pollution mitigation strategies. Furthermore, these findings support sustainable agricultural practices by providing recommendations for water quality management for policymakers and stakeholders.

Method

Study Area

This research was conducted in April 2025 in the coastal agricultural areas of Batang Regency, Central Java, Indonesia.

Station Determination

Sampling stations were selected based on the diversity of land uses and the overall environmental conditions of the study area to minimize potential data bias. The location map of the study area is presented in Figure 1.

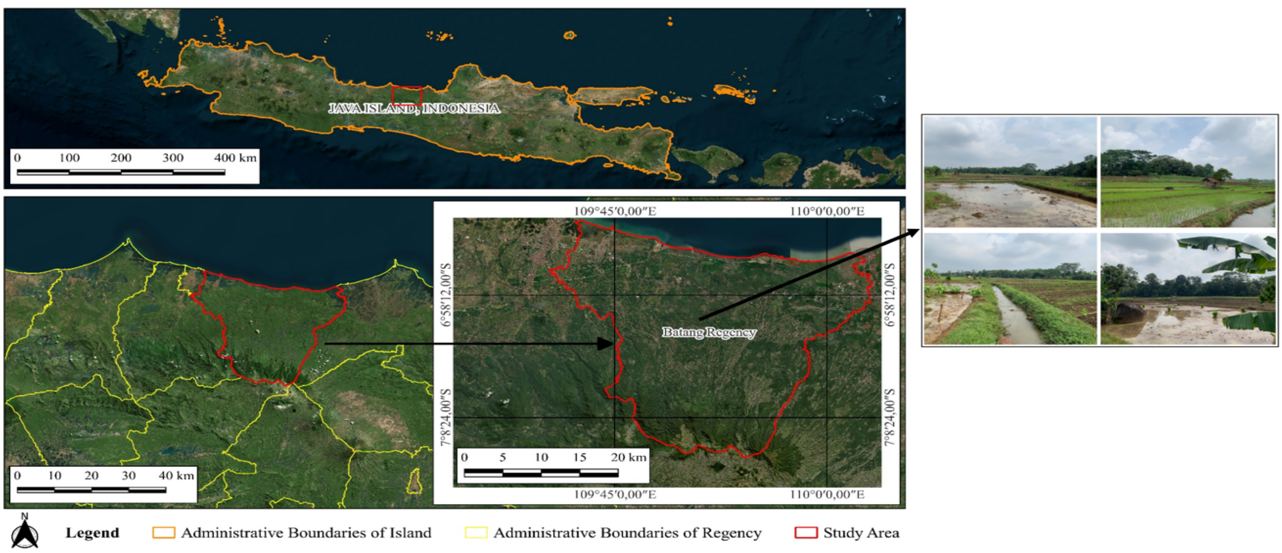

Figure 1. Study area in Batang Regency

Plankton samples were collected using 80 mL film bottles, each labeled according to the respective station. The samples were subsequently identified at the Water Quality Laboratory of Universitas Pekalongan.

Measurements of physicochemical water parameters, including pH, temperature, salinity, and dissolved oxygen, were conducted ex-situ.

Plankton abundance was calculated using the formula from American Public Health Association (2005):

$$N = \frac{T}{L} \times \frac{p1}{p2} \times \frac{V1}{V2} \times \frac{1}{w} \quad (1)$$

Where:
N : plankton abundance (ind/L)
T : number of squares in the Sedgwick-Rafter Counting Cell (SRC) (1.000)
L : number of squares in one field of view
$p1$: number of plankton observed
$p2$: number of SRC squares observed
$V1$: Volume of water in the sample bottle
$V2$: volume of water in one SRC square
w : volume of water filtered

Data Analysis

Shannon–Wiener Diversity Index (H')

Plankton diversity was calculated using the Shannon–Wiener formula (Odum, 1971):

$$H' = -\sum pi. \ln pi \quad (2)$$
$$pi = ni\ N \quad (3)$$

Where:
H' : Shannon–Wiener diversity index
ni : number of individuals of the i-th plankton genius
N : total number of individuals across all genera

Diversity criteria were classified as follows: $H' < 1$ = low community stability, $1 < H' < 3$ = moderate stability, and $H' > 3$ = high stability (Odum, 1971).

Evenness Index (e)

Evenness was calculated using the following equation:

$$e = \frac{H'}{H_{max}} \quad (4)$$
$$H_{max} = \ln S \quad (5)$$

Where:
e : evenness index
H' : Shannon–Wiener diversity index
H'max : maximum diversity index
S : number of plankton species

Evenness criteria: $e > 0.6$ = evenly distributed taxa; $0.4 \leq e \leq 0.6$ = moderately even distribution; $e < 0.4$ = uneven distribution (Odum, 1971).

Dominance Index (C)

Plankton dominance was calculated using the following equation (Odum, 1971):

$$C = \sum (ni/N)^2 \quad (6)$$

Where:
C : dominance index
ni : number of individuals of a species
N : total number of individuals across all species

Interpretation: C approaching 0 indicates no dominant species, while C approaching 1 indicates the presence of a dominant species.

Saprobic Index (X)

The saprobic index was calculated using the equation proposed by Dresscher & van der Mark (1976):

$$X = \frac{C+3D-B-3A}{A+B+C+D} \quad (7)$$

Where:
X : saprobic coefficient (range: -3 to +3)
A : number of taxa from Cyanophyceae (polysaprobic group)
B : number of taxa from Euglenophyceae (α-mesosaprobic group)
C : number of taxa from *Chlorophyceae* (β-mesosaprobic group)
D : number of taxa from Chrysophyceae (oligosaprobic group)

Water Quality Parameters

Water quality parameters were analyzed descriptively by comparing the measured values to the Indonesian water quality standards as stipulated in Government Regulation No. 82 of 2001. The analysis was conducted comprehensively to assess the overall condition of the water in the study area.

Results and Discussion

Plankton Abundance and Diversity

The results revealed that plankton abundance in the paddy-field waters of Batang Regency remained relatively low. The most dominant group was *Bacillariophyceae*, accounting for 40% of the total abundance, which was substantially higher than that of other plankton groups (Figure 2). Similar findings were reported by Ariadi et al. (2022), who observed that *Bacillariophyceae* were the dominant plankton group in the northern waters of Pekalongan–Batang. *Bacillariophyceae* are widely distributed in tropical waters due to their high adaptability to varying aquatic temperature ranges (Prasetiya et al., 2025). Batang Regency, located along the northern coast of Java, experiences warm temperatures year-round, providing favorable conditions for Bacillariophyceae to persist for extended periods.

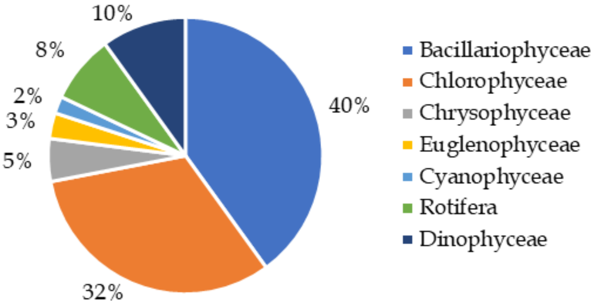

Figure 2. Percentage of plankton by division

The dominant plankton genera in the paddy field waters were *Chaetoceros* sp. and *Chlorella* sp. (Figure 3). *Chaetoceros* sp. belongs to *Bacillariophyceae*, while *Chlorella* sp. belongs to *Chlorophyceae*. Both are cosmopolitan plankton genera with moderate dominance levels (Hogg et al., 2018). The presence of *Chaetoceros sp.* indicates balanced nutrient availability in the water (Bhattacharjya et al., 2022), whereas *Chlorella* sp. reflects the tropical nature of the paddy field ecosystem in Batang Regency (Debnath et al., 2025).

Nutrient levels in the paddy field waters tend to be elevated due to agricultural fertilizer runoff. Additionally, domestic wastewater from nearby settlements contributes to nutrient enrichment. *Chaetoceros* sp. thrives in nutrient-rich environments (Pérez et al., 2017), while *Chlorella* sp. is highly adaptive and dependent on waters with elevated nutrient concentrations (S. Wang et al., 2022). The abundance of *Chaetoceros* sp. and *Chlorella* sp. is closely related to the N:P ratio in the paddy waters.

The cosmopolitan nature of *Chaetoceros* Sp. suggests that the plankton community in Batang's paddy fields is influenced by both freshwater and brackish water characteristics. *Chaetoceros* sp. is often found in brackish environments with moderate salinity (Zhang et al., 2025). In the coastal agricultural areas of Batang, seawater intrusion into paddy fields, although minimal, is common. Moreover, *Chaetoceros* sp. can also tolerate high concentrations of dissolved organic matter (Lanzillotta et al., 2004).

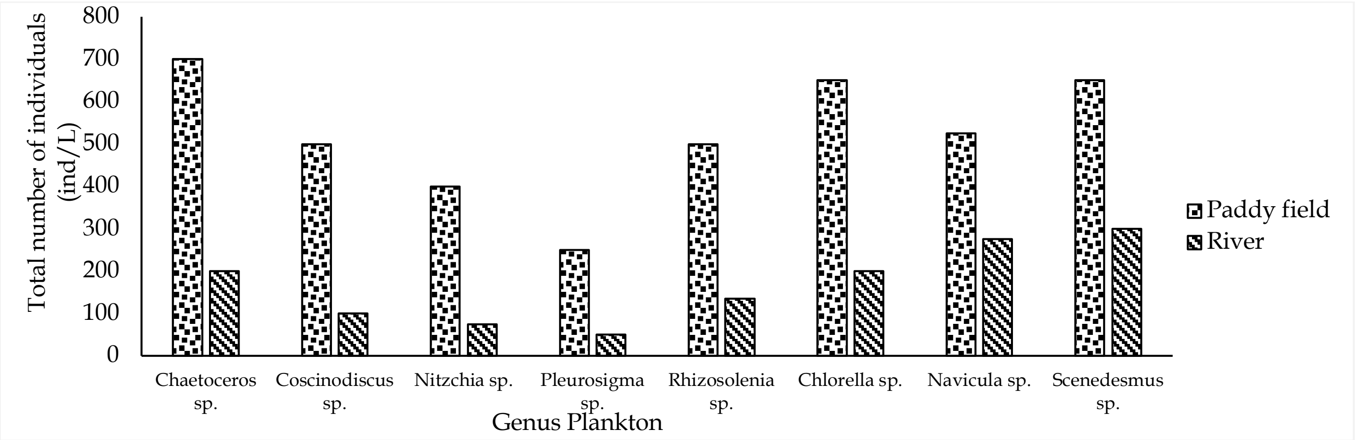

Figure 3. Plankton abundance in paddy field waters

Other commonly found plankton in the paddy field waters included *Coscinodiscus* sp., *Rhizosolenia* sp., *Navicula* sp., and *Scenedesmus* sp., all belonging to *Bacillariophyceae*. Members of *Bacillariophyceae* can survive even under poor-quality conditions (Zaghloul et al., 2024). *Coscinodiscus* sp., in particular, is used as a bioindicator of degraded aquatic environments (Ameryk et al., 2014).

The presence of several plankton genera such as *Chaetoceros* sp., *Navicula* sp., and *Scenedesmus* sp. indicates that the paddy field waters in Batang Regency are highly eutrophic. This condition is likely attributed to the elevated use of phosphorus and nitrogen during paddy cultivation (Gu & Yang, 2022; Zabbey et al., 2025). Furthermore, surrounding environmental factors, such as river inflows carrying excess nutrients, contribute to enhanced the primary productivity of paddy field waters (Chen et al., 2025). Agricultural lands in Batang Regency, located in lowland areas, are highly susceptible to runoff from upstream regions (Potdar et al., 2025).

Plankton diversity indices (H') in Batang's paddy fields ranged from 1.45 to 2.85, indicating a moderate level of diversity (Figure 4). These values also reflect relatively stable plankton community structures. Stations 1, 2, and 4 recorded relatively higher H' values, suggesting better community stability under various environmental conditions. Plankton's diversity stability is strongly influenced by surrounding aquatic environmental conditions (Amorim & Moura, 2021; Yan et al., 2025). The proximity of rivers, which serve as irrigation sources, significantly shapes plankton community composition.

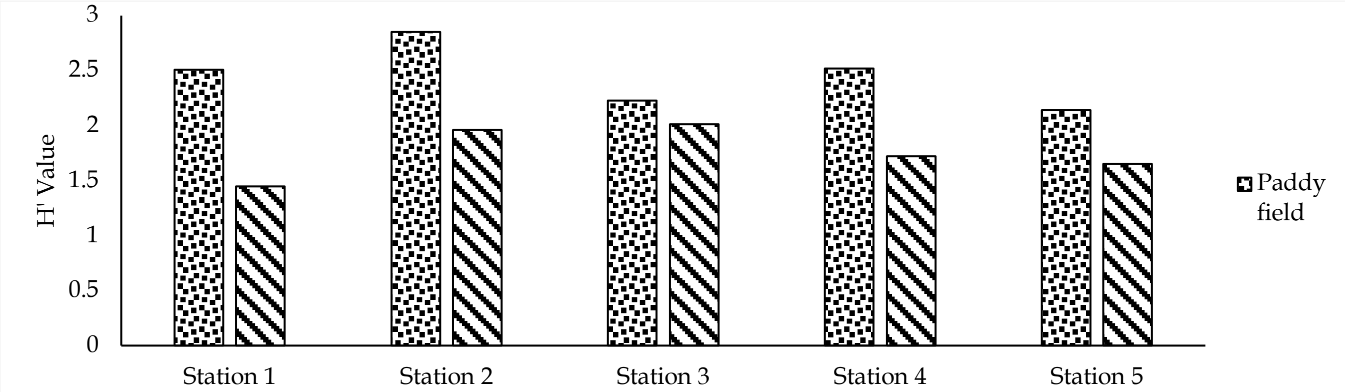

Figure 4. Plankton diversity index (H')

Evenness index values in the paddy waters were generally high (>0.6) or close to 1.0, indicating no dominance by any particular plankton species. This observation was consistent with low dominance index values (<0.5). The relatively stable evenness and dominance indices are attributable to the overall low plankton abundance in the study area (Figure 5). Seasonal variations and agricultural practices during the paddy cultivation period strongly influence plankton abundance patterns, which in turn affect evenness and dominance indices (Apego et al., 2024; Frau et al., 2021).

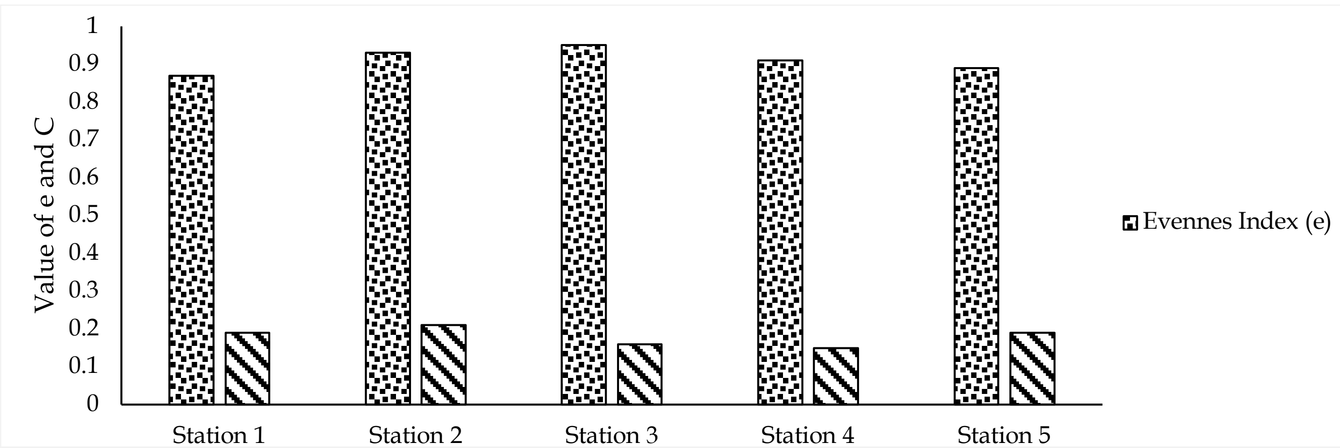

Figure 5. Plankton evenness and dominance indices

High plankton diversity in the paddy field ecosystem was associated with water temperature and dissolved oxygen levels (Jankauskienė et al., 2025). Elevated dissolved oxygen (>4.0 mg/L) and stable temperatures promote greater plankton diversity. High dissolved oxygen levels in paddy waters are driven by water circulation and the presence of aquatic vegetation (Amorim & Moura, 2021). Stable water circulation and the presence of nutrient-absorbing plants help maintain oxygen solubility in the aquatic ecosystem (Firdausa et al., 2024).

The relatively high evenness index and low dominance index values indicate active grazing processes in the paddy field ecosystem. Moreover, stable nutrient availability and high soil organic matter content influence plankton evenness (Ariadi et al., 2025). Paddy ecosystems with balanced interactions between soil, water, and fertilizer runoff tend to strongly support plankton persistence (Sudhakar et al., 2025). Additionally, water turbidity and flow velocity also play a role in shaping the existing plankton community structure (Mardiana et al., 2024).

Water Quality

The water quality parameters in the paddy field aquatic environment were generally favorable and complied with the water quality standards stipulated in Government Regulation No. 82 of 2001 (Table 1). The concentrations of these parameters within the paddy field ecosystem were highly supportive of both aquatic life and paddy cultivation as an agricultural commodity. Moreover, water quality values were relatively uniform across all sampling stations, indicating that the ecological conditions within the paddy field waters were largely homogeneous.

Table 1. Water quality parameters of paddy field waters

Parameter	Station					River
	1	2	3	4	5	
pH	7.1	7.2	7.1	7.1	7.2	7.1
Temperatur (°C)	23.50	24.15	23.50	24.00	23.25	23.15
Salinity (g/L)	0.5	0.5	0.5	0.5	0.5	0.0
Dissolved oxygen (mg/L)	4.53	4.67	4.21	4.79	4.52	4.88

A notable observation from the water quality data was the salinity level, which reached 0.5 g/L. This suggests the presence of saline elements in the paddy field water. The saline content is likely attributable to the proximity of the paddy fields to coastal areas, allowing for the intrusion of brackish water, coupled with high rainfall intensity. A salinity level of 0.5 g/L remains within the tolerance threshold for paddy growth (Peng et al., 2025). This slightly saline condition also influences plankton composition, which was dominated by *Bacillariophyceae* (Prasetiya et al., 2025).

High dissolved oxygen levels (>4.00 mg/L) combined with stable temperatures can promote crop growth under intensive agricultural systems. Furthermore, the generally favorable water quality indicates minimal pollution levels in the study area (Zou et al., 2021). Good water quality serves as an ecological indicator that the aquatic environment remains capable of sustaining biological life (Soeprapto et al., 2023). Appropriate agricultural engineering strategies should be considered to optimize crop selection based on these favorable water conditions (Al Ramadhani et al., 2024), thereby ensuring optimal paddy field productivity.

Saprobity Index of Paddy Field Waters

The ecological quality of paddy field water ecosystems can also be assessed through the saprobic index (X). The saprobic coefficient in the paddy field ecosystem indicated a condition ranging from slight to moderate pollution, classified within the β-Meso/Polysaprobic to α-Mesosaprobic phases (Table 2).

Table 2. Saprobity index of paddy field waters in Batang Regency

Location	Saprobic Index	Saprobic Phase	Pollution Level	Pollution Load
Paddy field				
Station 1	-1	α-Mesosaprobic	Moderately high	High organic compounds
Station 2	1	β-Meso/Polysaprobic	Slight/low	Organic and inorganic compounds
Station 3	-1	α-Mesosaprobic	Moderately high	High organic compounds
Station 4	1	β-Meso/Polysaprobic	Slight/low	Organic and inorganic compounds
Station 5	0	β/α-Mesosaprobic	Moderate	Organic and inorganic compounds
River				
Station 1	-1	α-Mesosaprobic	Moderate	High organic compounds
Station 2	-1	α-Mesosaprobic	Moderate	High organic compounds
Station 3	-1	α-Mesosaprobic	Moderately high	High organic compounds
Station 4	0	β/α-Mesosaprobic	Moderate	Organic and inorganic compounds
Station 5	-1	α-Mesosaprobic	Moderate	High organic compounds

Based on water quality data, the condition of paddy field waters in Batang Regency is still generally good when referring to the water quality standards stipulated in Government Regulation No. 82 of 2001. However, analysis of the saprobic index revealed relatively high levels of pollution at Station 1, Station 3, and Station 3 (river). This was primarily due to the proximity of these stations to densely populated areas and the timing of sampling. Pollution at Station 3 (river) was likely influenced by its location in a downstream area where tributaries converge, increasing the potential for water contamination. Seasonal variations also play a significant role in determining the pollution status of aquatic environments (Panigrahi et al., 2013).

The presence of pollution indicators in paddy field areas suggests that paddy cultivation zones in Batang Regency have already reached a polluted status. Potential sources of contaminants include domestic wastewater, industrial effluents, and tourism-related waste. The degree of pollution may change if there is a reduction in human activities around the paddy fields (Ma & Yuan, 2024). In addition, the excessive use of chemical fertilizers and pesticides also contributes significantly to pollution levels in paddy field ecosystems (Tan et al., 2020).

Polluted paddy field areas can be managed by adjusting the types of crops cultivated to suit environmental conditions (Hanif et al., 2023). Certain plant species, such as water spinach (*Ipomoea aquatica*), Chinese kale (*Brassica oleracea* var. *alboglabra*), and beans, are suitable for cultivation in dryland areas under tropical temperatures (Al Ramadhani et al., 2024; Handriatni et al., 2024). Moreover, agricultural land in the coastal areas of Batang Regency is also considered suitable for cultivating dragon fruit (*Hylocereus spp.*) and watermelon (*Citrullus lanatus*) (Mondol et al., 2025). Such alternatives could serve as agronomic references for developing productive agricultural zones.

Overall, this study found the dominance of the class *Bacillariophyceae*, with *Chaetoceros* sp. as the prevailing plankton. This indicates that paddy field waters remain sufficiently fertile, with good primary productivity levels (Ariadi et al., 2022, 2024). Furthermore, the relatively high diversity index and low dominance index suggest that the biological community in Batang Regency's paddy field waters is still ecologically sound. This is supported by water quality parameters that meet the standard requirements for agricultural and aquaculture activities.

A key finding from this research is the identification of several stations classified as moderately polluted based on the saprobic index. This serves as a warning that certain paddy field areas have entered a polluted state, thus requiring anticipatory measures. A healthy paddy field ecosystem supports both land productivity and the sustainability of agricultural practices (Colombi et al., 2025).

The adoption of precision agriculture is highly recommended to mitigate land quality degradation and prevent declines in crop yields (Sharma & Khullar, 2025). Coastal paddy field ecosystems are particularly vulnerable to pollution impacts, thus necessitating specific engineering strategies in farming operations (Mulla et al., 2025). In some cases, environmental manipulation for agriculture in coastal regions involves periodic cultivation cycles or the implementation of farming operations during specific periods (Y. Wang et al., 2025). Such an approach is considered ideal for moderate application in saline or marginal agricultural lands.

Conclusion

The plankton community in the paddy field waters of Batang's coastal region demonstrated relatively stable abundance, with Bacillariophyceae emerging as the predominant class. Chaetoceros sp. was identified as the leading bioindicator genus, reflecting a moderate level of diversity. These results align with the overall ecological condition of the paddy field waters, which remain in good status and meet established water quality standards for agricultural and aquaculture practices. Practically, these findings imply that routine monitoring of dominant plankton taxa can serve as an effective early-warning tool for detecting shifts in water quality, supporting better management of irrigation systems, optimizing fertilizer use, and maintaining the sustainability of coastal rice cultivation and integrated aquaculture activities.

Acknowledgments

The author gratefully acknowledges for Batang Governance and young farmer in Rowobelang village and Lembaga Penelitian & Pengabdian Masyarakat (LPPM) Universitas Pekalongan for grant research in 2025.

Author Contributions

Conceptualization, A.H. and H.A.; methodology, U.B and S.J.; software, F.M.A.R.; validation, R.A., M.A.F. and S.M.; formal analysis, A.H.; investigation, C.D.P.; resources, H.A.; data curation, F.M.A.R.; writing—original draft preparation, U.B.; writing—review and editing, S.J.; visualization, H.A.; supervision, A.H.; project administration, F.M.A.R.; funding acquisition, S.J. All authors have read and agreed to the published version of the manuscript.

Funding

This research was funded by Department of Research and Community Service, Pekalongan University, with grant number 100/B.06.01/LPPM/III/2025.

Conflicts of Interest

The authors declare no conflict of interest.

References

Al Ramadhani, F. M., Ariadi, H., Mufid, A., Handriatni, A., Sajuri, & Ximenes, R. da C. (2024). A comprehensive study on the business feasibility, and optimization model for paddy cultivation on marginal agricultural land in Pekalongan District. *AGRISEP: Journal of Agricultural Socio-Economic and Agribusiness Studies*, *23*(02), 351–372. https://doi.org/10.31186/jagrisep.23.02.351-372

American Public Health Association (APHA). (2005). *Standard Methods for the Examination of Water & Wastewater*. American Public Health Association (APHA).

Ameryk, A., Hahnke, R. L., Gromisz, S., Kownacka, J., Zalewski, M., Szymanek, L., Całkiewicz, J., Dunalska, J., & Harder, J. (2014). Bacterial community structure influenced by Coscinodiscus sp. in the Vistula river plume. *Oceanologia*, *56*(4), 825–856. https://doi.org/10.5697/oc.56-4.825

Amorim, C. A., & Moura, A. do N. (2021). Ecological impacts of freshwater algal blooms on water quality, plankton biodiversity, structure, and ecosystem functioning. *Science of the Total Environment*, *758*, 143605. https://doi.org/10.1016/j.scitotenv.2020.143605

Apego, G. C. M. B., Kudela, R. M., & Yñiguez, A. T. (2024). Phytoplankton assemblage shifts from whale shark off-season to in-season in Donsol, Philippines influenced by temperature and nutrients. *Regional Studies in Marine Science*, *80*, 103898. https://doi.org/10.1016/j.rsma.2024.103898

Ariadi, H., Khristanto, A., Soeprapto, H., Kumalasari, D., & Sihombing, J. L. (2022). Plankton and its potential utilization for climate resilient fish culture. *AACL Bioflux*, *15*(4), 2041–2051. Retrieved from http://bioflux.com.ro/docs/2022.2041-2051.pdf

Ariadi, H., Mardiana, T. Y., Linayati, L., Syakirin, M. B., & Madusari, B. D. (2025). Identification of plankton in the stomach of milkfish (Chanos chanos) seeds obtained from natural waters. *The Philippine Journal of Fisheries*, *32*(1), 9–18. https://doi.org/10.31398/tpjf/32.1.2023-0047

Ariadi, H., Linayati, L., Mardiana, T. Y., Wafi, A., Al Ramadhani F. M. (2025). Effect of Tidal Fluctuations on Water and Soil Quality in Shrimp Ponds. *Egyptian Journal of Aquatic Biology & Fisheries*, *29*(5), 2701-2716. https://doi.org/10.21608/ejabf.2025.331778.4856

Ariadi, H., Musa, M., Mahmudi, M., Hertika, A. M. S. (2025). Organic Material Solubility and Dynamic Modelling Analysis of Intensive Shrimp Farming Activities in the Coastal Area of Pekalongan, Indonesia. *Croatian Journal of Fisheries, 83*(2), 71-85. https://doi.org/10.2478/cjf-2025-0008

Ariadi, H., Mujtahidah, T., Tartila, S. S. Q., Azril, M., & Ayisi, C. L. (2024). Dynamic modelling analysis of Vibrio sp. and plankton abundance in intensive shrimp pond. *Biosaintifika*, *16*(3), 449–463. https://doi.org/10.15294/biosaintifika.v16i3.16465

Berman, M. C., O'Farrell, I., Huber, P., Marino, D., & Zagarese, H. (2022). A large-scale geographical coverage survey reveals a pervasive impact of agricultural practices on plankton primary producers. *Agriculture, Ecosystems & Environment*, *325*, 107740. https://doi.org/10.1016/j.agee.2021.107740

Bhattacharjya, R., Singh, P. K., Saxena, A., & Tiwari, A. (2022). Depiction of growth specific changes in concentration of storage products in centric marine diatom Chaetoceros gracilis. *Journal of Sea Research*, *190*, 102289. https://doi.org/10.1016/j.seares.2022.102289

Chadda-Harmer, D., Byrne, M., Reymond, C. E., Fellowes, T. E., Camp, E. F., & Foo, S. A. (2025). Benthic foraminifera as bioindicators of coral condition near mangrove environments. *Marine Environmental Research*, *209*, 107159. https://doi.org/10.1016/j.marenvres.2025.107159

Chang, C., Hu, E., Xue, X., Li, J., Du, D., Yang, F., & Li, M. (2024). Hydro-morphology and water quality jointly shape the structure and network stability of the plankton community in multi-tributary river basins. *Journal of Hydrology*, *643*, 131945. https://doi.org/10.1016/j.jhydrol.2024.131945

Chen, X., Yan, A., Lu, S., Zhang, H., Li, D., & Jiang, X. (2025). Accelerated stochastic processes of plankton community assembly due to tidal restriction by seawall construction in the Yangtze River Estuary. *Marine Environmental Research*, *204*, 106941. https://doi.org/10.1016/j.marenvres.2024.106941

Colombi, G., Martani, E., & Fornara, D. (2025). Regenerative organic agriculture and soil ecosystem service delivery: A literature review. *Ecosystem Services*, *73*, 101721. https://doi.org/10.1016/j.ecoser.2025.101721

Debnath, C., Bandyopadhyay, T. K., & Muthuraj, M. (2025). Evaluation of algal strains for carbohydrate production: Potentials of Chlorella lewinii FwC1 under different trophic modes and in open-pond conditions. *Algal Research*, *89*, 104050. https://doi.org/10.1016/j.algal.2025.104050

Dresscher, Th. G. N., & van der Mark, H. (1976). A simplified method for the biological assessment of the quality of fresh and slightly brackish water. *Hydrobiologia*, *48*(3), 199–201. https://doi.org/10.1007/BF00028691

Escobar, N., Tizado, E. J., zu Ermgassen, E. K. H. J., Löfgren, P., Börner, J., & Godar, J. (2020). Spatially-explicit footprints of agricultural commodities: Mapping carbon emissions embodied in Brazil's soy exports. *Global Environmental Change*, *62*, 102067. https://doi.org/10.1016/j.gloenvcha.2020.102067

Espinoza, M., & Escobal, J. (2025). The impact of Peru's land reform on national agricultural productivity: A synthetic control study. *Land Use Policy*, *157*, 107619. https://doi.org/10.1016/j.landusepol.2025.107619

Feng, L., Luo, G., Ioppolo, G., Zhang, X., & Liao, W. (2025). Prevention and control of soil pollution toward sustainable agricultural land use in China: Analysis from legislative and judicial perspectives. *Land Use Policy*, *151*, 107497. https://doi.org/10.1016/j.landusepol.2025.107497

Firdausa, D. I., Sulistiana, A., & Ariadi, H. (2024). Plankton community profile in silvofishery ponds. *BIO Web of Conferences*, *136*, 1–10. https://doi.org/10.1051/bioconf/202413601003

Frau, D., Gutierrez, M. F., Regaldo, L., Saigo, M., & Licursi, M. (2021). Plankton community responses in Pampean lowland streams linked to intensive agricultural pollution. *Ecological Indicators*, *120*, 106934. https://doi.org/10.1016/j.ecolind.2020.106934

Gu, J., & Yang, J. (2022). Nitrogen (N) transformation in paddy rice field: Its effect on N uptake and relation to improved N management. *Crop and Environment*, *1*(1), 7–14. https://doi.org/10.1016/j.crope.2022.03.003

Handriatni, A., Ariadi, H., Al Ramadhani, F. M., Jazilah, S., & Sajuri. (2024). Study assessment of soil and water quality conditions on barren agricultural lands in tropical regions. *Journal of Environment and*

Earth Science, *6*(3), 176–185. https://doi.org/10.30564/jees.v6i3.6977

Hanif, W., Mensi, W., Vo, X. V., BenSaïda, A., Hernandez, J. A., & Kang, S. H. (2023). Dependence and risk management of portfolios of metals and agricultural commodity futures. *Resources Policy*, *82*, 103567. https://doi.org/10.1016/j.resourpol.2023.103567

Hogg, O. T., Huvenne, V. A. I., Griffith, H. J., & Linse, K. (2018). On the ecological relevance of landscape mapping and its application in the spatial planning of very large marine protected areas. *Science of the Total Environment*, *626*, 384–398. https://doi.org/10.1016/j.scitotenv.2018.01.009

Jankauskienė, J., Janušaitienė, K., Karosienė, J., Paškauskas, R., Jurkonienė, S., & Mockevičiūtė, R. (2025). Impact of phytoplankton biomass on the growth and development of agricultural plants. *Agronomy*, *15*(5), 1–17. https://doi.org/10.3390/agronomy15051120

Kuncheva, G., Kercheva, M., Petkova, G., Perfanova, J., Paparkova, T., Kolchakov, V., Ginchev, G., Tribis, L., Doneva, K., & Mitova, M. (2025). Sensitivity and sustainability of soil quality indicators of Epicalcic Chernozem under soil erosion control technologies. *Geoderma Regional*, *42*, e00976. https://doi.org/10.1016/j.geodrs.2025.e00976

Lanzillotta, E., Ceccarini, C., Ferrara, R., Dini, F., Frontini, F. P., & Banchetti, R. (2004). Importance of the biogenic organic matter in photo-formation of dissolved gaseous mercury in a culture of the marine diatom Chaetoceros sp. *The Science of the Total Environment*, *318*(1–3), 211–221. https://doi.org/10.1016/S0048-9697(03)00400-5

Lyu, S., Hu, M., Zhu, Y., Deng, Z., Duan, L., Gao, R., & Wang, G. (2025). Response mechanisms of eukaryotic plankton community structure to complex environmental conditions in semi-arid river basins, China. *Journal of Environmental Management*, *376*, 124527. https://doi.org/10.1016/j.jenvman.2025.124527

Ma, X., & Yuan, H. (2024). Ecological footprint and carrying capacity of agricultural water-land-energy nexus in China. *Ecological Indicators*, *168*, 112786. https://doi.org/10.1016/j.ecolind.2024.112786

Mardiana, T. Y., Ariadi, H., Ramadhani, F. M. Al, Syakirin, M. B., & Linayati, L. (2024). Dynamic modeling system of cholorophyceae abundance in pen-culture ponds during the dry season. *Ecological Engineering & Environmental Technology*, *25*(8), 47–56. https://doi.org/10.12912/27197050/189238

Mondol, M. S. A., Akbar, U., Mandal, O., Rani, A., Dar, A. H., Chatterjee, A., & Abdi, G. (2025). Advances in agronomic practices, postharvest technologies, and medicinal potential of dragon fruit (Hylocereus spp.): A comprehensive updated review. *Journal of Agriculture and Food Research*, *22*, 1–13. https://doi.org/10.1016/j.jafr.2025.102157

Mulla, S., Singh, S. K., & Ahmed, R. (2025). Assessing the impact of climate change on land-falling tropical cyclones (LFTCs) over the North Indian Ocean (NIO) and their effects on coastal agriculture in Maharashtra: A case study. *Tropical Cyclone Research and Review*, *14*(2), 132–144. https://doi.org/10.1016/j.tcrr.2025.04.003

Odum, E. P. (1971). *Fundamentals of Ecology* (Third Edit). Saunders.

Panigrahi, S., Nydahl, A., Anton, P., & Wikner, J. (2013). Strong seasonal effect of moderate experimental warming on plankton respiration in a temperate estuarine plankton community. *Estuarine, Coastal and Shelf Science*, *135*, 269–279. https://doi.org/10.1016/j.ecss.2013.10.029

Peng, W., Zhu, X., Zheng, W., Xie, Q., Wang, M., & Ran, E. (2025). Rice cultivation can mitigate soil salinization and alkalization by modifying the macropore structure in saline–sodic paddy fields. *Agricultural Water Management*, *313*, 109473. https://doi.org/10.1016/j.agwat.2025.109473

Pérez, L., Salgueiro, J. L., González, J., Parralejo, A. I., Maceiras, R., & Cancela, Á. (2017). Scaled up from indoor to outdoor cultures of Chaetoceros gracilis and Skeletonema costatum microalgae for biomass and oil production. *Biochemical Engineering Journal*, *127*, 180–187. https://doi.org/10.1016/j.bej.2017.08.016

Potdar, S. S., Siingh, D., Biswasharma, R., Gautam, A. S., & Singh, R. P. (2025). Influence of land use land cover and topography on lightning distribution over north and north-east Indian region. *Journal of Atmospheric and Solar-Terrestrial Physics*, *268*, 106460. https://doi.org/10.1016/j.jastp.2025.106460

Prasetiya, F. S., Jauffrais, T., Mohamed-Benkada, M., Callac, N., Ansquer, D., Yılmaz, E., Lemieux, C., Turmel, M., Mouget, J., Prabowo, D. A., Purbani, D. C., Noerdjito, D. R., Fahmi, V., Arsad, S., & Gastineau, R. (2025). Diving into Diversity: Haslea berepwari (Bacillariophyceae, Naviculaceae), a new species of marine diatom from New Caledonia. *PhytoKeys*, *255*, 215–234. https://doi.org/10.3897/phytokeys.255.144697

Rosenqvist, E., Kiviruusu, O., & Konttinen, H. (2022). The associations of socioeconomic status and financial strain with restrained and emotional eating among 42-year-old women and men. *Appetite*, *169*, 105795. https://doi.org/10.1016/j.appet.2021.105795

Sahara, D., Yaumidin, U. K., Suhendrata, T., Setiani, C., Beti, J. A., Dewi, T., Fadwiwati, A. Y., Idaryani, Atman, Yardha, Waas, E., Asnawi, R., & Syam, A.

(2025). Sustainability of shallot farming system in lowland Central Java Province, Indonesia: MICMAC analysis approach. *Environmental Challenges*, *20*, 101212. https://doi.org/10.1016/j.envc.2025.101212

Sharma, I., & Khullar, V. (2025). Blockchain-enabled federated learning-based privacy preservation framework for secure IoT in precision agriculture. *Journal of Industrial Information Integration*, *44*, 100765. https://doi.org/10.1016/j.jii.2024.100765

Soeprapto, H., Ariadi, H., Badrudin, U., & Soedibya, T. P. H. (2023). The abundance of Microcystis sp. on intensive shrimp ponds. *DEPIK: Jurnal Ilmu-Ilmu Perairan, Pesisir Dan Perikanan*, *12*(1), 105–110. https://doi.org/10.13170/depik.12.1.30433

Sudhakar, K., Dathu, R. P., & Madhu, V. (2025). Assessing the effect of agricultural fertilizers on plankton community in culture ponds of Krishna District in Andhra Pradesh, India. *Uttar Pradesh Journal of Zoology*, *46*(7), 159–167. https://doi.org/10.56557/upjoz/2025/v46i74873

Tan, H., Li, Q., Zhang, H., Wu, C., Zhao, S., Deng, X., & Li, Y. (2020). Pesticide residues in agricultural topsoil from the Hainan tropical riverside basin: Determination, distribution, and relationships with planting patterns and surface water. *Science of the Total Environment*, *722*, 137856. https://doi.org/10.1016/j.scitotenv.2020.137856

Wang, S., Yin, C., Yang, Z., Hu, X., Liu, Z., & Song, W. (2022). Assessing the potential of Chlorella sp. for treatment and resource utilization of brewery wastewater coupled with bioproduct production. *Journal of Cleaner Production*, *367*, 132939. https://doi.org/10.1016/j.jclepro.2022.132939

Wang, Y., Lei, H., & Chen, J. (2025). Effects of continuous periodic Phragmites harvesting on microbial characteristics and soil multifunctionality in wetlands adjacent to residential and agricultural areas. *Environmental Technology & Innovation*, *40*, 104386. https://doi.org/10.1016/j.eti.2025.104386

Xu, H., Yong, J., & Xu, G. (2016). Bioassessment of water quality status using a potential bioindicator based on functional groups of planktonic ciliates in marine ecosystems. *Marine Pollution Bulletin*, *110*(1), 409–414. https://doi.org/10.1016/j.marpolbul.2016.06.033

Yan, C.-R., Hu, L.-S., Zhang, X.-M., Li, S.-W., Li, F., & Dong, Y.-W. (2025). Water-sediment regulation drives multi-taxon biodiversity and ecological network dynamics in the Yellow River Estuary. *Regional Studies in Marine Science*, *89*, 104336. https://doi.org/10.1016/j.rsma.2025.104336

Yasmeen, A., Pumijumnong, N., Arunrat, N., Punwong, P., Sereenonchai, S., & Chareonwong, U. (2024). Nature-based solutions for coastal erosion protection in a changing climate: A cutting-edge analysis of contexts and prospects of the muddy coasts. *Estuarine, Coastal and Shelf Science*, *298*, 108632. https://doi.org/10.1016/j.ecss.2024.108632

Zabbey, N., Akokhia, F., Nwipie, G. N., Nkeeh, D. K., Keke, U. N., Okoro, C. M., & Eziefule, G. C. (2025). Relationship between habitat factors, nutrient loads, and plankton community structure in varied mangrove swamps. *Ecohydrology & Hydrobiology*, *25*(2), 367–376. https://doi.org/10.1016/j.ecohyd.2024.05.005

Zaghloul, F. A., Ghobrial, M. G., Hussein, N. R., Deghady, E. E. D., & Hussein, M. M. A. (2024). Long-term monitoring of water quality and phytoplankton community structure of Lake Manzala, Mediterranean Coast of Egypt. *Scientific African*, *26*, e02345. https://doi.org/10.1016/j.sciaf.2024.e02345

Zhang, X., Chen, J., Xu, Z., & Liu, H. (2025). Metabarcoding reveals high species diversity of Chaetoceros, Pseudo-nitzschia, and Thalassiosira in Hong Kong coastal waters, a typical subtropical region. *Marine Pollution Bulletin*, *212*, 117549. https://doi.org/10.1016/j.marpolbul.2025.117549

Zou, M., Zhou, S., Zhou, Y., Jia, Z., Guo, T., & Wang, J. (2021). Cadmium pollution of soil-rice ecosystems in rice cultivation dominated regions in China: A review. *Environmental Pollution*, *280*, 116965. https://doi.org/10.1016/j.envpol.2021.116965