The Relationship Between Plankton Diversity and Water Quality in Aquaculture Ponds at Tani Mandiri Farm, Sambora Village, Mempawah Regency

Deski Fitri Novianti*, Widadi Padmarsari Soetignya, Yunita Magrima Anzani
Universitas Tanjungpura, Pontianak, Indonesia
*dski.fn@gmail.com

Abstract

Plankton diversity serves as a biological indicator of water quality in aquaculture ponds. This study aimed to analyze the relationship between plankton diversity and water quality parameters in catfish, pangasius, and tilapia aquaculture ponds in Sambora Village, Mempawah Regency. The research was conducted over a three-month period (July-September 2025) using a field survey approach involving periodic plankton sampling and water quality measurements. The observed water quality parameters included temperature, water transparency, pH, nitrate, total phosphate, and biochemical oxygen demand (BOD), while plankton communities were assessed based on abundance, diversity, evenness, and dominance indices. The results revealed 22 phytoplankton genera representing seven phyla and four zooplankton taxa, with Anabaena sp. as the dominant phytoplankton taxon. Water quality varied among ponds, with the catfish and pangasius ponds generally characterized by lower pH and water transparency and higher nutrient concentrations than the tilapia pond, while relatively high BOD values were recorded across the three ponds. Correlation analysis indicated that pH was the only water quality parameter significantly associated with plankton diversity. These findings provide baseline information for the application of plankton as a bioindicator of water quality in traditional freshwater aquaculture ponds.

Keywords: Plankton Diversity; Water Quality; Aquaculture Ponds; Bioindicator

Abstrak

Keanekaragaman plankton berperan sebagai indikator biologis kualitas air pada kolam budidaya ikan. Penelitian ini bertujuan menganalisis hubungan antara keanekaragaman plankton dengan parameter kualitas air pada kolam budidaya ikan lele, patin, dan nila di Desa Sambora, Kabupaten Mempawah. Penelitian dilaksanakan selama tiga bulan (Juli–September 2025) dengan metode survei lapangan melalui pengambilan sampel plankton dan pengukuran kualitas air secara periodik. Parameter yang diamati meliputi suhu, kecerahan, pH, nitrat, total fosfat, dan biochemical oxygen demand (BOD), sedangkan komunitas plankton dianalisis berdasarkan kelimpahan, keanekaragaman, keseragaman, dan dominansi. Hasil penelitian menunjukkan adanya 22 genera fitoplankton yang mewakili tujuh filum dan empat taksa zooplankton, dengan Anabaena sp. sebagai takson fitoplankton yang dominan. Kualitas air bervariasi antar kolam, dengan kolam lele dan patin secara umum memiliki pH dan kecerahan yang lebih rendah serta konsentrasi nutrien yang lebih tinggi dibandingkan kolam nila, sedangkan nilai BOD yang relatif tinggi tercatat pada ketiga kolam. Analisis korelasi menunjukkan bahwa pH merupakan satu-satunya parameter kualitas air yang berhubungan signifikan dengan keanekaragaman plankton. Hasil penelitian ini memberikan informasi dasar bagi pemanfaatan plankton sebagai bioindikator kualitas air pada kolam budidaya air tawar tradisional.

Kata Kunci: Keanekaragaman Plankton; Kualitas Air; Kolam Budidaya; Bioindikator

Introduction

Water quality is a primary factor determining the survival and sustainability of aquatic organisms, including plankton. Variations in physical and chemical parameters, such as temperature, pH, water transparency, dissolved oxygen, and nutrient concentrations, directly influence the structure, diversity, and stability of plankton communities (Geng et al., 2022). Because plankton respond rapidly to changes in environmental conditions, they are widely recognized as reliable biological indicators for assessing the ecological status and trophic condition of freshwater ecosystems (Astuti et al., 2026; Chandel et al., 2023; Dehingia et al., 2026; Reynolds, 2006; Wetzel, 2001; Wu et al., 2017; Xuewei et al., 2022).

Plankton consist of phytoplankton and zooplankton, both of which play essential roles in aquatic food webs (Iswanto et al., 2015). Phytoplankton diversity reflects the trophic status and ecological balance of aquatic environments, whereas zooplankton regulate phytoplankton populations and contribute to natural water purification processes. A high dominance of a single plankton species may indicate environmental disturbances, such as organic pollution or nutrient imbalance, which can potentially reduce water quality and aquatic productivity.

Nutrient enrichment caused by eutrophication frequently promotes blooms of opportunistic phytoplankton species while reducing overall community diversity, thereby affecting ecosystem stability and fish production (Jia et al., 2022; Smith and Schindler, 2009). Furthermore, pH is considered one of the most important environmental variables influencing plankton composition because it affects nutrient availability, physiological processes, and species tolerance (Wetzel, 2001). Aquaculture ponds are artificial aquatic environments that are highly susceptible to changes in water quality resulting from farming activities, including feed application and the accumulation of organic matter.

Sambora Village, Mempawah Regency, possesses considerable potential for freshwater aquaculture, particularly the cultivation of catfish, pangasius, and tilapia. The culture system at Tani Mandiri Farm is predominantly traditional to semi-intensive, relying on natural water supplied from drainage canals surrounding secondary forests and oil palm plantations for catfish and pangasius ponds, whereas the tilapia pond receives water from a mountain stream. Fish are fed commercial pellets several times daily, while water exchange is relatively infrequent and generally conducted only when water quality visibly deteriorates or during pond preparation.

Such management practices may lead to the accumulation of organic matter, increased nutrient concentrations, and fluctuations in water quality that influence plankton community structure. Previous studies have demonstrated that plankton diversity is closely associated with water quality in freshwater ecosystems. Studies conducted in Indonesian freshwater aquaculture environments have also shown that variations in water quality are accompanied by changes in plankton diversity, emphasizing the importance of biological indicators for sustainable aquaculture management (Pagoray et al., 2025).

Recent studies conducted in aquaculture ponds have also demonstrated that plankton community structure reflects environmental conditions and can be applied as a reliable indicator of sustainable water quality management (Mao et al., 2025; Nafisyah et al., 2025). Pratomo et al., (2024) reported that plankton composition reflected variations in water quality in freshwater fish farming systems in West Kalimantan, while Ramadhan et al., (2025) found that nitrate and phosphate concentrations affected zooplankton community structure in tilapia hatchery ponds. Similarly, Iswanto et al., (2015) observed significant relationships between plankton diversity and nutrient concentrations in river ecosystems. However, most previous studies focused on nutrient dynamics, general water quality assessment, or individual plankton groups and did not comprehensively evaluate the relationships between multiple physicochemical variables and plankton diversity across different freshwater aquaculture pond systems (Xu et al., 2022).

In Sambora Village, information regarding plankton diversity as a biological indicator of water quality remains unavailable, despite the increasing development of freshwater aquaculture in the area. Routine monitoring by farmers generally emphasizes physical and chemical parameters without incorporating biological indicators, limiting the ecological assessment of pond conditions. Consequently, there is insufficient scientific information regarding how plankton diversity responds to variations in water quality among catfish, pangasius, and tilapia ponds that differ in management practices and water sources. This represents an important knowledge gap that needs to be addressed to support sustainable aquaculture management.

Therefore, this study aimed to analyze the relationship between plankton diversity and water quality in aquaculture ponds located in Sambora Village, Mempawah Regency. Unlike previous studies, this research simultaneously evaluated several physicochemical water quality parameters and plankton community indices across three freshwater aquaculture pond types using correlation analysis to identify environmental variables associated with plankton diversity. The findings are expected to provide scientific information on the ecological condition of pond aquatic ecosystems and serve as a reference for maintaining environmental balance and supporting the sustainability of aquaculture practices.

Methods

This study employed a quantitative field survey conducted from July to September 2025 at Tani Mandiri Aquaculture Farm, Sambora Village, Mempawah Regency, West Kalimantan, Indonesia. Three aquaculture ponds (catfish, pangasius, and tilapia) were purposively selected and sampled monthly at three stations in each pond. Plankton samples were collected using a 30-µm plankton net, preserved with 1% Lugol's solution, identified to the genus level under a microscope, and analyzed for abundance, diversity (H′), evenness (E), and dominance (C). Water quality parameters, including temperature, water transparency, pH, nitrate, total phosphate, and biochemical oxygen demand (BOD), were measured through in situ observations and laboratory analyses using standard methods. The relationships between plankton diversity and water quality parameters were evaluated using Spearman's rank correlation at a significance level of $p < 0.05$.

Result and Discussion

1. Water Quality in Aquaculture Ponds

The water quality conditions varied among the three aquaculture ponds (Table 1). Water temperature ranged from 30.7 to 32.0 °C, with values of 32.0 °C in the catfish pond, 31.6 °C in the pangasius pond, and 30.7 °C in the tilapia pond. These values were within the 25-32 °C range reported as suitable for freshwater fish growth by Suraya et al., (2021) indicating that temperature was unlikely to be a major limiting factor during the study period. Water transparency differed considerably among the ponds. The catfish and pangasius ponds had relatively low transparency values of 16.7 and 14.4 cm, respectively, whereas the tilapia pond had substantially higher transparency at 42.3 cm. Pratomo et al., (2024) reported a transparency range of 30-40 cm as suitable for supporting photosynthetic processes and water quality in freshwater fish farming environments.

The lower transparency observed in the catfish and pangasius ponds may have been associated with suspended particles, plankton abundance, organic matter, and the characteristics of the drainage water supplying these ponds. In contrast, the greater transparency of the tilapia pond was consistent with its mountain-stream water source and comparatively lower phytoplankton abundance. The pH values also differed among the ponds, ranging from 5.6 to 6.6. The catfish and pangasius ponds were more acidic, with pH values of 5.8 and 5.6, respectively, whereas the tilapia pond had a pH of 6.6.

These differences indicate contrasting chemical conditions among the pond water sources and may have contributed to differences in plankton community structure. Because pH influences nutrient availability, cellular physiological processes, and the tolerance of aquatic organisms, relatively acidic conditions may favor some plankton taxa while limiting others. Total phosphate concentrations were highest in the pangasius pond (3.8 mg/L), followed by the catfish pond (1.4 mg/L), while the lowest concentration was recorded in the tilapia pond (0.35 mg/L).

Rather than being interpreted against a single universal threshold, these values indicate substantial differences in phosphorus availability among the ponds. The higher concentrations in the catfish and pangasius ponds may have been associated with the accumulation and decomposition of uneaten feed, fish excreta, organic-rich bottom sediments, limited water exchange, and inputs from surrounding drainage canals. Such nutrient enrichment can stimulate phytoplankton production and alter community composition, particularly when environmental conditions favor rapidly growing or competitively dominant taxa.

Nitrate concentrations ranged from 1.7 to 4.0 mg/L, with the highest value recorded in the pangasius pond and the lowest in the tilapia pond. These concentrations were below the reference value of 10 mg/L used by Pratomo et al., (2024) in evaluating water suitability for freshwater fish farming. Nevertheless, differences in nitrate concentrations among ponds may still influence phytoplankton growth because nitrate serves as an important source of inorganic nitrogen for primary producers. BOD values were 10.7 mg/L in the catfish pond, 7.2 mg/L in the pangasius pond, and 7.3 mg/L in the tilapia pond. All values were above the reference value of 6 mg/L used by Pratomo et al., (2024) indicating relatively high biodegradable organic matter loads in the three ponds. The highest BOD value in the catfish pond suggests greater oxygen demand associated with microbial decomposition of organic matter. The accumulation of uneaten feed, fish waste, decomposing organic material, and limited water exchange may have contributed to the observed BOD levels.

Overall, the catfish and pangasius ponds were characterized by lower water transparency, more acidic conditions, and higher nutrient concentrations than the tilapia pond. However, the tilapia pond, despite its greater water transparency and lower total phosphate and nitrate concentrations, exhibited lower plankton diversity and higher dominance. This pattern indicates that greater water clarity or lower nutrient concentrations do not necessarily correspond to greater plankton diversity. Differences in water source, nutrient availability, pond characteristics, and management practices may jointly shape plankton community structure.

Table 1. Average Water Quality Parameters In The Aquaculture Ponds And Reference Values Reported In The Literature

Parameter	Catfish Pond	Pangasius Pond	Tilapia Pond	Reference Range/Value
Temperature (°C)	32.0	31.6	30.7	25-32
Water transparency (cm)	16.7	14.4	42.3	30-40
pH	5.8	5.6	6.6	–
Total phosphate (mg/L)	1.4	3.8	0.35	–

Nitrate (mg/L)	2.5	4.0	1.7	≤ 10
BOD (mg/L)	10.7	7.2	7.3	≤ 6

Sources: Of Reference Values Suraya et al., (2021); and Pratomo et al., (2024)

Note: Reference values are presented as comparative benchmarks reported in the cited literature and should not be interpreted as universally applicable regulatory thresholds for all freshwater aquaculture systems. A dash (—) indicates that no specific comparative reference value was applied in this study.

2. Plankton Abundance

The results showed that phytoplankton comprised seven phyla, namely Bacillariophyta, Charophyta, Chlorophyta, Chrysophyta, Cyanobacteria, Euglenophyta, and Ochrophyta, represented by a total of 22 genera. The zooplankton community was represented by taxa belonging to Arthropoda, Rotifera, and Protozoa, including Cyclops sp., Astramoeba sp., Brachionus sp., and nauplius larvae. The highest phytoplankton abundance was recorded in the pangasius pond (56,856 cells/L), followed by the catfish pond (56,800 cells/L) and the tilapia pond (25,007 cells/L).

The occurrence of seven phytoplankton phyla and several zooplankton taxa indicates that the ponds supported relatively diverse plankton assemblages. Comparable patterns of phytoplankton and zooplankton richness, abundance, and diversity indices have also been reported in freshwater pond ecosystems, suggesting that pond environmental conditions strongly influence plankton community composition (Islama et al., 2022; Pham et al., 2026). Phytoplankton communities in all ponds were dominated by the phyla Cyanobacteria and Chlorophyta.

The genus Anabaena sp. exhibited the highest abundance in all observation ponds, reaching 19,492 cells/L in the catfish pond, 11,533 cells/L in the pangasius pond, and 16,725 cells/L in the tilapia pond. In addition, the genera Pediastrum sp. and Scenedesmus sp. were also recorded at relatively high abundances. Overall, phytoplankton abundance in the tilapia pond was lower than that observed in the catfish and pangasius ponds, indicating differences in environmental conditions among the aquaculture ponds. Zooplankton abundance exhibited distinct community compositions among the ponds.

In the catfish pond, four zooplankton taxa were recorded, namely Cyclops sp., Astramoeba sp., Brachionus sp., and nauplius larvae, with Brachionus sp. showing the highest abundance (50 ind. L^{-1}). In the pangasius pond, two zooplankton taxa were recorded, namely Astramoeba sp. and Brachionus sp., with Astramoeba sp. exhibiting the highest abundance (108 ind. L^{-1}). Meanwhile, the tilapia pond contained only one zooplankton taxon, Brachionus sp., with an abundance of 67 ind. L^{-1}. These findings indicate that both the diversity and abundance of zooplankton varied among the different aquaculture pond types.

3. Diversity, Evenness, and Dominance Indices

The ecological index analysis revealed differences in plankton community structure among the aquaculture ponds. For phytoplankton, the highest diversity index values were observed in the catfish and pangasius ponds (H′ = 2.17), whereas the lowest value was recorded in the tilapia pond (H′ = 1.30). The evenness index was also higher in the pangasius pond (E = 0.74) and catfish pond (E = 0.73) than in the tilapia pond (E = 0.48). Conversely, the highest dominance index was observed in the tilapia pond (C = 0.47), while the lowest value occurred in the pangasius pond (C = 0.16). For zooplankton, the highest diversity index was recorded in the catfish pond (H′ = 1.20), followed by the pangasius pond (H′ = 0.39), whereas the tilapia pond had a diversity index value of 0.

The highest evenness index was likewise observed in the catfish pond (E = 0.86), followed by the pangasius pond (E = 0.57), while the lowest value was recorded in the tilapia pond (E = 0). The dominance index was highest in the tilapia pond (C = 1.00), followed by the pangasius pond (C = 0.77), and lowest in the catfish pond (C = 0.36). These results indicate that plankton communities in the catfish and pangasius ponds were more diverse and evenly distributed than those in the tilapia pond, which tended to be dominated by particular taxa.

4. Correlation Between Plankton Diversity and Water Quality

The correlation analysis showed that pH was significantly and negatively correlated with phytoplankton diversity ($r = -0.686$; $p = 0.041$). Temperature, water transparency, total phosphate, nitrate, and BOD were not significantly correlated with phytoplankton diversity ($p > 0.05$).

Table 2. Correlation Between Phytoplankton Diversity And Water Quality

Variable (X)	Correlation Coefficient (r)	P-Value
Temperature	0.192	0.620
Water transparency	-0.159	0.683
pH	-0.686*	0.041
Total phosphate	0.377	0.318
Nitrate	-0.200	0.606
BOD	-0.433	0.244

*Significant at $p < 0.05$

For zooplankton, pH also showed a significant negative correlation with diversity ($r = -0.691$; $p = 0.039$). Temperature, water transparency, total phosphate, nitrate, and BOD were not significantly correlated with zooplankton diversity ($p > 0.05$).

Table 3. Correlation Between Zooplankton Diversity And Water Quality

Variable (X)	Correlation Coefficient (r)	P-Value
Temperature	0.415	0.267
Water transparency	-0.373	0.323
pH	-0.691*	0.039
Total phosphate	0.332	0.383
Nitrate	-0.193	0.619
BOD	0.193	0.619

*Significant at $p < 0.05$

Water quality conditions varied among the aquaculture ponds and coincided with differences in plankton community structure. Water temperature in all ponds remained within the range reported as suitable for freshwater fish growth and therefore was unlikely to constitute a major limiting factor during the study period (Suraya et al., 2021). Differences in water transparency were evident, with the catfish and pangasius ponds exhibiting lower transparency than the tilapia pond. Similar relationships between hydrographical characteristics and temporal variation in plankton diversity have been reported in freshwater ecosystems, indicating that transparency and other physical variables contribute to shaping plankton community composition (Annamalai et al., 2023).

The lower transparency in these ponds coincided with higher phytoplankton abundance and higher nutrient concentrations, although the present study did not establish a causal relationship among these variables. In contrast, the tilapia pond had greater water transparency, lower nutrient concentrations, and lower phytoplankton abundance. However, its plankton community was not more evenly structured, as indicated by lower diversity and evenness and higher dominance. Despite having lower water transparency, more acidic conditions, and higher nutrient concentrations, the catfish and pangasius ponds exhibited higher phytoplankton diversity than the tilapia pond.

This pattern suggests that differences in nutrient availability may have contributed to variation in phytoplankton community structure; however, total phosphate and nitrate were not significantly correlated with phytoplankton diversity in this study. Therefore, the observed differences cannot be attributed to nutrient concentrations alone. The lower phytoplankton diversity in the tilapia pond may also have been associated with differences in water source, pond characteristics, substrate conditions, and farm management. Because these factors were not experimentally controlled, their individual effects could not be separated in the present survey.

The comparatively low pH values observed in the catfish and pangasius ponds may have influenced the occurrence of plankton taxa with different tolerances to acidic conditions. The higher phosphate and nitrate concentrations recorded in these ponds also indicate greater nutrient availability; however, neither total phosphate nor nitrate was significantly correlated with plankton diversity in this study. Therefore, their individual effects on plankton community structure could not be established. Differences in phytoplankton composition may also have implications for zooplankton communities because phytoplankton taxa differ in their suitability as food resources.

Moreover, environmental conditions and culture management practices have been shown to influence the growth and abundance of rotifers, particularly Brachionus spp., which are commonly used as indicators of aquatic productivity in aquaculture systems (Hosain et al., 2024). Certain Cyanobacteria may be difficult to consume or nutritionally unsuitable for some zooplankton, potentially influencing zooplankton community structure (Ramadhan et al., 2025). Similarly, the relatively high BOD values indicate substantial oxygen demand associated with the decomposition of biodegradable organic matter, although BOD was not significantly correlated with plankton diversity in the present study.

The phytoplankton diversity index was higher in the catfish and pangasius ponds than in the tilapia pond, whereas the latter exhibited dominance by only a few taxa. A similar pattern was observed for zooplankton, where the catfish and pangasius ponds displayed higher diversity than the tilapia pond, which was dominated by a single genus. These findings demonstrate differences in plankton community structure among ponds with contrasting physicochemical conditions. High diversity is generally accompanied by high evenness and low dominance, whereas low diversity tends to be associated with low evenness and high dominance. Such patterns are influenced by water quality conditions, including pH, water transparency, and organic matter content (Saalidong et al., 2022). The dominance of Anabaena sp. observed in all ponds may have contributed to the lower evenness and higher dominance indices recorded, particularly in the tilapia pond. As one taxon becomes increasingly dominant, the proportional abundance of other phytoplankton taxa declines, resulting in reduced community evenness despite the continued presence of multiple genera.

Similar community structures are commonly reported in nutrient-enriched freshwater ecosystems, where cyanobacterial taxa are able to outcompete other phytoplankton under favorable environmental conditions (Reynolds, 2006; Smith and Schindler, 2009). The correlation analysis demonstrated that pH was the only water quality parameter significantly associated with both phytoplankton and zooplankton diversity. The significant negative correlation indicates that higher pH values were statistically associated with lower plankton diversity during the study period. However, because this study was based on a correlational survey using Spearman's rank correlation analysis, these findings should not be interpreted as evidence of a causal relationship.

Other environmental and management factors, including water source, nutrient availability, pond characteristics, stocking density, and feeding practices, may also have contributed to the observed patterns. Recent biomonitoring studies also suggest that interactions among environmental variables, aquaculture practices, and biological communities are generally more complex than simple pairwise correlations and should ideally be evaluated using integrated ecological approaches (Bredariol et al., 2026). Temperature, water transparency, nitrate, total phosphate, and BOD showed weak and non-significant correlations with plankton diversity, suggesting that no statistically significant associations were detected between these parameters and plankton diversity under the conditions of this study.

Conclusion

The water quality conditions of the catfish, pangasius, and tilapia aquaculture ponds differed and were associated with differences in plankton community structure. The catfish and pangasius ponds supported higher phytoplankton and zooplankton diversity than the tilapia pond, whereas the tilapia pond tended to be dominated by one or a few plankton taxa. The ponds differed in their physicochemical characteristics, with the catfish and pangasius ponds generally exhibiting more acidic conditions, lower water transparency, and higher nutrient concentrations, while relatively high BOD values were recorded across the three ponds. Among the environmental parameters examined, pH was the only water quality parameter significantly correlated with plankton diversity in this study, whereas temperature, water transparency, nitrate, total phosphate, and BOD showed weak and non-significant correlations. Because this study was based on a correlational survey, these findings indicate statistical associations rather than causal relationships. This study provides baseline information on the relationship between water quality and plankton diversity in traditional freshwater aquaculture ponds in Sambora Village and may serve as a scientific reference for future ecological monitoring and sustainable aquaculture management.

References

Annamalai, A., Kannan, R., Chinnadurai, G., Manickam, N., Raju, P., Perumal, P., & Santhanam, P. (2023). Temporal Changes In Plankton Diversity In Relation To Hydrographical Characteristics At Perumal Lake, Cuddalore District, Tamil Nadu, India. *The Journal of Basic and Applied Zoology*, *84*(13), 1-15.

Astuti, S. P., Hashmi, Z., Bilad, M. R., Payus, C. M., Affandi, M., & Soegianto, A. (2026). Freshwater Microalgae As Bioindicators: A Review Of Trait-Based Advances, Ecosystem Insights, And Biomonitoring Innovations. *Environmental Challenges*, *22*, 101428.

Bredariol, J. V., De Matos, M. H. D. O., Souza-Silva, A. C., Meira, B. R., Lansac-Tôha, F. A., & Velho, L. F. M. (2026). Rethinking Aquatic Bioindicators: Testate Amoebae Versus Metazoans In Plankton Samples For Assessing Anthropogenic Impacts On Freshwater Ecosystems. *Environmental Monitoring and Assessment*, *198*(3), 2-18.

Chandel, P., Mahajan, D., Thakur, K., Kumar, R., Kumar, S., Bhavna, B., Sharma, D., & Sharma, A. (2023). A Review On Plankton As A Bioindicator: A Promising Tool For Monitoring Water Quality. *World Water Policy*, *10*(1), 213-232.

Dehingia, R., Pankaj, P., Kakati, L., Gogoi, J., & Chakraborty, S. (2026). Cladocerans And Copepods As Bioindicators Of Aquatic Ecosystem Health: Ecological Roles, Anthropogenic Stressors And Limitations. *Ecological Indicators*, *184*, 114712.

Geng, Y., Li, M., Yu, R., Heyang, S., Zhang, L., Sun, L., Lv, C., & Xu, J. (2022). Response Of Planktonic Diversity And Stability To Environmental Drivers In A Shallow Eutrophic Lake. *Ecological Indicators*, *144*, 109560.

Hosain, M. E., Amin, S. N., Kamarudin, M. S., Arshad, A., Karim, M., Naser, M. N., & Fotedar, R. (2024). Effects of Different Carbon Sources On The Growth and Production of Rotifer (Brachionus Plicatilis) in a Zero-Water Exchange Biofloc Culture System. *Aquaculture Research*, *2024*(1), 8837330.

Islama, M. S., Azadib, M. A., Nasiruddinc, M., & Sarkerd, M. M. (2022). Plankton Species Composition, Abundance And Diversity Indices In Three Ponds Of Chittagong University Campus, Bangladesh. *Journal of Biological Pharmaceutical And Chemical Research*, *9*(2), 1-14.

Iswanto, C. Y., Hutabarat, S., & Purnomo, P. W. (2015). Analisis Kesuburan Perairan Berdasarkan Keanekaragaman Plankton, Nitrat Dan Fosfat Di Sungai Jali dan Sungai Lereng Desa Keburuhan, Purworejo. *Management of Aquatic Resources Journal (MAQUARES)*, *4*(3), 84-90.

Jia, J., Chen, Q., Ren, H., Lu, R., He, H., & Gu, P. (2022). Phytoplankton Composition And Their Related Factors In Five Different Lakes in China: Implications For Lake Management. *International Journal of Environmental Research and Public Health*, *19*(5), 3135.

Mao, C., Li, X., Dunthorn, M., Xu, W., Luo, X., Xiong, X., Al-Farraj, S. A., & Huang, J. (2025). Diversity And Assembly Mechanisms Of Zooplankton Communities In Freshwater Aquaculture Ponds. *Marine Life Science & Technology*, *7*(3), 549-564.

Nafisyah, A. L., Fitria, I. M. A., Nurkasanah, S., Wan, W. A. A. Q. I., & Nindarwi, D. D. (2025). Plankton Community Structure as a Bioindicator of Sustainable Water Quality in Koi (Cyprinus carpio) Ponds. *Egyptian Journal of Aquatic Biology and Fisheries*, *29*(2), 2677-2698.

Pagoray, H., Suyatna, I., Sukarti, K., Kesuma, A. D., Butarbutar, T., Raafi, M., Suyatna, M., & Daru, T. P. (2025). Water Quality And Plankton Diversity To Support Aquaculture In The Middle Mahakam Watershed, East Kalimantan, Indonesia. *Biodiversitas: Journal of Biological Diversity*, *26*(1), 233.

Pham, T. T., Le, T. K., Dang, T. T., Le, T. T., Ngo, T. H. T., Nguyen, C. H., Le, A. H., Nguyen, M. D., Nguyen, T. L., & Dang, D. H. (2026). Diversity of Phytoplankton Species In Aquaculture Ponds Of Dak Ha, Sa Thay, Kon Plong Districts, Quang Ngai province. *CTU Journal of Innovation and Sustainable Development*, *18*(1), 70-79.

Pratomo, M. F. B., Hasan, H., & Lestari, T. P. (2024). Water Quality And Plankton Composition For Freshwater Fish Farming In The Waters Of Parit Keladi Village, Kubu Raya Regency, West Kalimantan. *Asian Journal of Aquatic Sciences*, *7*(3), 349-358.

Ramadhan, F. R., Irawan, H., Permatasari, M. N., & Widhi, R. N. (2025). Analisis Nitrat dan Fosfat Terhadap Struktur Komunitas Zooplankton pada Kolam Pembenihan Ikan Nila (Oreochromis niloticus) Balai Budidaya Ikan Air Tawar Kutasari. *MOLUCCAS AQUATICUS: Journal of Aquatic Management and Innovation*, *1*(2), 87-95.

Reynolds, C. (2006). *Ecology Of Phytoplankton*. Cambridge: Cambridge University Press.

Saalidong, B. M., Aram, S. A., Otu, S., & Lartey, P. O. (2022). Examining The Dynamics Of The Relationship Between Water Ph And Other Water Quality Parameters In Ground And Surface Water Systems. *PloS One*, *17*(1), 1-17.

Smith, V. H., & Schindler, D. W. (2009). Eutrophication Science: Where Do We Go From Here?. *Trends In Ecology & Evolution*, *24*(4), 201-207.

Suraya, U., Gumiri, S., & Permata, D. D. (2021). Hubungan Kualitas Air dengan Pertumbuhan Ikan Lele Sangkuriang (Clarias sp.) Yang Dibesarkan Di Dalam Ember. *Journal of Tropical Fisheries*, *16*(2), 109-115.

Wetzel, R. G. (2001). *Limnology: Lake and River Ecosystems*. Houston: Gulf Professional Publishing.

Wu, N., Dong, X., Liu, Y., Wang, C., Baattrup-Pedersen, A., & Riis, T. (2017). Using River Microalgae As Indicators For Freshwater Biomonitoring: Review of Published Research And Future Directions. *Ecological Indicators*, *81*, 124-131.

Xu, H., Zhao, D., Zeng, J., Mao, Z., Gu, X., & Wu, Q. L. (2022). Evaluating The Effects Of Aquaculture On The Freshwater Lake From The Perspective Of Plankton Communities: The Diversity, Co-Occurrence Patterns And Their Underlying Mechanisms. *Environmental Pollution*, *309*, 119741.

Xuewei, S., Zhang, H., Wang, Z., Huang, T., & Huang, H. (2022). Phytoplankton Community Response to Environmental Factors Along A Salinity Gradient in a Seagoing River, Tianjin, China. *Microorganisms*, *11*(1), 75.