



***Hydrilla verticillata* Density as a Bioindicator of Pollution in the Waters of Lake Talaga, Dampelas District**

^{1*}Azizatul Khasanah, ²Astija, ³Amalia Buntu, ⁴Aan Febriawan, ⁶Mursito S. Bialangi, ⁶Vita Indri Febriani

^{1,2,3,4,5,6}Department of Biology Education, Faculty of Teacher Training and Education, Universitas Tadulako, Palu, Indonesia.

*Corresponding Author e-mail: khasanaha661@gmail.com

Received: January 2026; Revised: February 2026; Accepted: March 2026; Published: March 2026

Abstract: This study aimed to determine the density of *Hydrilla verticillata* in Lake Talaga and to evaluate its potential as a bioindicator of changes in water quality caused by domestic pollution. The study was conducted at three stations, where physicochemical parameters were measured, including temperature, pH, light intensity, turbidity, dissolved oxygen, and the heavy metals Pb, Fe, and Cu. The results showed that water temperature ranged from 26 to 28°C and dissolved oxygen from 8.04 to 8.49 mg/L, indicating conditions that still support aquatic life. Heavy metal concentrations were below the established water quality standards. However, the pH was categorized as highly alkaline, and the highest turbidity was recorded at the station located near residential areas, suggesting environmental pressure associated with domestic activities. The density of *Hydrilla verticillata* varied among stations, reaching 607,333.3 ind/ha at Station II (high category), 180,000 ind/ha at Station I (moderate category), and 6,066 ind/ha at Station III (low category). The high density observed in the residential area indicates nutrient enrichment that may stimulate excessive growth of aquatic vegetation. This condition suggests symptoms of eutrophication and indicates that Lake Talaga is experiencing localized light to moderate pollution. Therefore, the density of *Hydrilla verticillata* has strong potential to be used as a bioindicator for assessing changes in water quality.

Keywords: *Hydrilla verticillata*; bioindicator; pollution; Lake Talaga

How to Cite: Khasanah, A., Astija, Buntu, A., Febriawan, A., Bialangi, M. S., & Febriani, V. I. (2026). *Hydrilla verticillata* Density as a Bioindicator of Pollution in the Waters of Lake Talaga, Dampelas District. *Bioscientist: Jurnal Ilmiah Biologi*, 14(1), 368–376. <https://doi.org/10.33394/bioscientist.v14i1.19908>



<https://doi.org/10.33394/bioscientist.v14i1.19908>

Copyright© 2026, Khazanah et al

This is an open-access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) License.



INTRODUCTION

Lake Talaga is a freshwater ecosystem with important ecological and socio-economic functions for the surrounding communities. The lake is utilized for capture fisheries, aquaculture, and domestic activities such as washing and bathing. The high intensity of domestic activities may increase the pollutant load in the form of household waste. Such waste generally contains organic matter, surfactants, and phosphates, all of which can significantly affect water quality (Effendi, 2016; Cahyono et al., 2024).

Several studies have shown that domestic waste contributes to increased nutrient concentrations in freshwater systems. Phosphate concentrations in waters receiving domestic runoff may exceed 0.03 mg/L, which is considered the threshold for eutrophication (Wetzel, 2001). This condition can lead to increased turbidity, accumulation of organic matter, and reduced dissolved oxygen levels. A decline in dissolved oxygen to below 5 mg/L may disrupt the survival of aquatic biota (Boyd, 2020). These indications suggest the presence of ecological pressure resulting from anthropogenic activities.

Lake Talaga covers an area of approximately 542.6 hectares and has an average depth of 20 m. In recent years, the presence of the aquatic plant *Hydrilla verticillata* has been identified, with its distribution showing an increasing trend. *Hydrilla verticillata* is known to grow optimally in waters with high nutrient contents, particularly nitrate and

phosphate. This condition indicates a shift in the trophic status of the lake toward a more eutrophic state (Zakiyah et al., 2017).

Previous studies have demonstrated that *Hydrilla verticillata* plays an important role in water quality dynamics. The density of this plant is correlated with the fertility level of aquatic ecosystems. *Hydrilla* is capable of absorbing nutrients as well as heavy metals such as Pb, Cu, and Fe through phytoremediation mechanisms (Marthana et al., 2014). Another study reported that *Hydrilla* effectively reduced the concentration of Linear Alkylbenzene Sulphonate detergent from 20 ppm to 0.058 ppm within seven days (Putriarti et al., 2021). In addition, the photosynthetic activity of *Hydrilla* increases dissolved oxygen levels during the daytime, whereas respiration at night may decrease oxygen concentrations in the water (Handoko & Fajariyanti, 2013).

Although numerous studies have examined the role of *Hydrilla* as a bioindicator and phytoremediation agent, most have been conducted outside Central Sulawesi. Information regarding the density of *Hydrilla verticillata* and its relationship with water quality in Lake Talaga remains limited. This limitation indicates a gap in research at the local scale. A site-specific study is therefore needed to better understand the relationship between pressure from domestic activities and the biological response reflected in *Hydrilla* density within the lake ecosystem. Accordingly, this study aims to analyze the density of *Hydrilla verticillata* and its relationship with water quality influenced by domestic activities in Lake Talaga.

METHOD

This study employed a quantitative descriptive approach. This approach was used to describe the density of *Hydrilla verticillata* and the water quality conditions based on numerical data obtained from field measurements and laboratory analyses (Sugiyono, 2019). The study was conducted in Lake Talaga, Talaga Village, Dampelas District, Donggala Regency, Central Sulawesi, Indonesia. The study site is located at coordinates 0°20'–0°22' S and 119°48'–119°50' E. Lake Talaga covers an area of approximately 542.6 hectares and has an average depth of 20 m. The characteristics of the water body are influenced by domestic activities, tourism, and inflow from the surrounding catchment area. Observation stations were determined based on gradients of anthropogenic pressure and the hydrological conditions of the lake (Effendi, 2016). The study was conducted from October to December 2025 and comprised the following stages: preparation, field data collection, laboratory analysis, and data processing and interpretation. The study location in Talaga Village is shown in the following figure.

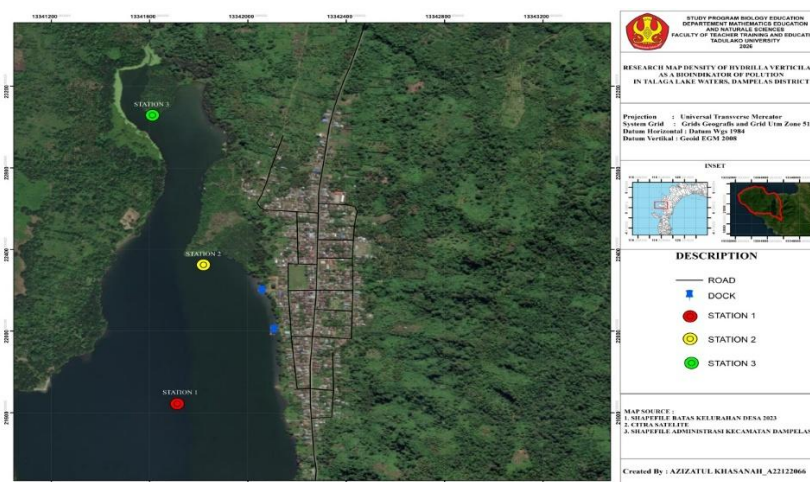


Figure 1. Study location in Talaga Village

Figure 1 presents a general map of Lake Talaga, showing the location and overall condition of the aquatic area. The map also indicates the planned sampling points, marked with red, yellow, and green symbols, which represent the three observation stations: Station 1, Station 2, and Station 3.

The study population consisted of all *Hydrilla verticillata* plants found in the waters of Lake Talaga. The research samples were individual plants identified at the observation sites. Samples were collected using a purposive sampling technique. Sampling locations were selected based on the level of human activity and the environmental conditions of the aquatic ecosystem (Sugiyono, 2019).



Figure 2. Sampling technique

Figure 2 illustrates the sampling design. Observations were carried out at three stations. Station I was located in a tourism area with recreational activities. Station II was situated in a residential area directly affected by domestic waste discharge. Station III was located near a spring area with relatively minimal anthropogenic disturbance. This station division was intended to represent the spatial variation in water quality. Plant samples were collected using the quadrat transect method. A 15 m transect line was laid from the shoreline toward the central part of the water body. Each transect was divided into three plots measuring 5 × 5 m. The distance between plots was approximately 1 m, arranged in a zigzag pattern. Observations were conducted at depths of 30–100 cm, taking into account water clarity and light intensity (Brower et al., 1998).

Plant density was calculated based on the number of individuals in each plot. One stem was counted as one individual. Density was calculated using the following formula (Larasati et al., 2022):

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

Note:

K_i = Species density (stands/ M^2)

N_i = Number of individuals (one stem = one individual)

A = Area of the observation belt transect (M^2)

The density values were then converted into individuals per hectare (ind/ha) and classified according to the following plant population density categories:

Table 1. Plant population density categories

Density (ind/Ha)	Category
> 5.000	High
1.000 – 5.000	Moderate
< 1.000	Low

The data used in this study were quantitative data obtained from field measurements and laboratory analyses. The data source consisted of primary data. The independent variables were water quality parameters, whereas the dependent variable was the density of *Hydrilla verticillata*. The analyzed water quality parameters included temperature, pH, dissolved oxygen (DO), turbidity, light intensity, and the heavy metals Pb, Fe, and Cu. All parameters were used consistently throughout the analysis to avoid differences in data interpretation. Data collection was conducted through field observations, measurement of plant density, measurement of physicochemical parameters, and laboratory analysis. Heavy metal analysis was performed at the Integrated Laboratory of Tadulako University over a period of 14 days. The instruments used included a thermometer, pH meter, DO meter, lux meter, and turbidimeter. Observation sheets were used to record environmental conditions and plant morphology.

RESULTS AND DISCUSSION

The study was conducted in the waters of Lake Talaga by dividing the area into several observation stations based on the distribution of *Hydrilla verticillata* growth. A descriptive overview of Stations I–III is presented in the figures below.

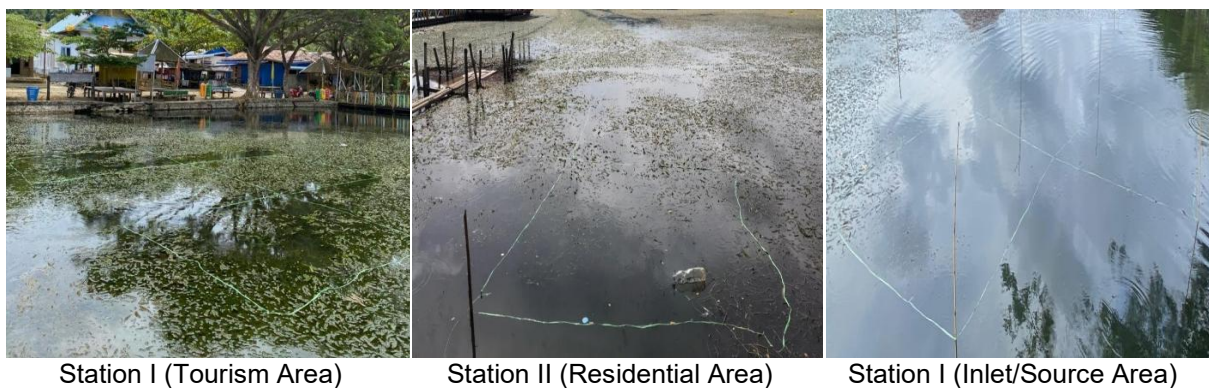


Figure 3. Research location

Station I was located in a water area used by the local community as a tourism site. Activities occurring at this station included small-scale trading, recreation, and direct community interaction with the lake water. Station II was situated in a water area adjacent to residential settlements. Domestic activities such as clothes washing and household waste disposal may exert pressure on water quality at this location. Station III was located in the part of the lake near the outlet or estuarine section connected to the flow toward the sea. The environmental characteristics at this station were influenced by current dynamics and water mass exchange, resulting in conditions that differed relatively from those at the other two stations.

Physical Conditions of Lake Talaga Waters

Measurements of the physical water parameters were conducted on January 29, 2026. The results indicated variation in environmental conditions among the observation stations.

Table 2. Physical parameters of Lake Talaga waters

No.	Parameter	Station I (Tourism Area)	Station II (Residential Area)	Station III (Source Area)	Average
1	Temperature (°C)	26	28	27	27
2	pH	13,02	13,18	13,25	13,15
3	Light intensity (lux)	1119	6563	1018	2900
4	Turbidity (NTU)	0.14	9.76	0.03	3,31
5	Dissolved oxygen (mg/L)	8,30	8,49	8,04	8,28

Water temperature ranged from 26 to 28 °C, with an average of 27 °C. This temperature range remains optimal for tropical aquatic organisms and supports the growth of aquatic macrophytes such as *Hydrilla verticillata*. Relatively stable water temperature is an important factor in maintaining the balance of aquatic ecosystems (Wetzel, 2001).

Light intensity showed considerable variation among stations. The highest value was recorded at Station II at 6,563 lux, whereas Stations I and III recorded 1,119 lux and 1,018 lux, respectively. Light intensity plays an essential role in the photosynthetic process of aquatic plants and therefore can influence the growth and distribution of macrophytes in aquatic environments (Aqmal et al., 2022).

Water turbidity ranged from 0.03 to 9.76 NTU, with the highest value observed at Station II. This station is located in a residential area where domestic activities, such as washing and household waste disposal, may contribute to increased suspended particles in the water. High turbidity can inhibit light penetration into the water column, thereby potentially affecting the distribution of photosynthetic organisms (Effendi, 2016).

Dissolved oxygen (DO) concentration ranged from 8.04 to 8.49 mg/L, with an average of 8.28 mg/L. These values indicate water conditions that are still favorable for aquatic life. Dissolved oxygen concentrations above 5 mg/L generally support the survival of aquatic organisms. The relatively high DO values are likely influenced by photosynthetic activity of aquatic plants and oxygen diffusion from the atmosphere (Boyd, 2020; Wetzel, 2001).

The measured pH ranged from 13.02 to 13.25. These values are highly alkaline and are ecologically uncommon in natural waters. Lake waters generally have a pH range of 6–9 (Boyd, 2015). Therefore, these unusually high pH values may have resulted from instrument calibration errors or data recording errors and should be re-verified through additional measurements.

Heavy Metal Content in Lake Talaga Waters

Chemical analysis was conducted to determine the concentrations of the heavy metals Pb, Fe, and Cu.

Table 3. Heavy metal content of Lake Talaga waters

No.	Metal	Station I	Station II	Station III	Average
1	Lead (Pb)	< 0.03	< 0.03	< 0.03	< 0.03
2	Iron (Fe)	< 0.009	< 0.009	< 0.009	< 0.009
3	Copper (Cu)	< 0.007	< 0.007	< 0.007	< 0.007

These results indicate that the waters of Lake Talaga have not yet experienced heavy metal contamination. This condition is likely influenced by the limited industrial activity surrounding the lake and the predominance of domestic activities by local communities (Nurhidayati et al., 2021).

Distribution and Number of *Hydrilla verticillata* Individuals

The number of *Hydrilla verticillata* individuals recorded at each observation station showed clear variation.

Table 4. Number of *Hydrilla verticillata* individuals

Station	Plot 1	Plot 2	Plot 3
Station I	900 individuals	3.200 individuals	1.300 individuals
Station II	920 individuals	8.300 individuals	9.000 individuals
Station III	70 individuals	50 individuals	62 individuals

The highest number of individuals was found at Station II, which was located in the residential area. This finding indicates that the environmental conditions at this station were more favorable for the growth of *Hydrilla verticillata*. Nutrient availability derived from domestic activities is suspected to have increased water fertility, thereby stimulating more intensive growth of aquatic vegetation.

The lowest number of individuals was found at Station III. Water conditions at this outlet-related location were relatively more dynamic due to the influence of currents and water mass movement, making the site less favorable for the optimal growth of *Hydrilla verticillata*.

Density of *Hydrilla verticillata*

The population density calculation showed differences among the observation stations.

Table 5. Density of *Hydrilla verticillata* in Lake Talaga

No.	Station	Density (ind/ha)	Category
1	Station I	180,000	Moderate
2	Station II	607,333.3	High
3	Station III	6,066	Low

The observed number of *Hydrilla verticillata* individuals demonstrated very clear variation among stations. Station II had the highest number of individuals compared with Stations I and III. This indicates that environmental conditions at Station II strongly supported the growth of *Hydrilla verticillata*, particularly in terms of high light intensity and nutrient availability associated with domestic community activities. In contrast, Station III had the lowest number of individuals. Its location near the lake outlet toward the sea likely exposed it to current influence and changes in water quality, thereby making the environment less suitable for the optimal growth of *Hydrilla verticillata*. According to Aqmal et al. (2022), light intensity plays a highly important role in photosynthesis; through this process, algae are able to utilize carbon substances dissolved in water, which are then converted into organic matter assimilated into plant tissues, indirectly supporting algal growth and development.

Based on the absolute density calculation, *Hydrilla verticillata* in the waters of Lake Talaga exhibited different density levels at each station. Station II had the highest density, reaching 607,333.3 ind/ha, and was categorized as having high density. This high density was closely associated with supportive environmental conditions, such as high light intensity, suitable temperature, and nutrient input from domestic waste.

Station I had a moderate density of 180,000 ind/ha. This condition may have been influenced by tourism and recreational activities, which can physically disturb the growth of aquatic plants, even though the overall water conditions remained relatively supportive. Meanwhile, Station III had the lowest density, at 6,066 ind/ha, and was categorized as low density. The low density at this station was likely due to the dynamic water conditions in the outlet area as well as the lower light intensity and reduced nutrient availability for the growth of *Hydrilla verticillata*. Samman & Achmad (2023) explained that algal distribution intensity is influenced by environmental parameters such as nutrients, light intensity, temperature, pH, and DO.

CONCLUSION

This study demonstrates that the environmental characteristics of Lake Talaga vary among observation stations and significantly influence the distribution and density of *Hydrilla verticillata*. Among the three stations, Station II showed the highest abundance and density of *H. verticillata*, indicating that this area provided the most favorable conditions for its growth. The high density recorded at this station was likely associated with greater light availability and increased nutrient input derived from surrounding domestic activities.

In contrast, Station III exhibited the lowest abundance and density of *H. verticillata*. Its location near the lake outlet, which is influenced by water currents and mass exchange toward the sea, likely created less stable environmental conditions for the establishment and growth of this macrophyte. Station I showed moderate density, suggesting that although the environmental conditions remained supportive, tourism-related activities may have contributed to physical disturbance of the vegetation.

Overall, the physical water quality of Lake Talaga, particularly temperature and dissolved oxygen, was generally suitable for aquatic organisms and for the growth of *H. verticillata*. In addition, Pb, Fe, and Cu concentrations were below detectable limits, indicating that the lake waters were not contaminated by heavy metals. However, the extremely high pH values recorded in this study were not typical of natural lake ecosystems and therefore require further verification through repeated and more careful measurements. These findings confirm that local environmental conditions and anthropogenic influences play an important role in shaping the distribution pattern and population density of *Hydrilla verticillata* in Lake Talaga.

RECOMMENDATION

Based on the results of this study, it is recommended that these findings be used as baseline data for the continuous monitoring of water quality in Lake Talaga. Information on the physicochemical characteristics of the water and the density of *Hydrilla verticillata* is expected to be utilized by local governments, environmental agencies, and other relevant stakeholders as a basis for policy-making related to the management of water quality and the control of aquatic plant growth in Lake Talaga.

In addition, this study is expected to serve as a learning resource and contextual reference in biology education, particularly in topics related to ecosystems, environmental pollution, and bioindicators of water quality. Research findings grounded in local environmental conditions can help students understand concepts in a more concrete and applicable manner, thereby improving both comprehension and environmental awareness.

For future researchers, further studies are recommended by incorporating additional water quality parameters, such as nitrate, phosphate, and biochemical oxygen demand (BOD), as well as conducting a comprehensive pollution index

analysis. Research may also be extended to examine the effects of *Hydrilla verticillata* growth on the diversity of aquatic biota, thereby providing a more comprehensive understanding of the ecosystem dynamics of Lake Talaga.

ACKNOWLEDGMENT

The authors express their deepest gratitude to the research funding provider/donor for the financial support that made this study possible. This support was invaluable in facilitating all stages of the research, from preparation and field data collection to the preparation of the final report. The authors also wish to thank the government and community of Talaga Village for granting permission, providing support, and offering assistance throughout the research process in the Lake Talaga area. High appreciation is also extended to all parties who contributed to sample collection, water quality parameter measurements, and laboratory analyses. Furthermore, the authors would like to thank colleagues and all other individuals who cannot be mentioned individually for their moral support, effort, and thoughtful contributions. May all forms of assistance and cooperation provided be duly rewarded and become a source of goodwill for everyone involved.

REFERENCES

- Aqmal, A., Iswahyuddin, Purwanti, A., & Muriati, S. (2022). Perbandingan intensitas cahaya bantuan dan alami terhadap pertumbuhan rumput laut (*Kappaphycus* sp.) di dalam bak terkontrol. *Journal of Education Language Teaching and Science*, 3(4), 2656–8772.
- Aqmal, A., et al. (2022). Pengaruh intensitas cahaya terhadap pertumbuhan makroalga dan tumbuhan air. *Jurnal Ekologi Perairan*, 10(1), 25–33.
- Boyd, C. E. (2015). *Water quality: An introduction*. Springer.
- Boyd, C. E. (2020). *Water quality: An introduction*. Springer.
- Brower, J. E., Zar, J. H., & von Ende, C. N. (1998). *Field and laboratory methods for general ecology*. McGraw-Hill.
- Cahyono, B., et al. (2024). Dampak limbah domestik terhadap kualitas perairan tawar. *Jurnal Lingkungan Perairan*, 12(1), 45–56.
- Cahyono, D., Putro, D. S., & Santoso, A. I. (2024). Efektivitas tanaman alga (*Hydrilla verticillata*) dan eceng gondok (*Eichhornia crassipes*) sebagai fitoremediasi pengolahan detergen limbah cair laundry. *Jurnal Lingkungan Nusantara (JLN)*, 1(1).
- Effendi, H. (2016). *Telaah kualitas air bagi pengelolaan sumber daya dan lingkungan perairan*. Kanisius.
- Franklin, J. R. (2012). *Hydrilla verticillata* invasion in the Potomac River. Impacts on submerged aquatic vegetation and waterfowl. *Journal of Limnology*, 71(1).
- Handoko, P., & Fajariyanti, Y. (2013). Pengaruh spektrum cahaya tampak terhadap laju fotosintesis tanaman air *Hydrilla verticillata*. *Jurnal Pendidikan Biologi*, 10(2).
- Kementerian Lingkungan Hidup. (2003). *Keputusan Menteri Negara Lingkungan Hidup Nomor 115 Tahun 2003 tentang pedoman penentuan status mutu air*.
- Kirk, J. T. O. (2011). *Light and photosynthesis in aquatic ecosystems*. Cambridge University Press.
- Larasati, R. F., et al. (2022). Keanekaragaman, kepadatan, dan penutupan jenis lamun di Pantai Kastela, Ternate Selatan, Maluku Utara. *Journal of Indonesian Tropical Fisheries*, 5(2), 162–178.

- Nur, R. F., & Purnomo, T. (2022). Efektivitas *Hydrilla verticillata* dan *Lemna minor* sebagai fitoremediator LAS pada detergen limbah domestik. *Lentera Bio: Berkala Ilmiah Biologi*, 11(2).
- Nurhidayati, L. A., Didik, & Zohdi, A. (2021). Identifikasi pencemaran logam berat di sekitar Pelabuhan Lembar menggunakan analisis parameter fisika dan kimia. *Jurnal Ilmiah Fisika FMIPA Universitas Lambung Mangkurat*, 18(2), 139–148.
- Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.
- Putriarti, D., et al. (2021). Kemampuan *Hydrilla verticillata* sebagai agen fitoremediasi linear alkylbenzene sulphonate (LAS) detergen. *Prosiding Seminar BIO*.
- Samman, A., & Achmad, M. J. (2023). Diversitas dan distribusi alga merah (Rhodophyta) di perairan Pulau Ternate. *Jurnal Kelautan Tropis*, 26(1), 148–154.
- Sasmita, L., & Prayudi, A. (2024). Pengembangan media pembelajaran poster digital pada mata pelajaran Ilmu Pengetahuan Sosial. *Jurnal Pendidikan dan Media Pembelajaran*, 3(1).
- Sekar Marthana, W., Soeprbowati, T. R., & Izzati, M. (2014). Bioakumulasi timbal (Pb) oleh *Hydrilla verticillata* di Danau Rawapening, Ambarawa, Semarang. *Jurnal Sains dan Matematika*, 22(2).
- Siregar, A., Jubaedah, D., & Wijayanti, M. (2017). Penggunaan *Hydrilla verticillata* sebagai fitoremediator dalam pemeliharaan ikan patin (*Pangasius* sp.). *Jurnal Akuakultur Rawa Indonesia*, 5(1).
- Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.
- Wetzel, R. G. (2001). *Limnology: Lake and river ecosystems*. Academic Press.
- Zakiah, U., Cahyono, H. B., & Urifah, D. (2017). Adsorpsi logam timbal (Pb) oleh tanaman *Hydrilla verticillata*. *Jurnal Perikanan dan Ilmu Kelautan Universitas Brawijaya*, 11(2).