

WATER QUALITY PARAMETERS AND BACTERIAL LOADS OF A MIGRATORY BIRD-INHABITING LAKE IN JAHANGIRNAGAR UNIVERSITY CAMPUS

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Abstract: This study assessed selected physico-chemical parameters and bacterial loads in a migratory bird-inhabited lake at the Jahangirnagar University (JU) campus from July to December 2025. Water samples were collected monthly from three depth strata—surface, middle, and bottom, along with bottom mud samples from three locations of the lake. Temperature, pH, and DO were significantly higher in surface water than in the middle and bottom layers ($p < 0.05$), whereas EC, TDS, and total hardness tended to be higher in bottom water across the study period. Bacterial abundance varied significantly among water depths and sampling months, with bottom water showing significantly higher bacterial loads than surface and middle waters, indicating that lake sediments function as a major microbial reservoir. The findings demonstrate clear vertical and temporal variations in water quality and bacterial abundance within the studied lake. Regular monitoring of physicochemical and microbial conditions is therefore essential for maintaining good ecological health of the migratory bird habitat. Further the need for sustainable lake management strategies is evident to minimize microbial pollution and protect the ecological integrity of the lake ecosystem.

Key words: Water quality, bacterial load, migratory bird-inhabiting lake, Jahangirnagar University (JU)

INTRODUCTION

Jahangirnagar University campus in its geographical location holds 29 lakes. These lakes are very important for campus landscape as well as the ecological point of view. Some of these lakes are used for fish culture through giving lease by the authority and others provide ideal habitats for the migratory birds particularly in winter season which expand the aesthetic values of the campus (Sharmin *et al* 2019). The migratory birds add organic matter and nutrient through fecal deposition to the lake water which possibly boost bacterial growth and nutrient enrichment (Olowu *et al.* 2026). Though some researchers consider only physico-chemical properties of different lakes in JU campus in their studies (Sultana *et al.* 2013; Rahman *et al.* 2015); but no one consider both water quality parameters and bacterial loads of lakes yet.

Having a terrain feature, a lake is a body of liquid on the surface of the planet act as a water retention basin during the Monsoon and harbor source of

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©2026 Zoological Society of Bangladesh DOI: <https://doi.org/10.3329/bjz.v54i2.93675>

biodiversity of the area and provides important scenic beauty (Rahman *et al.* 2015; Chowdhury and Chowdhury 2018). Lake is also a community where biotic and abiotic components interact with each other to transfer energy and for cycling nutrients (Sharmin *et al.* 2019). Out of all components, water is considered as the most important and significant components because of its necessity for all life (Copper *et al.* 1998; Chowdhury and Chowdhury 2018). The physiochemical properties of water monitor the lives of aquatic organisms living in it, and determined the organisms' distribution and productivity levels (Ashton and Schoeman 1983; Rahman *et al.* 2015; Akter *et al.* 2023). Any changes in the water quality have direct effects on the biota, where different species perform their specific responses to the altered environment (Akter *et al.* 2023). Water quality is a dynamic web of physical, chemical and biological factors that constitute the water environment and influence the production aquatic animals including fish (Boyd 1982; Piper *et al.* 1982; Akter *et al.* 2023); therefore, the hydrological study is essential to elucidate the relationships among its diverse ecological interactions (Soundarapandian *et al.* 2009; Rahman *et al.* 2015).

Bacteriological study is one of the important parameters for determining the lake dynamics and the health and hygiene of the lake system. Bacteria are responsible for many dominant chemical processes that occur within the lake system to maintain delicate balance between the host and environment (Akter *et al.* 2023). Moreover, bacterial population directly controls the aquatic health and hygiene by their decomposing ability, and serves as primary or secondary pathogens to cause many infectious aquatic diseases, particularly to the fishes (Lightner 1993; Cabral 2010). Bacterial counts are used as an index of the abundance of the microbial community of any given aquatic ecosystems (Uddin and Al-Harabi 2004). Studies on bacterial populations in a lake system are essential for predicting the possibilities of diseases outbreaks and providing information for developing sustainable management strategies to maintain the ecological health of the lake. Furthermore, detailed information about the bacterial loads in a lake system is also crucial for recognizing and managing the abnormal conditions of aquatic animals, particularly fishes, which might be a precursor to the appearance of epizootic diseases (Uddin and Al-Harabi 2004; Akter *et al.* 2023).

Furthermore, water quality of any aquatic ecosystems is deteriorating day by day due to increased anthropogenic activities in and around the aquatic systems (Upadhyay *et al.* 2010; Ali *et al.* 2022). Rapid urbanization, reduction of catchments of surface water bodies, siltation and pollution which lead to eutrophication are the major problems to protect and control the natural water bodies (Shaw *et al.* 1991; Singh 2012). Water quality and also ecosystem

stability are greatly impacted by changes in microbial activity, organic matter load, or fertilizer input. Bacterial communities are among the biological components that are essential to the decomposition and recycling of nutrients, but excessive bacterial growth may be a sign of pollution and declining water quality (Akter *et al.* 2023). Therefore, short- and long-term studies on water quality parameters and bacterial loads of a water body are essential for designing effective water resource management and pollution control strategies (Wood 1995; Reilly and Kaferstein 1997; Naim *et al.* 2007; Rahman *et al.* 2015; Alam *et al.* 2025).

Considering the above issues, it is important to study on both water quality parameters and bacterial loads of the lake in order to comprehend the current state of the lake ecosystem and to develop successful conservation and management strategies. Therefore, the main objective of this study was to work out the present status of some water quality parameters and bacterial loads of a migratory bird-inhabiting lake in JU campus.

MATERIAL AND METHODS

Study area: A migratory bird-inhabiting lake in JU campus situated about 33 km away in the north-western side of Dhaka city was selected for the present study. This lake is located (GPS location: 23°52'–23°54' N and 90°15'–90°17' E) in between the eastern side of the Engineering Office and western side of the Jahanara Iman Hall of JU (Fig. 1). The selected lake is well known for providing vital habitats for migratory bird species during the winter months (Khan 2015; Mohsanin *et al.* 2014). In addition to anthropogenic pressures, surface runoff, recreational activities and campus-related trash inputs, the lake ecology is affected by natural variables including seasonal rainfall and hydrological connectivity (Islam *et al.* 2017). These features make it an appropriate location for assessing water quality and bacterial loads in connection to the migrating birds' habitat utilization.

Study period: Samplings were conducted on monthly-basis and in between 6-8 a.m. of every sampling day for a period of 6-months from July to December, 2025.

Sample collection: Water samples were collected from upper-, mid- and bottom layers of the lake. About 200 mL of water from each water layer was collected in pre-sterilized 250 mL plastic bottles while mud samples were collected from lake bed using pre-sterilized zipper bags. Water temperatures were measured on the spot while other water quality parameters and bacterial procedures were done immediately after brought back the both water and mud samples to the General Laboratory, Department of Zoology, JU.

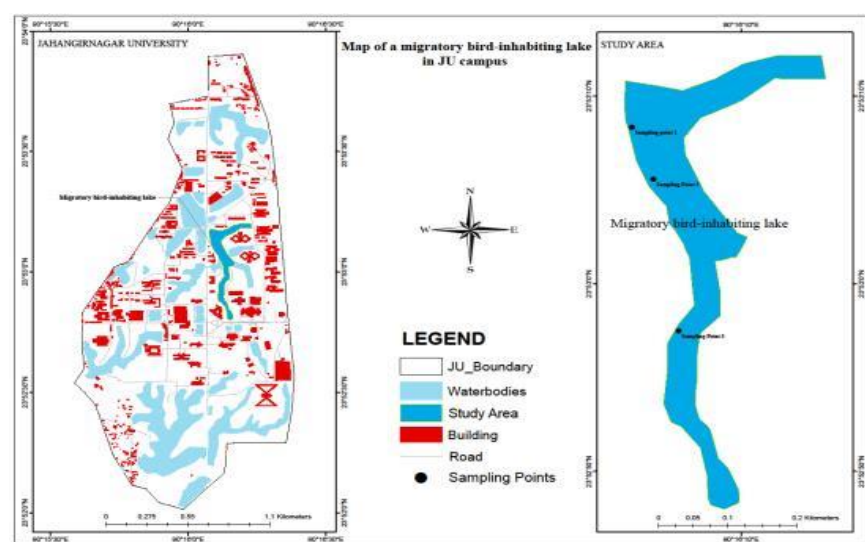


Fig. 1. Map of the study area in JU campus

Analysis of some water quality parameters: Temperature, pH, Dissolved Oxygen (DO), total hardness, Total Dissolved Solids (TDS) and Electrical Conductivity (EC) among the water quality parameters were assessed in the said laboratory followed by the well-established analytical methods stated in Table 1.

Table 1. Water quality parameters and instruments used for analysis

Parameter	Units	Instruments used for analysis
Temperature	°C	Digital thermometer (NB, Model: TP300, China), directly in the field
pH	-	pH tester (DLAB, Model: DPH1, USA)
DO	mg/L	DO meter (AZ instrument, Model: 84131, Taiwan)
Total hardness	mg/L	Hardness test kit (Hanna, Model: HI3812, Romania)
TDS	mg/L	TDS tester (DLAB, Model: DEC1, USA)
EC	μS/cm	Conductivity tester (DLAB, Model: DEC1, USA)

Bacteriological analysis: Total Bacterial Count (TBC) was determined by applying determinative dilution technique according to the Burgey's manual, followed by standard spread plate count (Sharp and Lyles 1969). The water and mud samples were plated on nutrient agar (Hi Media M001), and thereafter the plates were incubated at 37 °C for 24-48 hr. The colonies were counted and expressed as colony forming unit per mL (cfu/mL) for water samples using the following formula. Moreover, cfu/g was used for mud samples.

$$cfu/mL = \frac{\text{Number of colonies} \times \text{Total dilution factor}}{\text{volume of culture plated (mL)}}$$

Statistical analysis: The collected data were compiled, tabulated and analyzed using MS Office Excel 2007 and SPSS ver. 24 (SPSS Chicago IL, USA). The analyzed data were integrated and presented in tabular forms.

RESULTS AND DISCUSSION

Water quality parameters of the lake: The results of some water quality parameters of different water layers of a migratory bird-inhabiting lake in JU campus were summarized in Table 2.

Table 2. Water quality parameters of different water layers of a migratory bird-inhabiting lake in JU campus from July to December, 2025

Water column	Month	Temp	pH	DO	EC	TDS	Hardness
		°C		mg/L	(µS/cm)	mg/L	mg/L
Surface water	Jul	29.55 ± 0.25	6.96 ± 0.15	4.03 ± 0.66	162.80 ± 6.94	113.67 ± 3.61	45.00 ± 7.94
	Aug	30.00 ± 00	7.16 ± 0.18	4.20 ± 1.06	138.37 ± 1.42	98.97 ± 2.64	43.50 ± 15.22
	Sep	29.17 ± 0.06	6.71 ± 0.35	3.81 ± 0.68	130.30 ± 4.42	92.30 ± 3.51	42.00 ± 00
	Oct	28.00 ± 0.00	6.99 ± 0.08	4.37 ± 0.94	131.17 ± 9.05	95.83 ± 7.65	70.70 ± 1.13
	Nov	22.00 ± 0.00	6.66 ± 0.16	5.92 ± 1.14	148.80 ± 4.73	105.23 ± 1.92	46.00 ± 7.55
	Dec	19.00 ± 0.00	6.74 ± 0.15	5.89 ± 0.03	151.40 ± 2.92	106.87 ± 2.11	54.67 ± 8.50
	<i>p</i> -value	0.0000	0.0542	0.0148	0.0000	0.0003	0.0100
Middle water	Jul	29.50 ± 0.26	6.86 ± 0.05	3.66 ± 0.56	162.70 ± 1.21	116.63 ± 2.11	46.00 ± 6.93
	Aug	29.37 ± 0.15	6.94 ± 0.08	3.60 ± 0.45	138.67 ± 1.62	99.30 ± 1.99	47.33 ± 1.53
	Sep	28.97 ± 0.15	6.53 ± 0.24	3.73 ± 0.63	141.57 ± 15.44	100.60 ± 11.26	45.33 ± 0.58
	Oct	27.50 ± 0.50	6.92 ± 0.07	4.13 ± 0.21	135.27 ± 3.52	91.40 ± 1.90	77.73 ± 15.48
	Nov	21.00 ± 1.00	6.47 ± 0.07	5.58 ± 0.19	152.87 ± 1.14	108.63 ± 0.98	48.33 ± 2.08
	Dec	18.67 ± 0.58	6.60 ± 0.27	5.33 ± 0.70	155.07 ± 2.36	108.10 ± 1.85	55.67 ± 4.16
	<i>p</i> -value	0.0000	0.0023	0.0000	0.0017	0.0006	0.0009
Bottom water	Jul	28.30 ± 0.20	6.32 ± 0.20	2.91 ± 0.28	169.63 ± 13.31	121.20 ± 8.67	49.00 ± 4.58
	Aug	27.80 ± 0.62	6.44 ± 0.89	3.11 ± 0.10	141.13 ± 2.96	101.90 ± 3.30	52.00 ± 7.21
	Sep	27.30 ± 0.20	6.23 ± 0.52	3.42 ± 0.48	148.27 ± 11.84	102.73 ± 9.42	47.33 ± 4.73
	Oct	26.37 ± 0.55	6.86 ± 0.01	4.00 ± 0.11	135.93 ± 3.64	98.43 ± 1.53	78.37 ± 16.09
	Nov	20.00 ± 1.00	6.37 ± 0.10	5.27 ± 0.23	153.33 ± 1.89	109.07 ± 1.60	49.67 ± 4.04
	Dec	17.67 ± 0.58	6.33 ± 0.10	4.88 ± 0.52	157.87 ± 1.10	111.90 ± 5.05	60.00 ± 6.00
	<i>p</i> -value	0.0000	0.5578	0.0000	0.0887	0.0050	0.0047
Values were expressed as mean ± SD of three replicates.							

Overall, water temperature of three water layers gradually decreased from July to December, 2025. The highest water temperature were recorded as

29.55±0.25 °C (mean±SD), 29.50±0.26 °C and 28.30±0.20 °C in July, 2025 for surface, middle and bottom layer waters, respectively while the lowest were 19.00±0.00 °C, 18.67±0.58 °C and 17.67±0.58 °C in December, 2025 for the said water layers, respectively (Table 2). These significant ($p<0.05$) gradual decreasing trends in water temperature of all water layers across months possibly due to the geographic location, sampling time, seasonal changes in atmospheric temperature, temperature of effluents entering into the water systems and solar radiation (Ahipathy and Puttaiah 2006). Similar trends were reported by Rahman *et al.* (2015) in JU lakes, and also by Hossain *et al.* (2017) in another freshwater lake of Bangladesh.

The values of pH of surface water ranged from 6.74±0.15 to 7.16±0.18 while those of middle and bottom waters varied from 6.47±0.07 to 6.94±0.08 and 6.33±0.10 to 6.86±0.01, respectively during the study period (Table 2). The pH of middle water showed significant ($p<0.05$) differences among the months. The best range for water pH is set from 6.5-8.5 (WHO 1984), and all of our pH values with a very few exceptions were also within this range. Very little fluctuations in pH values might be associated with organic matter decomposition, rainfall dilution, and biological activity (Dewangan *et al.* 2023; Zeng *et al.* 2023). Similar reports were recorded by Sultana and Huda (2013) and Rahman *et al.* (2015) in their studies on the wetlands and lakes in JU campus, respectively.

The surface (5.92±1.14 mg/L), middle (5.58±0.19 mg/L) and bottom (5.27±0.23 mg/L) waters showed the highest level of DO content in November among the months (Table 2). Moreover, DO exhibited significant ($p<0.05$) variations among the months for all waters. In this study, DO levels were within the optimum range (4-7 mg/L), which supports the results reported by Abedin *et al.* (2017) and Roy and Barat (2011). Optimum DO is essential for the better production of fish culture. However, the lower values of DO (2.91±0.28 mg/L and 3.11±0.10 mg/L) were observed in bottom waters in July and August, 2025 respectively which indicated higher level of biological oxygen demand (BOD) particularly for those months (Akter *et al.* 2023). Though variations of DO happened due to the flow of freshwater and terrigenous impacts of sediments (Paramasivam and Kannan 2005) while increased inputs of organic matters caused lower DO and enhanced microbial decomposition. Chowdhury and Mazumder (1981) found the similar findings regarding DO in case of Kaptai lake. Rahman *et al.* (2015) also found the similar results (2.8 - 5.6 mg/L) for the same lake of JU campus. Moreover, pH influences oxygen availability through its effects on biological activity and organic matter decomposition (Rahman *et al.* 2016; Islam *et al.* 2017). Neutral pH conditions are generally associated with improved oxygen conditions in freshwater lakes, as reported in several limnological studies of Bangladesh (Ahmed *et al.* 2015).

The values of EC, TDS and the total hardness showed increasing trends during the study periods, and those values were found relatively higher in bottom water than others (Table 2). The EC, TDS and total hardness were also significant ($p < 0.05$) across the months except EC of bottom waters ($p > 0.05$). However, EC measure the ability of water to carry out an electric current which largely depends on several factors such as presence of ions, their concentrations, mobility, valence and temperature etc. (Sripathy *et al.* 2012). Though the EC values of this study were within the preferable range but those outside the range (150-500 $\mu\text{S}/\text{cm}$) are not suitable for aquaculture (APHA 1992; Rahman *et al.* 2015). Higher values of EC and TDS in July, 2025 might be linked to runoff carrying dissolved minerals and organic materials, while lower values during August and September, 2025 could result from dilution by heavy rainfall. Moderate increase during November and December, 2025 indicated gradual stabilization of the lake system (Wang *et al.* 2023; Lei *et al.* 2023). Based on the total hardness, water can be categorized as soft (0-60 mg/L), moderately hard (61-120 mg/L), hard (121-160 mg/L) and very hard (> 180 mg/L) (Kannan 1991). Though hardness < 300 mg/L is regarded as potable but the values above this limit cause gastro-intestinal disturbance (ICMR 1975). Our results were within the 1st two categories for all waters. More or less similar results were reported by Sultana and Huda (2013) and Rahman *et al.* (2015) based on their studies in the wetlands and lakes of JU campus, respectively.

Correlation among the water quality parameters of the lake: The correlation among the water quality parameters of three water layers within the lake were analyzed at 5% significant level. Water temperature showed significant ($p < 0.05$) negative correlation with DO in water of surface ($r = -0.76$), middle ($r = -0.77$) and bottom ($r = -0.89$) layers of the studied lake. This results revealed that increased temperature reduces oxygen solubility and enhance microbial oxygen consumption. Elucidating the relationships between temperature and DO is crucial as temperature is a major controlling factor of DO dynamics in lake ecosystems (Wetzel 2001; Boyd 1982). pH showed significant negative correlation with DO in surface ($r = -0.39$) and bottom ($r = -0.03$) waters while those had non-significant ($p > 0.05$) positive correlation in middle water ($r = 0.32$) of the lake. Similar types of correlations were also reported by Rahman *et al.* (2015) and Islam *et al.* (2017).

Furthermore, pH exhibited significant positive correlation with hardness in bottom water ($r = 0.50$) while that was non-significant positive in case of surface ($r = 0.10$) and middle waters ($r = 0.13$) of the lake. Hardness showed significant negative correlation with TDS in surface ($r = -0.08$), middle ($r = -0.53$) and bottom waters ($r = -0.39$) of the studied lake. TDS showed significant strong positive correlation with EC of all waters (surface and middle waters: $r = 0.96$;

and bottom water: $r = 0.79$) while EC had strong significant negative correlation with pH of surface ($r = -0.13$), middle ($r = -0.19$) and bottom ($r = -0.18$) waters of the lake.

Bacterial loads in lake water (cfu/mL) and mud (cfu/g): Through the study period, the highest and lowest bacterial loads for surface water were $(99.67 \pm 24.28) \times 10^3$ and $(31.33 \pm 30.91) \times 10^3$ cfu/mL, respectively; for middle water, those were $(37.44 \pm 41.30) \times 10^3$ cfu/mL and $(126.56 \pm 23.64) \times 10^3$ cfu/mL, respectively while those of bottom water were $(38.55 \pm 35.68) \times 10^3$ cfu/mL and $(174.33 \pm 37.96) \times 10^3$ cfu/mL, respectively (Table 3). Among the water of three layers the lowest and highest bacterial loads were found in surface and bottom waters, respectively across the months. The bacterial loads in middle water were significantly higher than the surface water while those were significantly lower than the bottom water for the study period. The bacterial loads in bottom water were significantly higher than those of surface and middle waters of the studied lake. Moreover, significant differences in bacterial loads were found among the study months for all waters of the lake. The highest value of bacterial loads $(174.33 \pm 37.96) \times 10^3$ was observed in bottom water in October, 2026 while the lowest $(31.33 \pm 30.91) \times 10^3$ was in surface water in July, 2025 (Table 3). The highest and lowest bacterial loads in bottom mud were $(263.78 \pm 43.66) \times 10^5$ cfu/g in October, 2025 and $(59.89 \pm 61.23) \times 10^5$ cfu/g in July, 2025, respectively (Table 3). The bacterial loads in mud showed significant differences among the study months (Table 3).

Table 3. Bacterial loads in different water layers and mud of a migratory bird-inhabiting lake in JU campus from July to December, 2025

Month	Bacterial loads			
	Surface water	Middle water	Bottom water	Lake mud
Jul	31.33 ± 30.91	37.44 ± 41.30	38.55 ± 35.68	59.89 ± 61.23
Aug	75.67 ± 43.13	91.56 ± 55.08	110.89 ± 76.79	161.44 ± 83.18
Sep	99.67 ± 24.28	126.56 ± 23.64	150.56 ± 62.77	211.89 ± 42.15
Oct	62.56 ± 13.15	104.11 ± 52.55	174.33 ± 37.96	263.78 ± 43.66
Nov	41.33 ± 50.75	54.11 ± 25.19	104.33 ± 21.12	125.00 ± 50.09
Dec	49.67 ± 22.90	81.89 ± 17.85	127.33 ± 24.65	160.56 ± 57.89
<i>p</i> -value	0.0008	0.0001	0.0514	0.0000

Values are expressed as mean $\pm$ SD of total nine replicates; three replicates from each sampling point.

Bacterial load is considered as one of the important parameters to understand the microbial dynamics of any aquatic environments (Akter *et al.* 2023). In our study, bottom water was highly abundant with bacterial populations over the

months. Bacterial loads in mud were significantly higher than those of water layers throughout the study periods. This finding is consistent with established ecological understanding that sediments serve as reservoirs of microbial populations due to higher organic content, nutrient availability and stable environmental conditions (Wetzel 2001), and not heavily influenced by perturbations caused by rainfall and transient movements of water-borne substances (Akter *et al.* 2023). Traroo and Agarwal (2011) reported TBC were $(4.90 \pm 0.06) \times 10^3$ cfu/mL in water and $(3.50 \pm 0.07) \times 10^4$ cfu/g in sediment of a pond in India. Bacterial loads of this study were relatively lower than the results documented by David *et al.* (2015), Sikdar *et al.* (2018), Akter *et al.* (2023). Bisht *et al.* (2014) found that TBC in pond sediment (6.40×10^4 cfu/g) was 10-fold higher than the pond water (6.93×10^3 cfu/g). The highest bacterial load recorded in September, 2025 suggests that monsoon-driven deposition of organic matter and nutrients strongly influences microbial proliferation in lake sediments. Even after the monsoon period, bacterial populations remained relatively high, emphasizing the long-term role of sediments in regulating microbial dynamics within lake ecosystems (Zhou *et al.* 2010; Rahman *et al.* 2018). During monsoon months, enhanced surface runoff, nutrient enrichment, sediment resuspension and organic matter input determined the increase in bacterial populations (Islam *et al.* 2017; Sultana *et al.* 2021). In addition, bacterial loads decreased during post-monsoon (October and November), indicated partial recovery of the lake environment as runoff and organic inputs declined. The little increase in bacterial load in December, 2025 might be due to localized organic inputs and sediment–water interactions (Zhou *et al.* 2010).

The relationship between water quality parameters and bacterial loads highlights the influence of seasonal environmental factors on microbial dynamics. Periods of higher bacterial abundance coincided with lower DO and increased environmental disturbance during the monsoon. Conversely, improved water quality conditions during the post-monsoon (September and October) and winter periods (November and December) were associated with reduced bacterial loads indicating seasonal regulation of microbial dynamics (Boyd 1982; Rahman *et al.* 2016). These findings demonstrate that bacterial loads in relation to water quality parameters serves as an effective indicator of ecosystem health and environmental stress. The results revealed that monsoon months represent a critical period for microbial contamination and water quality deterioration. Effective lake management strategies should therefore be prioritized in controlling runoff, minimizing organic waste input and maintaining regular monitoring programs. Such measures are crucial for sustaining ecological integrity and preventing long-term degradation of lake ecosystems (Wetzel 2001; Rahman *et al.* 2016). The migratory bird-inhabiting lake in JU campus is

ecologically very important as the lake-a natural ecosystem in which bacterial proliferation occurred in a nature-based system (Akter *et al.* 2023) thereby the bacterial loads remained in a suitable condition (Thornber *et al.* 2020). The results of this study revealed that bottom water and mud had higher bacterial loads than the surface water as bacterial community prefer to stay either in soil/mud or near the soil/mud (Akter *et al.* 2023).

CONCLUSION

This study gives a comprehensive assessment of some water quality parameters and bacterial loads in a migratory bird-inhabiting lake of JU campus. Overall findings were within the preferable range for the aquatic life with few exceptions. Our study revealed that climatic factors strongly influencing the water quality and microbial dynamics of the lake ecosystem. However, through we couldn't carry out this experiment during the visiting month of migratory birds to elucidate more insight phenomenon but hopefully; it would make sense to widen the gateway to future investigations. Moreover, progress was initiated through this research as no one considers water quality and bacterial loads together in any lakes of JU campus. It still had some limitations, based on which the research suggested, further studies are crucial to enumerate insights of various phenomenon from different ecological aspects. To maintain the healthy state of the lake ecosystem, water and microbial quality need to be conserved through establishment of vegetative buffer zone to reduce runoff-induced contamination, preventing solid waste disposal and organic waste input, minimizing the disturbing activities around the lake, and long-term ecological studies incorporating nutrient dynamics and microbial diversity for improved lake management.

Acknowledgements: The authors are grateful to the Department of Zoology, Jahangirnagar University for permission and providing necessary facilities to carry out this work. This study was supported by Jahangirnagar University Research Fund in 2025-2026 which is also gratefully acknowledged.

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(Manuscript received on 6 March 2026 revised on 30 July 2026)