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# PLANKTON ASSEMBLAGE AND POTENTIAL INDICATOR SPECIES FOR WATER QUALITY ASSESSMENT IN SELECTED WETLANDS IN COLOMBO

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## ABSTRACT

*Wetlands are considered one of the most productive ecosystems on Earth. Plankton is an essential part of wetland biodiversity and vital to wetland functioning. Plankton is an ideal bioindicator for assessing wetlands' water quality and environmental status. This study was carried out to determine plankton assemblage and to identify potential indicator species for water quality assessment in selected wetlands in Colombo Ramsar Wetland City, including Nawala Wetland Park, Diyatha Uyana, Diayasaru Park, and Beddagana Wetland Park. Water and plankton samples were collected for four months (October 2022- February 2023). Both phytoplankton and zooplankton were studied. During the study period, 39 phytoplankton and 24 zooplankton species were reported. The identified phytoplankton species were categorised into three prominent families: Bacillariophyceae, Chlorophyceae, and Cyanophyceae. Genus Melosira was recorded as the* Most abundant species *in all wetlands (more than 50%). Identified zooplankton were categorized into three main groups: Rotifera, Copepoda, and Ichthyoplankton. Rotifers were the dominant zooplankton group, and Keratella spp.; Brachionus spp. were dominant in all wetlands. Pediastrum spp., Chlorella sp., Closterium sp., Phacus sp., Euglena sp., Melosira spp., Microcystis spp., Navicula sp., Oscillatoria sp., Scenedesmus sp., and Synedra sp., Keratella spp., Brachionus spp., and Lecane spp. were identified as potential bioindicators for pollution. According to the Shannon-Wiener diversity index, phytoplankton diversity is higher than zooplankton diversity. Fourteen indicator species were observed, exhibiting varying levels of abundance. Most of them are indicators of pollution. Hence, it may be inferred that the population density of these species was relatively high, and the degree of contamination in the wetland was also found to be high.*

**KEYWORDS:** *Wetlands, Water quality, Plankton, Bioindicators*

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# 1. INTRODUCTION

Wetlands are crucial for safeguarding global biodiversity as they serve as hotspots for different species (Alikhani *et al*., 2021). Wetland ecosystem services are estimated to have the highest value per hectare of any ecosystem. Moreover, 47% of all global ecosystem values come from the services provided by wetlands. (Xu *et al*., 2019). Therefore, wetlands are considered one of the planet's most essential and productive ecosystems.

However, wetlands are among the most threatened habitats globally (Davidson, 2014; Assefa *et al*., 2022). Worldwide inland wetland loss is 69–75% in the twentieth century and has increased in the twenty-first century (Davidson, 2014). Over one-third of the wetlands have disappeared in the first two decades of the twenty-first century around the world (Assefa *et al*., 2022). Nevertheless, in the past 100 years, almost 50% of the world's wetlands have degraded and are lost due to human interference, and the degradation of wetlands is continuing (Wu and Chen, 2020).

Physio-chemical characteristics of the water in wetlands can be used to evaluate the status of wetlands (Wijeyaratne and Nanayakkara, 2020). Bioindicators are living organisms that can be utilized to monitor the health of natural ecosystems (Parmar, Rawtani, and Agrawal, 2016). Aquatic organisms such as plankton are used as biological indicators to determine water quality, such as collecting, counting, and identifying species (Soetignya et al., 2021).

Plankton are aquatic organisms that inhabit the water column. They comprise phytoplankton (unicellular plants) and zooplankton (millimeters or less small animals) that drift on the currents (Harris and Vinobaba, 2012). Due to their short life cycle, plankton respond rapidly to anthropogenic environmental changes and disturbances, which can be considered early-warning signs that indicate the overall condition of an aquatic system (Singh *et al.*, 2013). Therefore, planktons are very useful for identifying the condition of the water body and have been widely used in assessing the quality of the water (Parmar, Rawtani, and Agrawal, 2016; Hemraj *et al*., 2017). Furthermore, plankton are ideal bioindicators that assess water status and quality in wetlands (Wijeyaratne and Nanayakkara, 2020; Kahsay *et al*., 2022).

Globally, wetland ecosystems are under pressure from rapidly increasing urban populations (Ehrenfeld, 2000). Hydrological conditions in wetlands induce habitat heterogeneity (Chaparro *et al*., 2018). Frequent water quality and pollution assessment is necessary to minimise further wetland damage.
Sri Lanka is a rapidly urbanising country in South Asia. In Colombo, the commercial capital of Sri Lanka, wetlands are alarmingly reducing because of the area's high urbanisation and development projects (Munaweera and Bandara, 2021). Colombo was declared a Ramsar wetland city in 2018 by Ramsar, and it is the first capital to become a Ramsar wetland city in the world (Wijeyaratne and Nanayakkara 2020). Over the past 30 years, 40% of Colombo's wetlands have been lost because of direct and indirect influences. Therefore, determining the status of Colombo wetlands is crucial. However, fewer previous studies have been reported in plankton-based studies conducted in Colombo wetlands (Wijeyaratne and Nanayakkara, 2020; Wickramasinghe *et al*., 2012). Most of the previous studies were focussed on the assessments of biological and physicochemical parameters from the whole wetland area of Diyawanna Oya. They lack detailed, site-specific studies that examine water quality conditions in each wetland. This approach will allow to identify more targeted conservation strategies and management practices, which are essential for protecting the unique ecological roles that different wetlands play. Therefore, the current study was conducted to determine the water quality status of some selected wetlands in Colombo, with particular emphasis on plankton communities as indicators.

# 2. MATERIALS AND METHODS

## *A. Study area*

The present study was conducted in four selected wetlands in Colombo, Sri Lanka, which are connected to Diyawanna Oya (Figure 1), including Nawala Wetland Park, Diyatha Uyana Wetland Park, Diyasaru Wetland Park, and Beddagana Wetland Park.

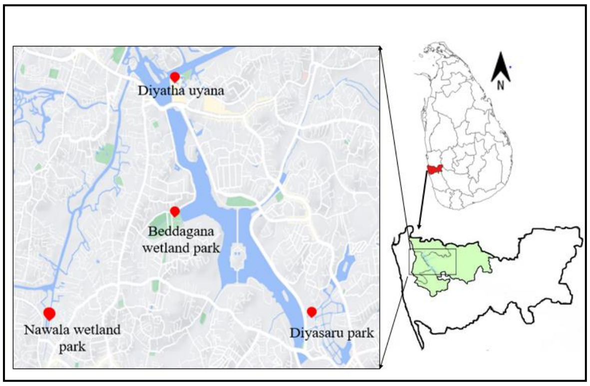


**Figure 1. Map of the study area**

***B. Sampling***

***i) Plankton sampling***

Plankton samples were collected every month from October 2022 to February 2023 using a 55 µm mesh-sized plankton net. Three samples were collected from each wetland each month. Lugol's solution and 4% formalin were used immediately to preserve the plankton samples, which were then transported to the laboratory for further analysis.

***ii) Water sampling***

The sampling locations within wetlands were chosen from four directions, namely site 1 (West), site 2 (North), site 3 (East), and site 4 (South) in each wetland within the same distance. Water samples were collected during the same period. Water samples were collected into high-density polythene screw-capped bottles (500mL) for laboratory analysis of water quality parameters. Glass bottles (250mL) were used to collect water samples to determine Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD). Collected water samples were labelled and placed in an insulated box before transportation to the laboratory.

***C. Sample analysis***

***i) Plankton analysis***

Plankton were identified to the lowest possible taxonomic level and counted using a light microscope at 10×10 magnification. Their abundance was calculated using a Sedgwick rafter counting chamber (SRC) for quantitative investigations.

***ii) Water sample analysis***

Physical parameters, including temperature, total dissolved solids, pH, salinity, and electrical conductivity, were measured at the site. DO, $BOD_5$, total phosphate, and nitrate concentrations were measured in the laboratory using standard methods (APHA, 2017) (Table 1).

**Table 1. Water sample analysis methods**

| **Parameter** | **Test method** |
|---|---|
| 1. Temperature | Thermometric (Thermometer) |
| 2. pH | Electrometric (pH meter - pH400S) |
| 3. Electrical conductivity (EC) | Electrometric (Conductivity meter - HQ14d) |
| 4. Total Dissolved Solids (TDS) | |
| 5. Salinity | |
| 6. Dissolved Oxygen (DO) | Titrimetric (Winkler's method) |
| 7. Biological Oxygen Demand ($BOD_5$) | |
| 8. Nitrate | Spectrometric (Sodium salicylate method) |
| 9. Total Phosphate | Spectrometric (Phospho-vanado-molybdate method) |

***D. Data analysis***

***i) Calculation of plankton abundance***

Zooplankton and phytoplankton were counted using a Sedgwick rafter counting cell. The following equation was used to calculate the abundance of plankton cells/m³ units (Soetignya et al., 2021).

$$N = n \times V_t / V_{src} \times A_{src} / A_a \times 1 / V_d$$

Where,

N = Plankton abundance (cells/$m^3$)
n = number of observed plankton
$V_t$ = volume of water in the sample bottle (mL)
$V_{src}$ = volume of water in the SRC (mL)
$A_{src}$ = SRC's area of view (1000 $mm^2$)
$A_a$ = area of view ($mm^2$)
$V_d$ = volume of filtered water sample ($m^3$)

***ii) Calculation of Shannon-Wiener diversity index (H') and Pielou's evenness index (J)***

The Shannon-Wiener diversity index was used to calculate species diversity in the samples. The Shannon-wiener diversity index was used to determine the pollution level and condition of the plankton. H′ values of 0–1, 1– 2, 2–3, and > 3 represent heavy, moderate, light, and no pollution, respectively. If H′<, the biota community is unstable and 1<H′ 3, the biota community is stable.

The following formula was used for the calculations (Soetignya et al., 2021)

$$H' = - \sum pi \ln pi$$

Where,

ni = number of individual species th
N = total number of individuals
Pi = ni/N

Pielou's evenness index (J) was calculated using the following equation,

$$J = H'/\ln S$$

Where,

S = Number of species encountered

Evenness measures the relative abundance of various species in a given area. If evenness is 1, all species were perfectly even in site. J values of 0-0.3, 0.3-0.5 and >0.5 represent heavy, moderate, and light or no pollution, respectively (Zhu *et al*., 2021).

***iii) Calculation of Simpson's Dominance Index (C)***

The Simpson Dominance Index was used to identify the dominance of species in the wetlands. The Simpson index was calculated using the following equation.

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

Where,

N = total number of individuals
ni = number of individual species
The index values are in the 0 to 1 range. If the value is close to 0, the community has no dominating genus; if it is close to 1, there is a dominant genus (Soetignya *et al*., 2021).

***iv) Similarity index / Sorenson's coefficient (CC)***

Sorenson's coefficient (CC) was calculated to determine the similarity between the different communities. The range of Sorenson's coefficient is 0 to 1. The closer the value is to 1, the more communities share similarities (Khatri *et al*., 2022).

Sorenson's coefficient was calculated using the following equation,

$$CC = 2C/ (S1+S2)$$

Where,

C = number of species the two communities have in common
S1 = total number of species found in community 1
S2 = total number of species found in community 2

***v) Statistical analysis***

Pearson correlation analysis was used to determine the relationship between water quality parameters. A one-way ANOVA test was employed to find significant differences between parameters. Microsoft Office Excel 2013 and Minitab 18.1 software were used for calculations and statistical analysis.

## 3. RESULTS AND DISCUSSION

***A. Plankton identification***

***i) Plankton distribution and diversity***

During the study period, 39 phytoplankton species belonging to three main groups (Bacilariophycea, Cynophycea, and Chlorophycea) were recorded from the four wetlands (Table 2, Figure 3). In addition, 24 zooplankton species belonging to three groups (Copepods, Rotifers, and Ichthyoplankton) were identified (Table 2, Figure 4). Figure 2 displays some of the observed plankton species during the study.

**Table 2. Identified plankton species and their occurrence during the study period in wetlands**

| Plankton Group | Species | Number of species | Nawala | Diyatha | Diyasaru | Beddagana |
|---|---|---|---|---|---|---|
| **Phytoplankton** | | | | | | |
| *Bacillariophyceae* (Diatom | *Asterionella* sp. | 1 | | | + | + |
| | *Attheya* sp. | 1 | + | | | |
| | *Cymbella* sp. | 1 | + | | | |

| Plankton Group | Species | Number of species | Nawala | Diyatha | Diyasaru | Beddagana |
|---|---|---|---|---|---|---|
| | *Melosira* spp. | 3 | + | + | + | + |
| | *Navicula* sp. | 1 | | + | + | + |
| | *Nitzchia* sp. | 1 | | + | + | |
| | *Synedra* sp. | 1 | | | + | |
| *Chlorophyceae* (Green Algae) | *Actinastrum* sp. | 1 | | | + | |
| | *Chlorella* sp. | 1 | | + | + | + |
| | *Coelastrum* sp. | 1 | + | + | | |
| | *Gonium* sp. | 1 | + | | | |
| | *Monactinus* spp. | 2 | | + | + | |
| | *Pandorina* sp. | 1 | + | | | + |
| | *Pediastrum duplex* | 1 | | + | + | |
| | *Pediastrum simplex* | 1 | + | + | + | + |
| | *Pediastrum* spp. | 2 | + | + | + | |
| | *Scenedesmus* spp. | 2 | | + | + | |
| | *Staurastrum* spp. | 2 | + | + | + | |
| | *Tetraselmis* sp. | 1 | | + | + | |
| | *Tetraedron* sp. | 1 | | | + | |
| *Cyanophyceae* (Blue Green Algae) | *Anabena* sp. | 1 | | | | + |
| | *Lyngbya* sp. | 1 | | | + | |
| | *Microcystis* spp. | 3 | + | + | + | + |
| | *Ocillatoria* sp. | 1 | | + | + | + |
| | *Nostoc spp.* | 2 | | | | + |
| | *Spirulina* sp. | 1 | + | + | | |
| *Euglenophyceae* | *Euglena* sp. | 1 | | + | | |
| | *Phacus* spp. | 2 | | + | | |
| | Unidentified sp.3 | 1 | + | + | | |
| | Unidentified sp.4 | 1 | + | + | | |
| **Zooplankton** | | | | | | |
| Copepods | *Cyclops* spp. | 3 | + | + | + | + |
| | Nauplius | 3 | + | + | + | + |
| Rotifers | *Brachionus angularis* | 1 | + | | + | |
| | *Brachionus falcatus* | 1 | | + | + | |
| | *Brachionus* spp. | 2 | + | + | + | + |
| | *Filinia* sp. | 1 | + | | | |
| | *Karetella cochlearis* | 1 | + | | + | |
| | *Karetella* spp. | 3 | + | + | + | + |
| | *Lecane* spp. | 2 | + | + | + | |
| | *Lecane luna* | 1 | + | + | + | |
| | *Polyathra* sp. | 1 | + | + | + | |
| | *Polyathra vulgaris* | 1 | + | + | | |
| Ichthyoplankton | | 2 | + | + | + | + |
| | Unidentified sp.1 | 1 | + | + | + | + |
| | Unidentified sp.2 | 1 | + | | | |
| | + indicate the presence of the species | | | | | |

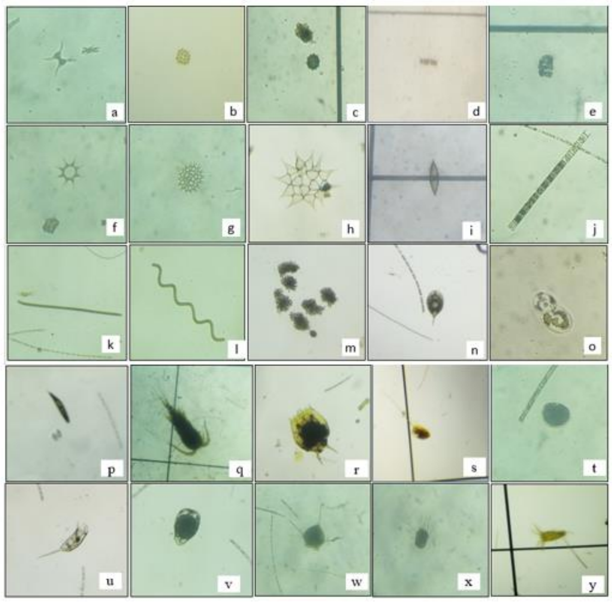


**Figure 2. Some recorded plankton species (a) *Staurodesmus* sp. (b) *Gonium* sp. (c) *Coelastrum* sp. (d) *Scenedesmus* sp. (e) *Pandorina* sp. (f) *Pediastrum simplex* (g) *Pediastrum duplex* (h) *Pediastrum* sp. (k) *Ocillatoria* sp.(l) *Spirulina* sp. (m) *Microcystis* spp. *(n) Phacus* sp. (o) unidentified sp. 3 (p) *Euglena* sp. (q) Copepod (r) *Brachionus* sp. (s) unidentified sp. 1 (t)**

**unidentified sp. 2 (u) *Keratella* sp. (v) *Lecane* sp. (w) *Filinia* sp. (x) *Polyathra* sp. (y) Nauplii**

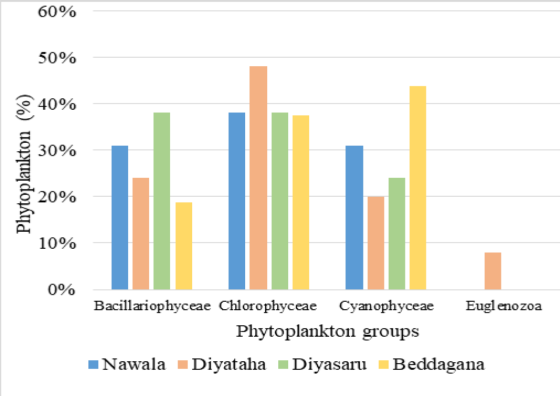


**Figure 3. Phytoplankton diversity of wetlands**

Chlorophycea was the most diverse phytoplankton group in wetlands. Besides the three main groups (Chlorophycea, bacilariophycea, and cyanophycea), two plankton species from class Euglenoidea were recorded in Diyatha. The highest number of phytoplankton species was found in Diyatha wetland. The lowest diverse phytoplankton community was found in the Nawala wetland. Previously, the presence of phytoplankton species such as *Pediastrum* spp., *Melosira* sp., *Synedra* sp., *Cymbella* sp., *Navicula* sp., *Spirulina* sp., *Microcystis* spp., and *Scenedesmus* sp. have been reported from the selected sites in the Diyawanna Wetland System (Wijeyaratne and Nanayakkara, 2020).

*Melosira* spp. was recorded as the dominant species in all wetlands. The other major phytoplankton in study sites were *Pediastrum spp, and Microcystis spp.*. Some of the recorded phytoplankton species were identified as potential bioindicators of pollution in the studied wetlands. The occurrence of such species as *Pediastrum* spp., *Melosira* spp., and *Microcystis* spp. is a terrific indicator of pollution (Harris and Vinobaba, 2013; Wijeyaratne and Nanayakkara, 2020; Heramza et al., 2021). *Microcystis* spp. requires a relatively low phosphorus amount and can utilise sulfur instead of phosphorus in its metabolism. It indicates that *Microcystis* spp. can be adapted to tolerate changes in water chemistry. *Melosira* spp. is opportunistic and well-adapted to environmental fluctuations (Heramza *et al*., 2021). *Pediastrum simplex* and *Pediastrum duplex* were identified as potential eutrophication indicators because these two species are increasing their number in response to increased nutrient concentrations (Wijeyaratne and Nanayakkara, 2020).

*Pediastrum* spp. *Chlorella* sp., *Closterium* sp., *Euglena sp., phacus* sp., *Melosira* spp., *Microcystis* spp., *Navicula* sp., *Oscillatoria* sp., *Scenedesmus* sp., and *Synedra* sp., *Cymbella* sp. were identified as indicator phytoplankton in eutrophic water bodies (Abubacker *et al*.,1996; Harris and Vinobaba, 2013; Wijeyaratne and Nanayakkara, 2020; Heramza *et al*., 2021). Furthermore, phytoplankton genera such as Melosira, Navicula, Pandorina, Phacus, Chlorella, Synedra, Pediastrum, Actinastrum, Coelastrum, and Nitzschia were identified as organic pollution indicators (Palmer,1969).

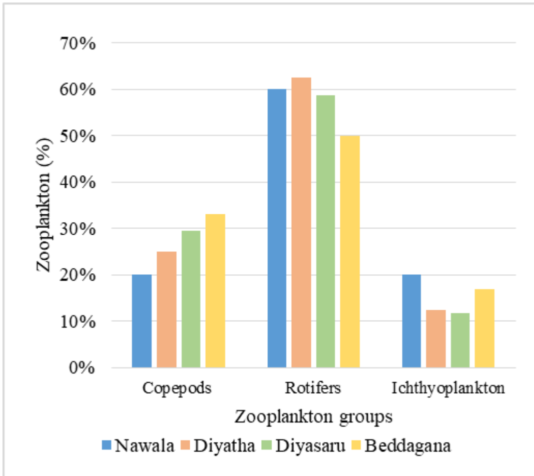


**Figure 4. Zooplankton diversity of wetland**

In four wetlands, copepods, rotifers, and ichthyoplankton were recorded as zooplankton (Figure 4). The group rotifers were the most diverse zooplankton group in wetlands. Among rotifers, *Brachionus* spp. and *Keratella* spp. were most dominant in all wetlands. However, zooplankton's diversity was generally lower in wetlands than phytoplankton.

Like the present study, Rotifers have been recorded as the most diverse zooplankton group in the Kotte Kolonnawa wetland, Sri Lanka (Wickramasinghe *et al*., 2012). Rotifers belonging to the Brachionidae family are known to be strongly associated with water eutrophication (Houssou *et al*., 2018). *Keratella* spp., *Brachionus* spp., and *Lecane* spp. were identified as indicator zooplankton in eutrophic water bodies (Houssou *et al*., 2018). Due to the aforementioned zooplankton species, the four wetlands are more likely to be eutrophic. Industrial runoff, urbanised catchment areas, and anthropogenic activities mostly cause the eutrophication in these wetlands. According to Goel and Chavan (1991), *Brachionus* sp. and *Keratella* sp. are organic pollution indicators. Therefore, Brachionus spp. and Keratella spp were present. indicates organic pollution in these wetlands. However, zooplankton's diversity was generally lower in wetlands than phytoplankton.

***ii) Plankton abundance***

The average plankton densities of the wetlands were 176 cell/L, 166 cell/L, 172 cell/L, and 68 cell/L in Nawala, Diyatha, Diyasaru, and Beddagana wetlands, respectively (Figure 5). According to one-way ANOVA test results (Table 5), plankton abundances calculated during the study period were not significantly different from each wetland ($p$ >0.05). However, the Beddagana wetland had the lowest abundance of plankton compared to other wetlands.

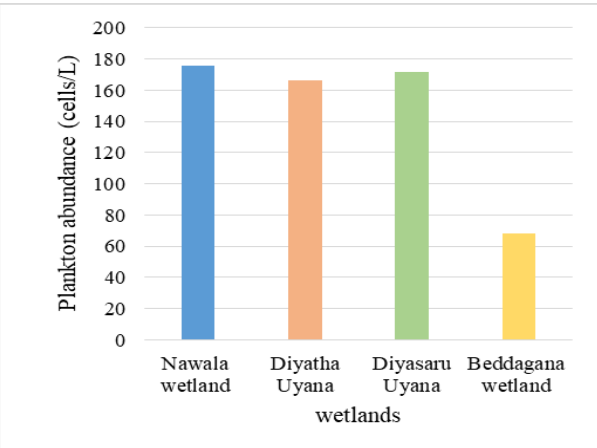


**Figure 5. Plankton abundance in wetlands**

***iii) Development of biotic indices***

The calculated Shannon-Wiener diversity index (H '), evenness (J), and Simpson's dominance index (C) values for wetlands are indicated in the table 3.

Shannon-Wiener index (H') was the most popular diversity index among researchers for plankton-based studies (Wu *et al*., 2014). According to the calculated H' values for zooplankton (0-1) and phytoplankton (1-2), there was a very low level of zooplankton diversity and a low level of phytoplankton diversity, respectively. Although the calculated H' values for phytoplankton are significantly different among wetlands (ANOVA, p=0.03), there was no significant difference (p=0.22) in H' values for zooplankton. High values of H' represent more diverse communities. A community with a single species would have a value of 0 for H', while if the species were distributed evenly H' value would be at a maximum (Wu et al., 2014). Hence, all wetlands have low H' values close to 1 for zooplankton and phytoplankton, which indicates that the studied wetlands did not indicate diverse plankton communities.

H′ values of 0-1, 1-2, 2-3, and >3, respectively, represented as heavy, moderate, light, and no pollution (Zhu *et al*., 2021). Clean water is indicated by Shannon Wiener index values over 3, while polluted water is indicated by values below 3. For all wetlands, H' for zooplankton communities were classified as heavily polluted, while phytoplankton communities at all wetlands were classified as moderately polluted. Previous studies have assessed the Diyawnna Oya wetland area as polluted (Wijeyaratne and Nanayakkara, 2020). H' value decreases with the deterioration of water quality. The Lowest H' value for phytoplankton was recorded in Diyatha wetland. Therefore, Diyatha wetland might have a higher level of pollution. .

Simpson's dominance index (C) values were 0.5 or less than 0.5 for zooplankton and phytoplankton in Diyatha, Diyasaru, and Beddagana wetlands. Nawala wetland has the highest C value for phytoplankton (Table 3).

These diversity indices have been constructed considering species number and relative abundances. This means that if the values of these diversity indices are high, the water body will be in good condition (Thakur *et al*., 2013). The study area is located within a highly urbanised city in Sri Lanka. Waste disposal by households, industrial runoff and other point and non-point pollution sources may influence nutrient enrichment of the area (Hettiarachchi *et al*., 2013). Throughout the study period, all wetlands exhibited abundant floating aquatic weeds in large quantities. Therefore, the abundance of weeds indicates a eutrophic condition of water bodies.

Simpson dominance index was used to quantify habitat biodiversity and give more weight to common or dominant species (Sharma *et al.*, 2015). In the Simpson index, values range between 0 and 1, where values near 0 indicate that species are evenly distributed in communities and there is no single dominant species. Values close to 1 indicate that species are unevenly distributed, which makes dominance of one species. Results of the study showed that the highest C value was recorded for phytoplankton in the Nawala wetland, indicating a dominant phytoplankton species in Nawala. In Nawala wetland, *Melosira* sp. was the most abundant and at 80% of the total phytoplankton density.

**Table 3. Shannon-Wiener diversity index (H '), evenness (J), and Simpson's dominance index (C) values for wetlands**

| Wetland | | H ' | C | J |
|---|---|---|---|---|
| Nawala | Phytoplankton | 1.6 | 0.7 | 0.7 |
| | Zooplankton | 1.0 | 0.4 | 0.8 |
| Diyatha | Phytoplankton | 1.2 | 0.5 | 0.4 |
| | Zooplankton | 0.8 | 0.5 | 0.7 |
| Diyasaru | Phytoplankton | 1.6 | 0.3 | 0.6 |
| | Zooplankton | 1.0 | 0.4 | 0.9 |
| Beddagana | Phytoplankton | 1.7 | 0.3 | 0.7 |
| | Zooplankton | 1.0 | 0.3 | 1.0 |

According to Sorenson's Coefficient values presented in Table 4, there was not much similarity between the Nawala and Beddagana wetlands and Diyasaru and Beddagana wetlands. Other wetlands have more similarities. Diyasaru and Diyatha have the highest similar species composition.

**Table 4. Sorenson's Coefficient values between wetlands**

| Wetland | Nawala wetland | Diyatha wetland | Diyasaru wetland |
|---|---|---|---|
| Diyatha wetland | 0.6 | | |
| Diyasaru wetland | 0.5 | 0.9 | |
| Beddagana wetland | 0.3 | 0.5 | 0.3 |

***iv) Water Quality Results***

Table 5 shows the reported mean values for each wetland's selected water quality parameters during the research period.

**Table 5. Water quality parameters**

| Parameter | Standard value | Mean ±SD | | | | *P* value |
|---|---|---|---|---|---|---|
| | | Nawala | Diyatha | Diyasaru | Beddagana | |
| pH | 6-8.5 | 6.88± 0.04 | 7.07 ±0.32 | 6.88± 0.14 | 6.32± 0.09 | **0.001** |
| Conductivity (µS/cm) | - | 346.6 ±29.4 | 168± 58.9 | 212.2 ±7.3 | 131.0 ±21.9 | **0.000** |
| TDS (ppm) | - | 170.3 ±32.4 | 80.3 ±27.3 | 102.0 ±5.1 | 68.75 ±5.5 | **0.000** |
| Nitrates (mg/L) | ≤ 5 mg/L | 1.55± 0.2 | 0.9± 0.08 | 0.9±0.08 | 1.05± 0.52 | **0.022** |
| Total Phosphate (mg/L) | ≤ 0.4 mg/L | 0.09± 0.009 | 0.24 ±0.04 | 0.07± 0.01 | 0.095 ±1.02 | **0.000** |
| DO (mg/L) | ≥ 3 mg/L | 7.35± 1.35 | 7.49 ±2.2 | 6.52± 1.2 | 5.93± 1.64 | 0.548 |
| BOD (mg/L) | ≥ 5 mg/L | 2.97± 0.78 | 3.0± 0.98 | 3.7±0.4 | 2.7±1.02 | 0.391 |
| Plankton abundance (cells/L) | - | 176±44.5 | 166± 52.3 | 147± 35.9 | 68±78.3 | **0.008** |

According to the Central Environmental Authority's water quality standards for maintaining healthy aquatic life in Sri Lankan inland waters, the results of the water quality analysis indicate that all the studied wetlands comply with the ambient water quality standards established by CEA (National Environmental (Ambient Water Quality) Regulations, No. 01 of 2019).

Physiochemical paramters indicate that water bodies of these wetlands are safe for aquatic life but not suitable for human consumption according to Sri Lankan standards. Eventhough, biological parameters indicate pollution in each wetland, water quality parameters show wetlands provide basic enviornmental conditions that allow life to thrive. Biological indicators suggest that some organisms are being affected, but the water quality has not reached the point where life cannot persist. Despite the pollution, water body supports the growth of life though the ecosystem may not be in its healthiest state.

In Nawala wetland, EC and temperature (0.983), BOD and DO (0.949) nitrate and TDS (0.888), Total phosphate and EC (0.967) showed strong positive correlations. In Diyatha wetland, pH and EC (0.914**)**, TDS and EC (1.0), TDS and pH (0.912), and DO and BOD (0.933) showed strong positive correlations. Nitrate and total phosphate (-0.860) showed a strong negative correlation. It indicates that if one variable increases the other variable tend to decrease. In Diyasaru wetland, EC and TDS (0.894), DO and BOD (0.907), DO and nitrate (0.750), pH and nitrate (0.912) showed strong positive correlations while EC and nitrate (-0.831) showed a strong negative correlation. In Beddagana wetland, EC and TDS (0.963), BOD and DO (0.930), phosphate and nitrate (0.979) showed strong positive correlations.

Among wetlands, there was no significant difference in DO and BOD concentrations (P>0.05). According to person correlation analysis values in wetlands, there is a robust positive correction between DO and BOD. If the concentration of organic matter in a water body is high, the degradation of those nutrients by microorganisms in water will be high, which causes an increase in BOD (Singh *et al.*, 2021). An increase in BOD in water can indicate higher levels of organic water pollution.

In this study, the concentration of total phosphate and nitrate shows significant variation among wetlands. The highest mean concentration of total phosphate (0.24±0.04 mg/L) was observed in Diyatha wetland, while the lowest mean concentration was at Diaysaru wetland (0.07±0.01 mg/L). Untreated sewage surface runoff, decomposing rocks, and industrial effluent are the primary sources of phosphate in water bodies (Singh *et al.*, 2021). The highest phosphate level was recorded at the Diyatha wetland, possibly due to its more stagnant water, as observed during the study period, compared to the other wetlands. The highest value of nitrates was recorded in the Nawala wetland (1.55±0.2 mg/L), and the minimum (0.9 ±0.08 mg/L) values were observed in Diyatha and Diyasaru wetlands.

Eutrophication is caused by a water body with high nitrate and phosphate levels (Singh *et al.*, 2021). Studies show mesotrophic streams' total phosphates range from 0.70–1.50, and total nitrate ranges from 0.025–0.075 (Gurung *et al.*, 2013). Therefore, all wetlands can be categorised as mesotrophic according to the phosphate and nitrate concentrations of the present study.

Previous studies show the water quality of the Diyawanna Oya area was not good during the 2004 – 2014 time period (Metro Colombo Urban Development Project, Environmental Screening Report, 2016). However, water quality seems to have improved after 2014. The water quality in Diyawanna Oya can be improved due to better wetland management strategies. It was found that the vegetation cover of the Colombo wetland area is increasing with time, and wastelands are converting into wetlands (Hettiarachchi *et al.*, 2014). Therefore, these factors may contribute to enhancing water quality in the region.

## 4. CONCLUSION

According to the diversity indices, there is a low level of plankton diversity in Nawala Wetland Park, Diyatha Uyana Wetland Park, Diyasaru Wetland Park, and Beddagana Wetland Park with a considerable level of water pollution, but they are still suitable for growth and survival of aquatic life. *Pediastrum* spp. *Closterium* sp., *Chlorella* sp., *Euglena sp., phacus* sp., *Melosira* spp., *Microcystis* spp., *Navicula* sp., *Oscillatoria* sp., *Scenedesmus* sp., and *Synedra* sp., *Keratella* spp., *Brachionus* spp., and *Lecane* spp. were identified as potential pollution indicator species.

In this case, the presence of pollution-indicator species might not be directly linked to nutrient pollution. Other factors, such as localised pollution sources and historical contaminations, can influence plankton diversity. Further investigations into potential pollutants (heavy metals, organic contaminants) might be necessary to understand the ecosystem's health fully.

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