VOLUME 8 ISSUE 2 2022

ISSN 2454-3055

# INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

*Forum for Biological and Environmental Sciences*

Published by Saran Publications, India

*International Journal of Zoological Investigations Vol. 8, No. 2, 490-496 (2022)*

**International Journal of Zoological Investigations**
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

**ISSN: 2454-3055**

# Mangrove Phytoplankton Quality Index Evolving Sustainability

**Padmavathy V.[1], Sesh Serebiah J.[2] and Stella C.[1]***

[1]Department of Oceanography and Coastal Area studies, School of Marine Sciences, Alagappa University, Thondi Campus, Thondi 623409, Tamil Nadu, India
[2]Jehovah Shamma Centre for Marine and Wildlife Research, Mudiveeranpattinam, Ramanathapuram, Tamil Nadu, India
**Corresponding Author*

**Received:** 14th August, 2022; **Accepted:** 20th September, 2022; **Published online:** 5th October, 2022

**https://doi.org/10.33745/ijzi.2022.v08i02.061**

**Abstract:** The growth of Mangroves along backwaters of Ennore creek, Tamil Nadu, India was selected for the present study. Study was undertaken every month for the period of one year from January to December 2021. Four decisive stations were identified for survey to bring out seasonal consequences. The phytoplankton community was investigated by estimating population through adopting qualitative and quantitative analysis such as species composition, percentage composition, density, diversity, richness, evenness. Supportive parameters viz. nitrate, silicate and phosphate were also examined. Meanwhile, regulating parameters such as temperature, salinity, pH, dissolved oxygen were also investigated. Three groups such as Bacillariophyceae, Cyanophyceae and Chlorophyceae were identified with 37, 31 and 18 (nos.) species, respectively. The phytoplankton density was observed as 280 to 8050 cells/l. Recorded density was lower compared to other ecosystems and back waters, the community structure of phytoplankton population still thriving due to supportive parameters as documented in the presented study. Despite, the recorded high level of BOD, COD, heavy metals and regulating parameters not conducive, the population of phytoplankton community has affluently sustained and made sustain other biota in vicinity, which can still regulate the carrying capacity of Ennore back waters by acting effectively as primary producers in the system.

**Keywords:** Ennore Mangrove, Primary producers, Qualitative, Quantitative, Supportive, Sustainability

**Citation:** Padmavathy V., Sesh Serebiah J. and Stella C.: Mangrove phytoplankton quality index evolving sustainability. Intern. J. Zool. Invest. 8(2): 490-496, 2022.
**https://doi.org/10.33745/ijzi.2022.v08i02.061**



## Introduction

Mangrove ecosystem is the ecologically dynamic most productive ecosystem in tropical, sub-tropical regions (Musthafa and Krishnamoorty, 2011). They are salt-tolerant trees, additionally known as halophytes, and are tailored to stay in harsh coastal environment. They incorporate a complicated salt filtration system through network of rooting in the coastal regions thereby salt intrusion is controlled. Mangrove ecosystem act as a buffer zone in the intertidal region to effectively control the pollutants and burry in the deeper sediment zone. Hence, mangroves contribute pollutants free water and enhance biodiversity especially `in coastal and estuarine

ecosystem. Mangrove phytoplankton is the fundamental platform for food chain and support wide array of faunal components. Mangrove ecosystem and phytoplankton community have interconnected biotic systems serving a vital source of energy flow to higher biotic components and thereby healthy surviving of biodiversity. Hence, the present research was executed to evaluate the distribution of phytoplankton and the supportive parameters *viz*. nitrate, silicate, phosphate and regulating parameters such as temperature, pH, salinity, dissolved oxygen in Ennore mangrove estuarine ecosystem. The waste from NCTPS (North Chennai Thermal Power Station), fly ash deposits, pipeline leaking, the construction debris, raw municipal sewage, industrial trade effluents, industrial cooling waters and Ennore satellite port sediment accretion altogether, causing the Ennore estuary water becoming turbid and highly polluted. Hence, BOD, COD and heavy metals in sediments were also assessed to record pollution index. The study aimed to understand the sustainability of resources amidst of pollutants is only due to phytoplankton community and its structure inhabiting in mangrove ecosystem.

## Materials and Methods

Four sampling stations were fixed by GPS (Table 1; Fig.1). Water and phytoplankton samples were collected from the predefined stations for the period of one year from January to December 2021.

Water and phytoplankton Samples were analysed and represented season wise. Temperature was measured through standard centigrade laboratory thermometer. The salinity and density were measured by salinity refractometer ATAGO) by the principle of refraction. pH was measured by a pH pen (Eutech instruments). Dissolved oxygen was determined by Winkler's method (Winkler, 1888). For nutrient analysis, the water samples were filtered through the Millipore filtering unit using Whatman GF/C filter and dissolved nutrients like nitrite, inorganic phosphate and silicate were estimated by calorimetric method using ECIL CE 303 Grating, Spectrophotometer at appropriate wave lengths as described by Strickland and Parsons (1972).

Phytoplankton samples were collected from the surface waters using plankton net with mesh size 60 µm by towing for half an hour at each station. These samples were preserved in 5% neutralized formalin for further analysis. The quantitative analysis of phytoplankton was carried out by the settlement method described by Sukhanova (1978). Qualitative plankton analysis was carried out using Utermohl's inverted plankton microscope by using standard references. Biodiversity indices such as species diversity, richness and evenness were calculated by standard methods (Shannon and Weiner, 1949; Simpson, 1949; Pielou, 1966).

## Results and Discussion

The water temperature ranged from 25 to 34°C. Temperature controls the features of water quality by influencing the kinetics of dissolved oxygen, photosynthesis, metabolic processes, and other chemical and physical processes. In the present study, a minimum surface temperature of 25°C was recorded in pre-monsoon (July 2021) and a maximum temperature of 34°C was recorded in summer season (April 2021). The variations are due to increased solar radiation, evaporation, lack of flushing, fresh water influx, cooling and mix up with ebb and flow from adjoining neritic waters. In the present study, summer peaks and monsoonal troughs has been found to be similar to the report on west coast of India (Desai, 1992; Arthur, 2000). The salinity varied from 22.35 to 54.65 ppt. Salinity fluctuation correlated with temperature. Upper estuary dried due to evaporation and caused elevated salinity. In the present study, a minimum salinity of 22.35‰ was recorded in post-monsoon season (February 2021) and a maximum salinity of 54.65‰ was recorded in summer season (April 2021). Salinity increased in summer when the volume of fresh water flux decreased and subsequently decreased in winter due to fresh water discharge from land run-off and monsoonal seawater input. The high

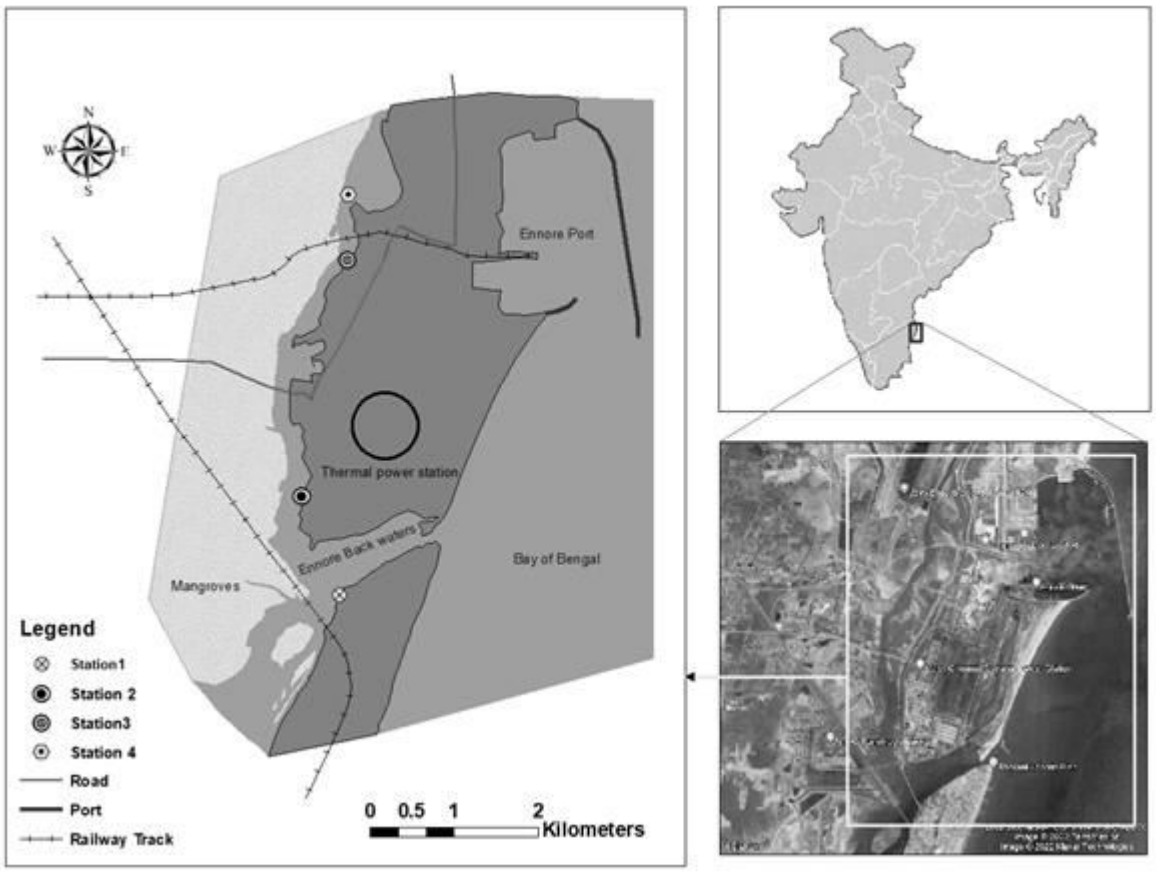


Fig. 1: Map showing study area- Ennore Backwaters.

Table 1: Stations with GPS units

| STATION | CO-ORDINATES | |
|---|---|---|
| | LATITUDE | LONGITUDE |
| 1 | 13°13'58"N | 80°19'46"E |
| 2 | 13°15'32"N | 80°19'22"E |
| 3 | 13°15'51"N | 80°19'30"E |
| 4 | 13°13'57"N | 80°19'21"E |

level of evaporation in the study area could be the cause of higher values in the summer (Sampathkumar and Kannan, 1996). The distribution of biota is constrained by salinity, and variations in salinity brought on by dilution and evaporation and have an impact on the intertidal zone's flora (Sridhar *et al*., 2006). Lower values in salinity during winter in study stations could probably be due to fresh water runoff entering creek systems as reported by Saisastry and Chandramohan (1990) in Godawari estuary. Generally, the salinity values in the coastal and offshore locations show negligible variations with tide, depth and distance. However, variations in salinity values with tides were observed in the Ennore creek samples. The lower salinity values are also due to the mixing of municipal wastewaters from the Buckingham canal and higher salinity values possibly due to lack of circulation in the upper reaches (National Institute of Ocean Technology). The pH ranged from 7.5 to 8.5. Minimum pH of 7.5 was recorded in monsoon season (December 2021) and a maximum pH of 8.5 was recorded in summer season (April 2021) and pre-monsoon season (July 2021). Hydrogen ion concentration, remained alkaline in all the

stations throughout the study period. The higher pH was because of the lower water level and low pH values because of monsoon rains causing inflow. The elimination of carbon dioxide by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, decrease in salinity and temperature, and breakdown of organic matter are some of the mechanisms that are often responsible for pH variations throughout the year (Paramasivam and Kannan, 2005)

The maximum values for DO, BOD COD were recorded as 3.4 mg/l, 10.26 mg/l and 17.45 mg/l, respectively. In the present study, minimum dissolved oxygen of 0.59 mg/l was recorded in pre-monsoon season (July 2021) and maximum dissolved oxygen of 3.4 mg/l was recorded in monsoon season (November 2021). Dissolved oxygen in water relies upon numerous factors, inclusive of salinity, temperature, reaeration, natural matter, productiveness and the presence of pollutants. High dissolved oxygen concentration was due to cumulative effect of wind velocity, rainfall, fresh water mixing and photosynthesis (Ramaraj *et al.,* 1987; Zingde *et al.,* 1981; Arunaba *et al.,* 1990). A decline in the dissolved oxygen was due to the increasing temperature, high salinity of the estuarine water, reduced agitation and turbulence of coastal and creek waters. Fluctuation, current, velocity, stream morphology and biological characters often responsible for dissolved oxygen variations (Chandran and Ramamurthy, 1984). Optimum concentration of oxygen is essential for aesthetic qualities of water as well as for supporting life. Temperature and salinity also affect dissolution of oxygen (Vijayakumar *et al.,* 2000). Ennore creek DO values show high variations with time of day, indicating the highly eutrophic conditions due to municipal and industrial waste water discharge (NIOT).

Maximum and minimum concentrations of nutrients viz. nitrite 0.005 to 0.12 µg/l, phosphate 0.02 to 0.68 µg/l and silicate 0.05 to 1.85 µg/l were noticed in the present investigations. In the present study, minimum inorganic phosphate concentration of 0.02 µg/l was recorded in post-monsoon season (March 2021) and a maximum of 0.68 µg/l was recorded in monsoon season (December 2021). Higher inorganic phosphate during the monsoon, might be influenced by land run off and fertilizer inputs from culture sites, whereas the lower value of phosphate during the summer could be due to decreased land drainage and utilization of phosphate by phytoplankton, which showed high photosynthetic activity as evidenced by high values of primary production which was recorded in Pitchavaram mangroves (Kannan and Krishnamoorthy, 1985). Higher values observed might also be due to transport of phosphate by bubbles rising to the surface, decomposition of particulate organic matter, which was high in Ennore back waters. Walsh (1967) reported that mangrove sediments release phosphate during fresh water inflow and absorbs them from overlying water when the water becomes saline again. In the present study, minimum inorganic nitrite concentration of 0.005 µg/l was recorded in the pre-monsoon season (July 2021, August 2021 and September 2021), and a maximum inorganic nitrite concentration of 0.12 µg/l was recorded in post-monsoon season (March 2021). Higher values recorded in this study could be possible due to heavy rainfall, land drainage, sewage contamination, municipal waste, agricultural discharge, industrial influx, influence of seasonal floods (Govindasamy and Azariah, 1997) and cellular production of nitrite by phytoplankton during assimilation of nitrite. Biological causes such as the activity of 'nitrogen-cycle', excretion of nitrogenous compounds by plankton and decay of vegetation (Sundararaj and Krishnamoorthy, 1975) also increases the values of inorganic nitrite. Nitrite values high in Muthupet mangroves and other mangrove environs support the present findings. The creek waters, the concentrations are higher showing that the ammonia is being oxidised to nitrate (NIOT).In the present study, minimum inorganic silicate concentration of 0.05 µg/l was recorded in

Table 2: Plankton groups, occurrence and its representation

| Groups | Species representation | Occurrence |
|---|---|---|
| Bacillariophyceae (Diatoms) | 37 | 499 |
| Cyanophyceae (Blue Green Algae) | 31 | 344 |
| Chlorophyceae (Green Algae) | 18 | 145 |

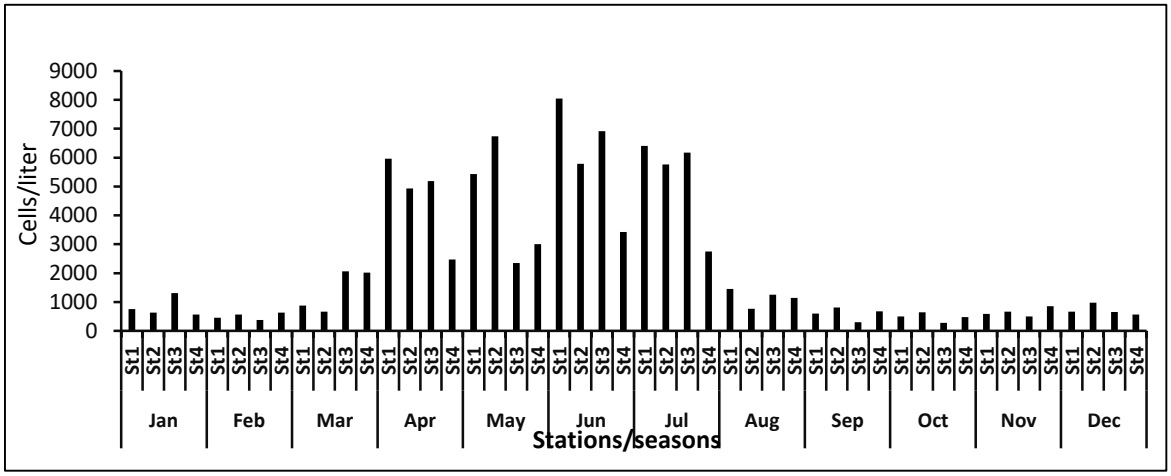


Fig. 2: Density of Phytoplankton in the study area (Cells/liter).

pre-monsoon season (August 2021) and maximum of 1.85 µg/l was recorded in monsoon season (December 2021). The higher values could be attributed to the influx of freshwater during the monsoon. The available silicate in the bottom sediment might get into the upper water layers when bottom sediment was agitated (Anbazhagan, 1988). High concentration was also found to be associated with fall in salinity (Govindasamy and Azariah, 1997). Low concentration of silicate during the pre-monsoon season could be due to higher salinity through more influence of neritic waters, cessation of fresh water inflow and removal by biological processes. Silicate finds its usefulness in the formation of skeleton of diatoms. Gouda and Panigraphy (1992) reported that the uptake by phytoplankton and other processes like absorption and co-precipitation of soluble silicon might also bring about the distribution of dissolved silicate in the estuarine environment. Diatoms were found to be the dominant in Ennore waterbody as in the estuarine waters in the west coast (Gopinathan *et al.,* 2001; Gowda *et al.,* 2001).

Monthly variation in phytoplankton species composition, percentage composition, population density, species diversity, richness and evenness were documented for a period of one year from January to December 2021 at the 4 stations. A total of 86 species of phytoplankton were recorded during the present study. Among them, 37 species Bacillaliophyceae, 31 species Cyanophyceae and 18 species Chlorophyceae (Table 2). The population density ranged from 280 to 8050 cells/l across the four stations (Fig. 2). The species percentage of the bacillaiophyceae was 43.02%, Cyanophyceae was 36.04% and Chlorophyceae was 20.93%. The overall richness value of the study area ranged from 1.77 to 5.47 and the species evenness index varied from 0.26 to 0.98.

The species diversity values across the four stations ranged from 0.894 to 3.36 in the study year. Adesalu and Nwarkwo (2008) and Rajagopal *et al.* (2010) reported that the population in the rainy season is due to the dilution of area and young settlements of species. Mesham (2005)

reported that overloading of nutrients and dissolved matter in the water bodies affect the phytoplankton diversity. Diversity index is a good tool for assessing and ranking the water quality (Singh and Singh, 2002). Diversity was found to be increasing with increasing species richness and evenness. In the present study, it was observed that species evenness is maximum in non – monsoon and minimum during monsoon. The species richness is high in monsoon and low in non – monsoon as limited species are dominant at their entities. The movement of standing water circulation allow good water renewal in the downstream sector responsible for high species richness. Further, it is evident that the phytoplankton density is low, compared to Pichavaram mangrove system (50,11,872 cells/l) as observed by Kannan and Vasantha (1992). The noticed level of phytoplankton density was attributed by nutrients and favourable limiting parameters.

## Conclusion

The present study demonstrated that the phytoplankton community thrives in the Ennore backwaters owing to buffering capacity of mangrove ecosystem. Beyond, regulative and supportive parameters help to survive the primary producers and thereby sustain other biota. Being an industrial area and besides the exceeding BOD, COD and relatively high concentrations of heavy metals, the phytoplankton quality index is evolving sustainability of the system.Further the study evidenced that the carrying capacity of water body having not exceeded, the system resiliates from additional stresses without causing any permanent damage to the productivity in a limited extent.

## Acknowledgements

Authors would like to express their sincere thanks to the Head, Department of Oceanography and Coastal area studies, Alagappa University, Karaikudi, India for having given an opportunity to pursue this research work and the lab facilities provided to carry the analysis.

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