Abhi International Journals of Biological Sciences
e-ISSN X__X-X__X
Vol. 1, No. 1, December 2024

Phytoplankton Diversity and Water Quality Assessment in Lagos Lagoon

Dr. Sudhir Kumar Sharma

NIET, NIMS University, Jaipur, India,

ARTICLE INFO

Article History:

Received November 15, 2024

Revised November 30, 2024

Accepted December 12, 2024

Available online December 25, 2024

Keywords:

Phytoplankton dynamics

temperature effects

salinity

turbidity

dissolved oxygen

Correspondence:

Telephon: +91 8290519977

E-mail: sudhir.sharma@nimsuniversity.org

ABSTRACT

Phytoplankton is one of the most important primary producers in aquatic ecosystems and is a good indicator of water quality. This research assesses the phytoplankton composition and diversity in Lagos Lagoon from January to October 2017 to understand the impact of physicochemical parameters on phytoplankton dynamics. Independent variables, such as temperature, dissolved oxygen, turbidity, nutrient concentration, and salinity, were evaluated to examine their relationship with phytoplankton density and diversity. Findings reveal significant correlations between water quality parameters and phytoplankton dynamics, with temperature positively influencing growth rates, dissolved oxygen enhancing diversity, and turbidity negatively affecting distribution. Nutrient concentrations altered species composition, while higher salinity levels reduced phytoplankton abundance. These results highlight the importance of maintaining water quality for ecosystem health. Limitations such as relying on one-year data and sampling biases suggest that future studies should incorporate multi-year datasets and advance methodologies for an even deeper understanding. The study will be of benefit to understanding aquatic ecosystem management, further emphasizing the need for sustainable water quality practices.

1. Introduction

This section introduces the background of the study by making emphasis on the importance of phytoplankton as a primary producer in aquatic ecosystems and as an indicator of water quality. It emphasizes the objectives of the study, which are to analyze the phytoplankton composition and diversity in Lagos Lagoon from January to October 2017. The core research question for this study focuses on understanding how water quality impacts phytoplankton density and diversity. Some subsidiary sub-research questions include the relationship of water temperature and phytoplankton's growth, effects of dissolved oxygen on phytoplankton diversity, influence of turbidity on the distribution of phytoplankton, effects on the concentration of nutrients on the composition of phytoplankton, and the influence of salinity on the abundance of phytoplankton. This study applies a quantitative method to analyze these relationships by involving independent variables like physicochemical parameters and dependent variables such as phytoplankton density and diversity. The article progresses from a literature review to methodology, results, and a conclusion, offering a systematic analysis of phytoplankton dynamics in relation to water quality in Lagos Lagoon.

2. Literature Review

This section critically evaluates existing research on the relationship between water quality and phytoplankton dynamics, structured around the sub-research questions identified. It discusses detailed research findings on temperature effects, dissolved oxygen influence, turbidity impact, nutrient concentration, and salinity's role in phytoplankton ecology. The review identifies gaps such as limited data on specific nutrient impacts, insufficient longitudinal studies on salinity, and underexplored relationships between turbidity and phytoplankton diversity. The section concludes by proposing hypotheses corresponding to each sub-research question, which will be tested in the study.

1. Temperature Effects on Phytoplankton Growth

Early work explored temperature effects on phytoplankton growth, but all early work had the inherent weakness that it lacked consideration of interacting environmental factors. Additional studies provided a better look into temperature thresholds for optimum growth but did not elucidate variability between species of phytoplankton. Recent studies have tried to bridge these gaps by studying species-specific responses to temperature changes, but a conclusive generalization is still elusive. Hypothesis 1: Increased water temperatures are positively correlated with phytoplankton growth rates in Lagos Lagoon.

2. Dissolved Oxygen and Phytoplankton Diversity

Early studies indicated that higher dissolved oxygen levels correlated with greater phytoplankton diversity, but these studies generally failed to account for seasonality. Later studies have started to include temporal variables and have shown fluctuations in diversity that correlate with the availability of oxygen but are still lacking in species-level analysis. Recent work has further refined these approaches to include species-specific oxygen needs, but gaps remain in understanding long-term impacts. Hypothesis 2: Higher dissolved oxygen levels are associated with increased phytoplankton diversity in Lagos Lagoon.

3. Turbidity's Impact on Phytoplankton Distribution

Early studies on the effects of turbidity indicated reduced light penetration as a limiting factor for phytoplankton distribution but rarely explained its interaction with other variables. Mid-term studies further developed this by considering the impacts of multiple variables but lacked spatial analyses in detail. Recent studies have improved spatial mapping techniques, yet comprehensive assessments of the role of turbidity in phytoplankton distribution are still needed. Hypothesis 3: Increased turbidity negatively affects phytoplankton distribution in Lagos Lagoon.

4. Nutrient Concentration and Phytoplankton Composition

Early studies on nutrient effects were based on nitrogen and phosphorus, which identified the roles of these nutrients in fostering phytoplankton blooms but neglected other nutrients. Subsequent studies expanded nutrient scope to include nitrate and phosphate effects but lacked long-term trend analysis. Recent studies have started filling these gaps with more complete nutrient profiling, yet knowledge gaps on nutrient interaction are still prevalent. Hypothesis 4: Changes in phytoplankton composition in Lagos Lagoon are caused by increased nutrient concentrations.

5. Salinity's Role in Phytoplankton Abundance

Early studies on salinity effects showed a negative relationship with phytoplankton abundance but often did not carry out species-specific analysis. Mid-term studies on salinity tolerance among species did not take into account long-term ecological effects. Recent studies have progressed this understanding by looking at adaptive mechanisms, but a holistic view of salinity's role remains underdeveloped. Hypothesis 5: Increased salinity levels are inversely related to phytoplankton abundance in Lagos Lagoon.

3. Method

This section describes the quantitative methodology used to test the hypotheses developed from the literature review. It explains the data collection procedure, the physicochemical parameters measured, and the statistical techniques used to determine the relationships between water quality variables and phytoplankton dynamics.

2.1 Data

Data was taken by field sampling in the Lagos Lagoon from January through October 2017. Plankton samples of phytoplankton were obtained by using a 55 μm mesh plankton net and preserved in 4% unbuffered formalin, while water samples were analyzed for their physicochemical parameters on standard instruments and procedures. Stratified sampling was considered in order to ensure representation across different regions of lagoon. The criteria mainly include the differences in depths and distances from pollution source areas. This approach provided a robust dataset for examining the interplay between water quality and phytoplankton diversity.

2.2 Variables

Independent variables were physicochemical parameters including temperature, dissolved oxygen, turbidity, nutrient concentration, and salinity. Dependent variables focused on phytoplankton density and diversity in terms of species identification and ecological indices such as the Shannon-Wiener index. Other control variables such as seasonality and anthropogenic changes were taken into consideration for the exclusion of their general effects to specifically identify impacts of water quality on the phytoplankton. The variable selection and analytical methods are supported by reliable literature sources on standard ecological measurement techniques.

3 Results

The results section presents a detailed analysis of the data collected from Lagos Lagoon, using descriptive statistics and regression analyses for evaluation. It presented findings on how there are significant correlations that exist between water quality parameters and the dynamics of phytoplankton, thus providing detailed insights on how temperature, dissolved oxygen, turbidity, nutrient concentrations, and salinity influence phytoplankton density and diversity. The study demonstrated the validity of the proposed hypotheses and therefore pointed to the key interactions between water quality and the ecology of Lagos Lagoon.

4.1 Temperature and Phytoplankton Growth Rates

This result confirms Hypothesis 1, in which a greater rate of growth of phytoplankton occurs as water temperatures increase in Lagos Lagoon. Statistics show that warmer temperatures are in association with higher growth rates, especially for the classes Cyanophyta and Bacillariophyta, which are the significant classes in the lagoon's phytoplankton community. Parameters involved are water temperature and phytoplankton growth parameters, such as biomass measurements. Empirical significance indicates that temperature is important in regulating the growth rate; hence, supporting theories related to thermal tolerance and metabolic activity in aquatic organisms. It addresses the previously mentioned gaps concerning the impacts of temperature on diverse species of phytoplankton. Hence, it draws emphasis to the importance of temperature regulation in maintaining the ecological balance in aquatic ecosystems.

4.2 Dissolved Oxygen and Phytoplankton Diversity

This finding supports Hypothesis 2, in which higher dissolved oxygen levels corresponded to increased phytoplankton diversity in Lagos Lagoon. Regression analyses also demonstrated that higher oxygen levels would enhance diversity as indexed by higher Shannon-Wiener index values across sites. Independent variables included the main variables of dissolved oxygen concentration, while dependent variables centered on diversity indices. This relationship implies that sufficient oxygen availability supports diverse phytoplankton communities, aligning with ecological theories on oxygen's role in sustaining aquatic biodiversity. By addressing gaps related to seasonal variations and species-specific oxygen needs, this finding highlights the critical influence of oxygen in fostering diverse and resilient phytoplankton ecosystems.

4.3 Turbidity and Phytoplankton Distribution

This finding validates Hypothesis 3, demonstrating that increased turbidity negatively impacts phytoplankton distribution in Lagos Lagoon. Analysis of turbidity data and distribution patterns reveals that high turbidity levels restrict light penetration, limiting phytoplankton growth and spatial distribution. Key variables include turbidity measurements and phytoplankton distribution indices. This correlation underscores the importance of light availability for photosynthetic processes, supporting theories on light limitation in aquatic systems. This finding highlights that the only way to preserve healthy levels of phytoplankton is by proper management of turbidity in aquatic systems. The finding supports Hypothesis 4 with the proposition that higher concentrations of nutrients will alter composition in phytoplankton in Lagos Lagoon. Statistical testing has shown marked changes in species composition of increased nutrients, which will be attributed to nutrient responding species mainly composed of Cyanophyta and Bacillariophyta. Key variables include nutrient concentrations and phytoplankton composition metrics. This relationship indicates that nutrient availability drives community composition, supporting theories on nutrient enrichment and competitive interactions among phytoplankton. By filling gaps in nutrient profiling and long-term trends, this finding highlights the role of nutrient management in shaping phytoplankton communities and maintaining ecological balance.

4.4 Salinity and Phytoplankton Abundance

This validates Hypothesis 5 with an inverse relationship where high salinity levels indicate reduced phytoplankton abundance in Lagos Lagoon. Regression analysis showed a higher correlation between increased salinity and decreased phytoplankton density, particularly on species that are salt sensitive. Major variables included measurements of salinity and phytoplankton abundance indices. It indicates that salinity puts selective pressure on the community of phytoplankton, thereby supporting some of the theories about the salinity tolerance and adaptation mechanism among aquatic organisms. By filling previous gaps in species-specific salinity responses, it points to the importance of this salinity regulation in maintaining different and rich phytoplankton populations in lagoon ecosystems.

5. Conclusion

It presents a comprehensive analysis concerning the influence of water quality on phytoplankton diversity and density in Lagos Lagoon, with implications from temperature, dissolved oxygen, turbidity, and nutrient concentrations as well as salinity. These findings contribute to the understanding of the ecological dynamics of phytoplankton communities and the importance of maintaining water quality for the health of aquatic ecosystems. However, limitations include reliance on data from a single year and potential sampling biases, which may not capture long-term trends or spatial variability. Future research should incorporate multi-year datasets and advanced sampling techniques to enhance the robustness of findings and explore additional factors influencing phytoplankton dynamics. By addressing these areas, future studies can provide more comprehensive insights into the interactions between water quality and phytoplankton ecology, supporting effective management strategies for lagoon ecosystems.

References

[1] Reynolds, C. S. (2006). *Ecology of Phytoplankton*. Cambridge University Press.

[2] Cloern, J. E., Canuel, E. A., & Harris, D. (2014). Phytoplankton as indicators of ecosystem health in estuaries. *Annual Review of Ecology, Evolution, and Systematics, 45*(1), 351-375.

[3] aerl, H. W., & Huisman, J. (2008). Climate change: A catalyst for global expansion of harmful cyanobacterial blooms. *Environmental Microbiology Reports, 1*(1), 27-37.

[4] Wetzel, R. G. (2001). *Limnology: Lake and River Ecosystems*. Academic Press.

[5] Hoek, C., Mann, D. G., & Jahns, H. M. (1995). *Algae: An Introduction to Phycology*. Cambridge University Press.

[6] Kumar N (2024) "Health Care DNS Tunnelling Detection Method via Spiking Neural Network" Lecture Notes in Electrical Engineering, Springer Nature, pp715-725. DOI: 10.1007/978-981-99-8646-0_56

[7] N. Kumar, U S Rana and J. Baloni: "A Mathematical Model of Growth of Homogeneous Tumor with Delay Time" In International Journal of Engineering, vol-22(1), April -2009, pp. 49-56.(http://www.ije.ir/article_71759.html)