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Seasonal variation in phytoplankton community structure in freshwater lakes

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Received: 02 January 2026; Revised: 16 January 2026; Accepted: 09 March 2026; Published: 20 April 2026

Abstract

This paper is a research inquiry on the seasonal change in the structure of the phytoplankton community of the freshwater lakes with a focus on the environmental changes affecting the changes in the form of temperature, light intensity, and nutrient levels. The aim of the study consisted of assessing the seasonal changes of abundance, diversity, and composition of phytoplankton, and correlating the changes with the significant environmental parameters. There were four seasons during which the sampling was performed in the spring, summer, autumn, and winter seasons, with varying trophic status in the freshwater lakes. Temperature, pH, light, and nutrient content and concentration on site were measured; phytoplankton material was identified and enumerated according to standard microscopic procedures. The statistical result revealed that the phytoplankton abundance was most abundant in the warmer months, i.e., 7,500 cells/mL in spring and 12,000 cells/mL in summer, with the dominance of the diatoms and green algae. Quite the contrary, phytoplankton diversity and abundance were less in winter, with a maximum of 4,000 cells/mL. The results showed the strong influence of the light and the nutrient content, particularly nitrogen, on the community structure, in which the higher the degree of light and nutrient content, the higher their diversity and abundance. It requires another investigation to investigate the trends of long-term phytoplankton dynamics, especially during climatic changes, in order to obtain predictive

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DOI: 10.70102/IJARES/V6I1/6-1-12

models of the algal explosions and also the control of the ecosystems. Additionally, by including more variables of the environment and more complex statistical models, perhaps would have gained more insight into the complex workings that take place in aquatic environments and how they respond to seasonal and anthropogenic changes.

Keywords: Phytoplankton, Seasonal variation, Freshwater lakes, Algal diversity, Diatoms, Green algae, Environmental factors, Water quality

Introduction

The freshwater ecosystems are very significant components of the world biosphere as they are able to have an enormous array of ecosystem services, including water regulation, nutrient cycle, and support a myriad of aquatic organisms. The foundation of these ecosystems is the primary producer phytoplankton, and it converts the solar energy into organic form through photosynthesis. The microscopic organisms are most essential in the food web of aquatic ecosystems because they include a greater trophic chain, which includes zooplankton, small invertebrates, and fish. Besides being the primary producers, Freshwater phytoplankton also play a significant role in the generation of oxygen and in the absorption of carbon. They also serve major purposes in reducing climate change as they can absorb carbon dioxide and in nutrient recycling, as well as maintaining the concentration of nitrogen, phosphorus, or other valuable nutrients. Being significant, the phytoplankton community is a key indicator of an ecosystem's health, and any alteration of its organization will cascade down to the top of the food web.

Phytoplankton are very cyclic, and the structure of a community is a factor of various environmental factors (Fan *et al.,* 2026). These communities exhibit complex responses to alterations in important ecological variables such as temperature, light, and the provision of nutrients (Kutlu *et al.,* 2020). The seasonal variation of these factors is directly linked to the growth of the phytoplankton, and a specific species may thrive at a certain season. Yet it is the changes in the seasons as well that identify the susceptibility of the freshwater ecosystems to environmental stressors (Kondowe *et al.,* 2022). An illustration of this is that the sudden changes in the intensity of light or temperature, whether due to climate change or due to other natural seasonal factors, can cause sudden changes in the phytoplankton community. As these alterations occur, there may be a degradation in the structure and the functioning of the phytoplankton populations and hence, the throughput of the entire ecosystem, leading to bad water quality and loss of biodiversity (Qu and Zhou, 2024; Anyanwu *et al.,* 2021).

Seasonal changes in freshwater environments, including light and temperature changes, are also typical of phytoplankton community dynamics (Okoth *et al.,* 2009; Yang *et al.,* 2019; Gong *et al.,* 2022). The effect of such seasonal changes on the life of the algal blooms is much more than in the timing and the size of the blooms, whereby the algal blooms are not only marked by increased growth in phytoplankton but in most instances also accompanied by an increment in nutrients (Liu, Liu and Shen, 2010). Even though these blooms have a capacity to enhance the primary productivity in the aquatic ecosystems, they can also be extremely challenging, particularly when they contain species of harmful algae. Harmful algal blooms (HAB) can adversely affect the water quality, have toxin-carrying properties against aquatic life, and disrupt the entire ecological composition. Additionally, these flowers have a strong connection with the quality of water, fish health, and recreational possibilities, and this is the reason why the seasonal monitoring of the phytoplankton community holds a lot of significance in the management of freshwater. It can, therefore, contribute to predicting the occurrences of the seasons regarding the change in the dynamics of phytoplankton and avoid the negative effects of the same on ecosystem health.

The paper will examine the seasonal dynamics of the structure of the phytoplankton communities in different freshwater lakes and how the environmental factors, such as temperature, nutrient levels, and the availability of light, define phytoplankton communities. The study is aimed at determining the key seasons that cause changes in the dynamics of the phytoplankton and the ecological implications of the latter through the analysis of several lakes that differ in their environmental conditions. The findings of this study will be implemented to a broader level of understanding of phytoplankton response to seasonal as well as environmental fluctuation. Moreover, the knowledge will be useful in the development of successful management procedures for the freshwater ecosystems. With the assistance of forecasting the algal growth and seasonal dynamics of the phytoplankton growth, which can assist in ensuring more robust protection and adaptation strategies against safeguarding freshwater resources, as the situation with climate change and new anthropogenic pressures sets in.

Key Contribution of the Paper:

- Seasonal Phytoplankton Dynamics: Seasonal alterations in the composition, structure, and diversity of phytoplankton communities in lacustrine ecosystems are noted.
- Environmental Drivers of Change: Environmental variables (temperature, light, and nutrients) influencing phytoplankton.
- Bloom Dynamics: Forecasting seasonal algal blooms is critical for effective water quality management.
- Ecosystem Changes: The management and conservation of freshwater ecosystems, considering the changes in the ecosystems.
- Phytoplankton Dynamics: A starting point for investigating the dynamics of phytoplankton in freshwater systems.

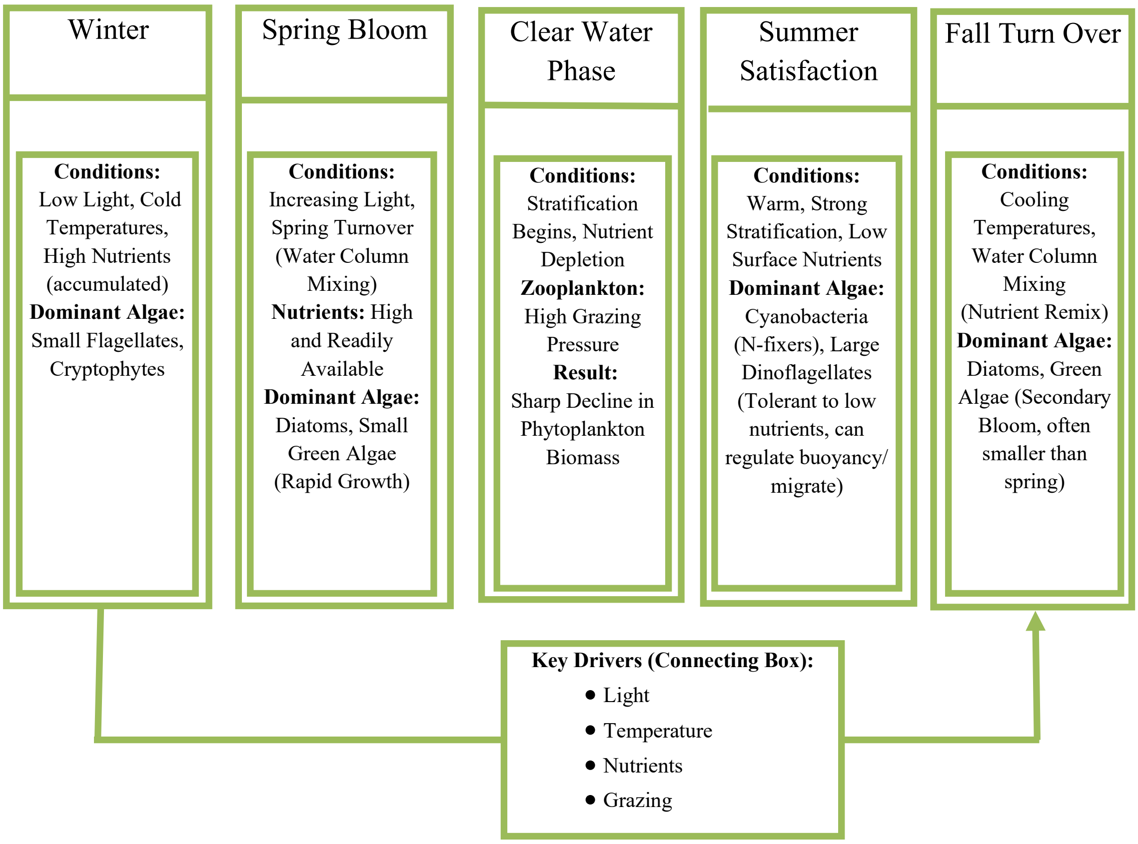

Figure 1: Linear seasonal succession of phytoplankton in temperate lakes.

Figure 1 illustrates that over the years, phytoplankton communities in freshwater lakes have documented the annual succession of phytoplankton due to the influence of diverse climatic parameters in the Fenner flowchart, Linear Seasonal Succession of Phytoplankton in Temperate Lakes. Each Winter marks the start of the cycle, where conditions of cool, overcast, and low-light favor the growth of flagellates. An important period is the Spring Bloom, achieving maximal growth, and triggered by the combination of decadal surplus of solar radiation from late Winter and nutrient resupply from the Spring Turnover. This bloom is rapidly stopped by nutrient overconsumption and heavy grazing by zooplankton, leading to a Clear Water Phase. Finally, cooling and Fall Turnover remix the nutrients and cause a smaller secondary bloom before the lake returns to Winter.

The paper is organized in the following way: Section I (Introduction) describes the nature of the role of phytoplankton in freshwater infrastructure and the aim of the study to estimate the changes in seasons. The literature review on the dynamics of phytoplankton has been covered in Section II, the Literature Review. The III (Methodology) describes the methods of sampling, measurements of the environment, and the phytoplankton analysis. Findings (Section IV) give the information about the seasonal difference in the community structure, abundance, and diversity, and how they relate to the environmental factors. In Section V, the results are described, and the implications of the results on ecosystem management are mentioned. Section VI is the conclusion, which summarizes the findings of the research and specifies the way of further investigation.

Literature Review

The community structure and diversity of phytoplankton are directly connected to functional processes of freshwater ecosystems, which involve primary production and the food web (Dong *et al.,* 2022). Temperature, nutrients, light, and water chemistry are the environmental factors that have an effect on the composition of phytoplankton communities (Tian *et al.,* 2017). Another criterion that could be used when regulating the metabolic activities and the overall growth rates of the phytoplankton is temperature, where generally, a high temperature is preferred, which favors faster metabolic activity and growth rate. Conversely, the domination of some species within a community is influenced immensely by the nutrition of a given community, particularly in relation to nitrogen, phosphorus, and silicates. Depending on the nutrient conditions of the particular species and their competitiveness in a given set of nutrients, nutrients could positively or negatively affect the growth of particular taxa (Yang, 2024; Huang *et al.,* 2023). The dynamics of phytoplankton are further complicated by the role of light on the dynamics of phytoplankton based on the depth of water, its clarity, and turbidity, since it determines the rate of photosynthesis and the productivity of the community as a whole. Seasonal changes in the phytoplankton communities are a result of the dynamic nutrient changes in light and temperature seasonality, which also typically result in seasonal variations in the patterning of succession.

Certain phytoplankton communities have been described by some species prevailing in spring and summer in light favorable conditions and also with favorable temperatures, i.e., euglenophytes and diatoms. These species are very much suited to the fertile environment of light and nutrition that is available during the warmer seasons, hence they grow fast and produce enormous flowers. On the contrary, in a cold environment, the diversity of species is normally reduced, as a small number of species can survive such harsh conditions of low light, low temperature, and limited nutrients. It has been known that seasonal alterations always greatly impact the structure of a phytoplankton community, whereby the composing species vary with the varying environmental conditions (Liu *et al.,* 2023). Studies have also been done on the seasonal transition of freshwater systems, where the succession of seasons has been dominant in ensuring that the level of the aquatic ecosystems is put in check (Zhu *et al.,* 2019). Moreover, these changes in phytoplankton structure and abundance directly impact the ecosystem health, as the change in the dynamics of phytoplankton can impact the nutrient turnover, creation of oxygen, and ecosystem functioning in general. The overall effect of water and light penetration has also been documented to have a direct effect on the composition and diversity of the phytoplankton communities, which further proves the importance of learning the effects of such seasonal variations in the management of freshwater ecosystems.

The freshwater ecosystems have a seasonal succession of the phytoplankton community due to changes in temperature, light, and nutrients. Species such as euglenophytes and diatoms are most dominant in warmer seasons, and the diversity is low in the colder seasons. Changes in seasons affect nutrient cycles, formation of oxygen, ecosystem health, and, as such, there is a need to value and manage such changes in order to ensure the sustainability of freshwater ecosystems.

Methodology

Site Selection and Strategy of Sampling Study

In this experiment, a sample of freshwater lakes of a large range of environments was taken as the sample to ensure that the dynamics of the phytoplankton community are comprehensively researched. The differences in the nutrient levels, the water clarity, and the geographical location of the sampled lakes led to the diversity of the phytoplankton communities. Specifically, the lakes of dissimilar trophic statuses (low nutrient and high nutrient) were chosen to get a variety of the phytoplankton species and structures of the community. There were also samples in both lakes taken in the different sites to ensure that the variability of different sites was well covered, as different sites may have different environmental factors within a lake. To observe the changes in the composition of the community between seasons, a year-long study was conducted, sampling in four seasons-spring, summer, fall, and winter to determine seasonal variation in the composition of the community. Each season of sampling the lake, water was collected at the surface layer (epilimnion) of the water in order to remove the possibility of stratification bias in the water column. The sampling of each month provided a chance to monitor the seasonal variation of phytoplankton communities in a fine manner. The three lakes were sampled in three different sites in an effort to sample the whole ecosystem. The lakes were measured on parameters, i.e., nutrients, water clarity, and their temperature, and the composition of the phytoplankton community. The data collection was organized in a structured format in such a way that it would make it accurate and consistent.

Environmental Parameter Measurement

The recording of the environmental parameters of interest in the sampling event was carried out to inform on their relationship with the phytoplankton communities. The temperature, pH, and light intensity were recorded in situ on both sites to document real-time conditions of the environment. These, among other important nutrient elements which include nitrogen (N), phosphorus (P), and silicates (Si), were other elements that were also identified in the laboratory to help in establishing whether they were present and their levels in the water. Measurement of the environmental data was made and compared to the changes in seasons regarding the variations in the phytoplankton community structure.

Phytoplankton Identification and Enumeration

Analysis of the phytoplankton communities was done using the standard microscopy methods; it entailed both qualitative and quantitative methods. The phytoplankton samples were captured and stored, after which they were subjected to the microscope to identify the species and to count the algae. The taxonomic classification of the samples was done at the lowest level available, and detailed information on the composition of the communities was obtained at high resolution. Phytoplankton community adequacy and development were determined based on cell count, in which abundance was determined for each species. Study was done on the diversity of the phytoplankton over seasons to identify the dominating species in the seasons.

To acquire the right and valid information a series of replicates of the sampling sites was prepared and a good record of the environmental conditions that were associated with a sample was kept. The samples were compared by their species diversity (number of different species in them) and evenness (the relative abundance of particular species). These were highly significant in study of seasonal changes in the phytoplankton community in relation to the seasons changing environment. The overall study approach is illustrated in the following figure that provides the sampling and analysis design:

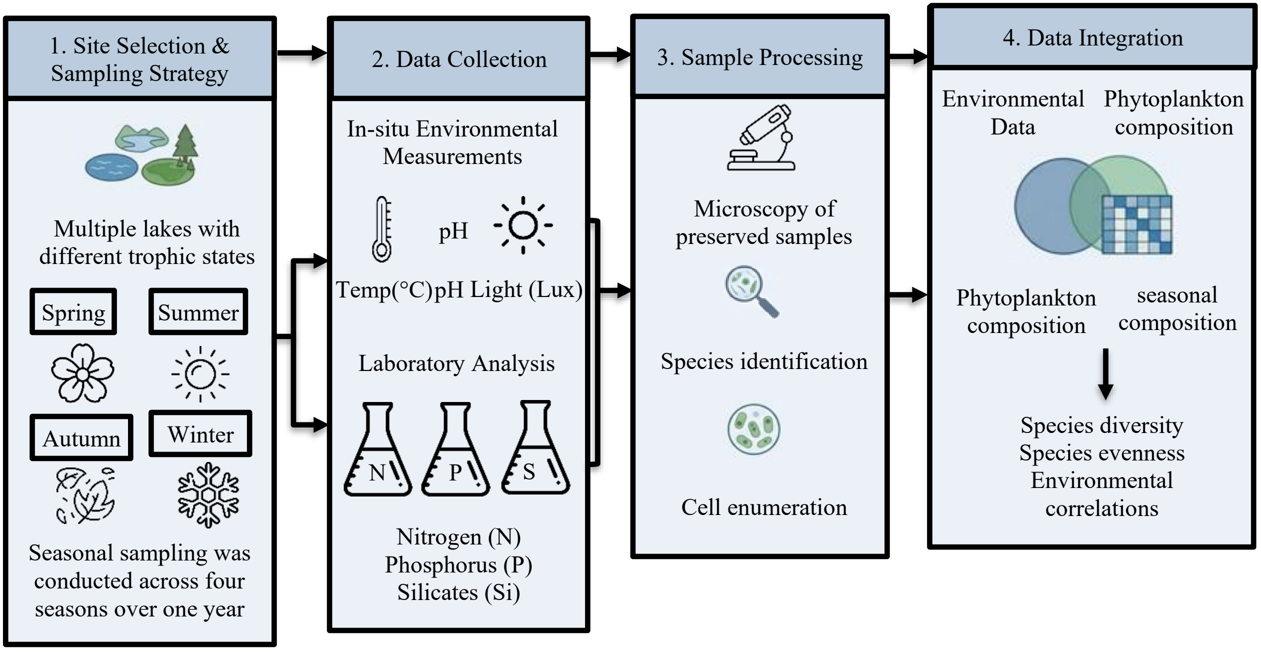

Figure 2: Methodology overview - freshwater phytoplankton study.

Figure 2 presents the systematic methodology of study of the processes of phytoplankton in freshwater lakes that explains the correlation between various phases of the study. It will start by taking a sample of different lakes in different trophic states and sampling at four seasons. In situ environmental parameters including temperature, pH and light intensity are measured and nitrogen, phosphorus and silicates are measured in the laboratory. Microscopic analysis of the processed samples is done to identify the species and count of cells. Integration will be the final step of the integration, which will combine environmental data with the composition of phytoplankton to assess the diversity of the species, evenness, and environmental connections, and track the seasonal dynamics of the community.

Mathematical Description

1. Phytoplankton Abundance

Abundance is used to describe the quantity of cells of the phytoplankton in a certain volume of water. It is calculated as:

$$\text{Abundance} = \frac{\text{Total Cells Counted}}{\text{Volume of Water Sampled}} \tag{1}$$

In equation (1) Where:

- Total Cells Counted is the total number of samples cells counted which are phytoplankton cells.
- Volume of Water Sampled is the volume (in mL) of water that the phytoplankton were taken.

2. Shannon-Wiener Diversity Index (H')

Diversity is also a significant measure, which considers the number of species, as well as the dispersion of individuals within the species. It is determined with the help of Shannon-Wiener Index.

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i) \tag{2}$$

In equation (2), where:

- H' is the Shannon-Wiener index of diversity.
- $p_i$is the %age of individuals of the i th species, which is given as $p_i = \frac{n_i}{N}$, where $n_i$is the number of individuals of the i -th species and N_i is the sample size.
- S is the sample size of the species.

3. Evenness (E)

Evenness is a measure of the distribution of the individuals evenly among the species. It is expressed as the ratio of the Shannon-Wiener index to the maximum possible value of the Shannon-Wiener index (i.e., when all species are equally abundant):

$$E = \frac{H'}{\ln(S)} \tag{3}$$

In equation (3) Where:

- $H'$is the Shannon-Wiener index of diversity.
- $S$is the total number of species in the sample.

Algorithm

```
BEGIN
// Listing of the lakes and sampling parameters
lakes = ["Lake A", "Lake B", "Lake C"]
locations = ["Location 1", "Location 2", "Location 3"]
seasons = ["Spring", "Summer", "Autumn", "Winter"]
// For each lake, obtain samples
FOR each lake IN lakes
FOR each season IN seasons
FOR each location IN locations
// Obtain a water sample from the upper part of the lake
sample = collect_sample (lake, location)
// Measure environmental parameters
temperature, pH, light, nutrients = measure_environmental_parameters(sample)
// Analyze phytoplankton
phytoplankton = identify_and enumerate phytoplankton(sample)
// Save results
save data (lake, season, location, temperature, pH, light, nutrients, phytoplankton)
```

```
END FOR
END FOR
// Perform final data analysis
analyze_data ()
END
```

Data collection structures on lakes, sampling sites, and seasons are first put in place before the study is conducted. The sampling of each lake is done in winter, spring, summer, and fall. Similarly, in line with the sampling site, surface water is sampled and analyzed together with the phytoplankton communities. Some important environmental parameters are also recorded (on-site) together with the water samples, such as temperature, pH, light, and nutrient levels (nitrogen, phosphorus, and silicates), and the water samples are preserved, which are subjected to analysis later. The stored samples undergo a microscopic examination of phytoplankton identification and enumeration. All the environmental conditions, phytoplankton data and their measures are systematically arranged and stored in each lake, season, site and depth. Upon collection and processing of all samples, analysis is done to identify the composition of the phytoplankton community and the seasonal patterns.

Results

Seasonal Variation in Phytoplankton Community Structure

Every season has unique characteristics, and in unison with changes in temperature, light, and nutrients during a season, a particular species of phytoplankton will likely predominate or be the only one present in the community. Cold water months, diatom and green algae will be present in less abundance and lower diversity. In warm water months, more diatoms and green algae will be present. Statistical analysis of the community structure reveals a distinct successional trajectory, where the dominance of diatoms and green algae is significantly correlated with seasonal fluctuations in temperature, pH, and nutrient availability. Specifically, the transition from cold-water dormancy to warm-water proliferation is marked by a shift in both taxonomic richness and total cellular abundance. The study reveals the phytoplankton community structure changes in response to relevant seasonal environmental changes in the dynamics of the ecosystem in the freshwater lake.

Seasonal Trends in Phytoplankton Abundance and Diversity

The analysis shows that diatoms and green algae are present during the warmer season, as the conditions of the light and nutrients are favorable. During the colder seasons, the diatoms and the green algae are found in lower abundance, with some of them being less active or not present in the community. The abundance and diversity of phytoplankton was evaluated in terms of seasonal patterns and the findings indicated evident outcomes on community structure. An example is that the spring and summer seasons have been identified with a larger number of species when compared to the winter seasons, which are characterized by a low number of species and low species diversity.

Table 1: Seasonal phytoplankton community structure & environmental response.

Metric	Cold Months (Winter)	Warm Months (Summer)
Representative Season	Winter	Summer
Phytoplankton Abundance	4,000 cells/mL	12,000 cells/mL
Dominant Groups	Diatoms (58%), Green Algae (22%), Cyanobacteria (12%)	Diatoms (32%), Green Algae (43%), Cyanobacteria (23%)
Species Diversity (H')	Low (1.2–1.5)	High (2.8–3.2)
Light Intensity	1,000 Lux	2,500 Lux
Nutrient Levels (Nitrogen)	0.5 mg/L	1.2 mg/L
Community Structure	High Diatom dominance; low richness	High taxonomic variety; Cyanobacteria blooms

Table 1 summarizes the quantitative shifts in the phytoplankton community structure across the thermal extremes of the study period. Analysis reveals a significant successional trajectory, with total abundance increasing three-fold from a winter minimum of 4,000 cells/mL to a summer peak of 12,000 cells/mL. This proliferation is mathematically correlated with seasonal increases in light intensity and nutrient availability (specifically nitrogen), triggering a taxonomic shift from cold-water Diatom dominance to a more diverse summer community characterized by Cyanobacteria and Green Algae. The transition is further evidenced by the Shannon-Wiener Diversity Index (H'), which reflects the rise in species richness as the water column stabilizes in warmer months.

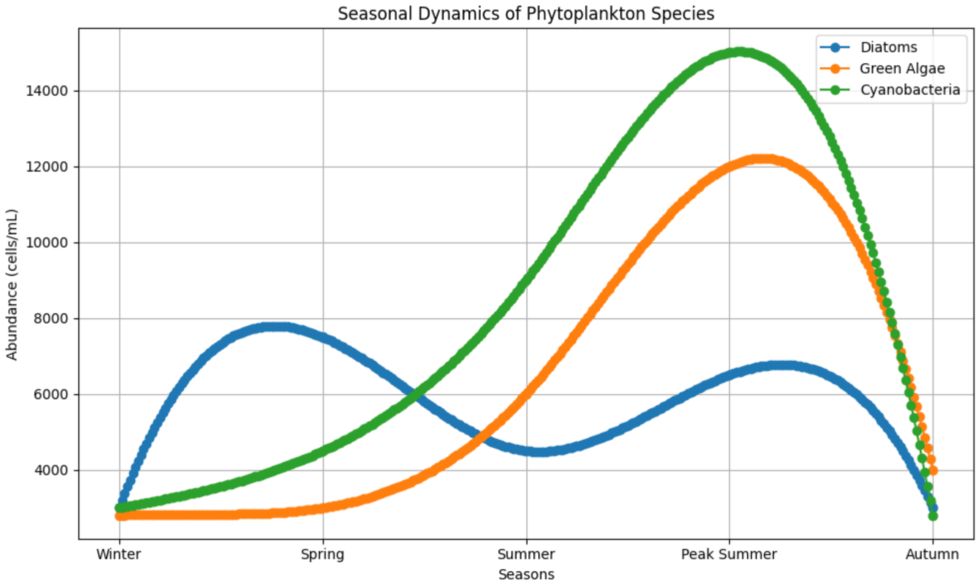

Figure 3: Seasonal dynamics of phytoplankton species.

Figure 3 visualizes the richness of the main phytoplankton diatoms, green algae, and cyanobacteria species at various seasons. The seasonal dominance of certain groups is shown by the significant rise in the abundance of the diatom in the spring and summer, with the highest concentration of the cyanobacteria. The reduced abundance during winter is also apparent, and this can be seen by the apparent reduction in the overall phytoplankton cover.

Table 2: Seasonal variations in environmental parameters and phytoplankton response.

Lake	Season	Temperature (°C)	Light Intensity (Lux)	Nutrient Levels (mg/L)	Phytoplankton Abundance (cells/mL)	Diatoms (%)	Green Algae (%)	Cyanobacteria (%)
Lake A	Spring	15	1500	0.8	7500	40	35	25
Lake A	Summer	22	2500	1.2	12000	30	45	25
Lake A	Autumn	18	1800	0.9	8000	45	32	23
Lake A	Winter	5	1000	0.5	4000	58	25	17
Lake B	Spring	16	1600	0.85	8200	45	38	17
Lake B	Summer	24	2400	1.1	11500	35	40	25
Lake B	Autumn	17	1700	0.9	7800	52	30	18
Lake B	Winter	4	950	0.45	3800	62	20	18
Lake C	Spring	17	1700	0.7	8200	45	40	15
Lake C	Summer	23	2300	1.0	11800	33	42	25
Lake C	Autumn	16	1600	0.85	7500	48	33	19
Lake C	Winter	6	1050	0.55	4200	54	22	24

The table 2 indicates the seasonal variation in the environmental conditions, light intensity, and nutrient content across Lake A, Lake B, and Lake C, where the highest values are recorded in summer with maximum phytoplankton abundance (approximately 11,500-12,000 cells/mL), compared to lower values of winter with low phytoplankton abundance (approximately 3,800-4,200 cells/mL). The diatoms prevail during cold seasons, particularly winter whereas the green algae is the most prevailing during summer because the environment is conducive to its growth. Cyanobacteria are comparatively steady, though they somewhat overgrow during warmer seasons with large amounts of nutrient components. Altogether, the findings reveal that lake productivity and species distribution have a very strong seasonal impact.

Figure 4 represents how the environmental factors change in a freshwater ecosystem according to the seasons in Eutrophic (1970 to 1990) and Oligotrophic (1996 to 2016) states. It shows the annual patterns/ trends in phytoplankton biomass, water temperature, nutrients (SRP, NO 3, Si), oxygen, pH, and Secchi depth in accordance with the time of year. The red lines depict the Eutrophic conditions where the nutrients available are high, and phytoplankton is growing in abundance in small numbers, and clear water is depicted by the blue lines.

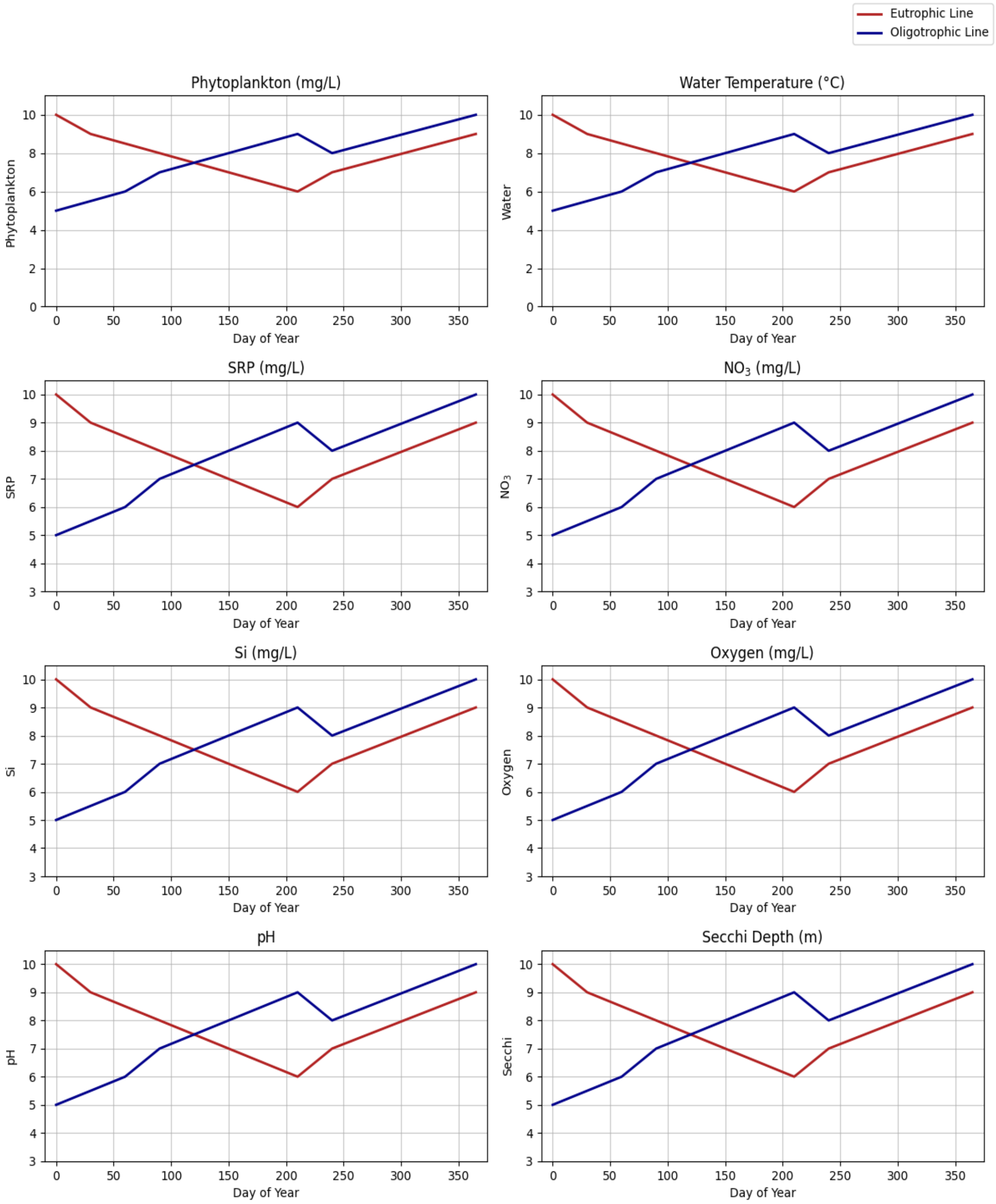

Figure 4: Environmental factors of freshwater ecosystems: eutrophic vs oligotrophic conditions.

Discussion

The research results indicate that significant seasonal variations occur in the structure of the phytoplankton community, in which the abundance, diversity, and species composition vary radically depending on the environmental factors, which are temperature, light, and nutrients. The phytoplankton community was richer and more diverse when the temperature was warmer, namely in spring, than in summer, when the phytoplankton abundance was vastly different, with 7500 cells/mL in spring and 12000 cells/mL in summer (Table 2). This is because of favorable conditions of higher light (1500 Lux of spring to 2500

Lux of summer) and higher nutrients (levels of nitrogen 0.8 mg/L in spring to 1.2mg/L in summer). The diatoms and green algae were also dominating and the diatoms and green algae occupied 30-50/35-45 % of the community respectively. On the other hand, during the colder seasons (winter), the phytoplankton biomass was lower than in the spring at 4000 cells/mL, with 58% of the community being diatoms, but with fewer species and less diversity. Table 1 indicates that the changes in light and nutrients between the seasons cause the phytoplankton abundance to increase threefold, with the highest concentration of 12,000 cells/mL. This shift is associated with a taxonomic shift of winter Dominance of Diatoms to a diverse community of Cyanobacteria in the summer. The richness of the most significant phytoplankton species is depicted in figure 3, which reveals that there are more diatoms in spring and autumn seasons, following which cyanobacteria thrive in summer because of the elevated nutrient concentration. The apparent effects of the environmental factors on the phytoplankton dynamics are also determined by table 2, according to which the abundance of phytoplankton and its diversity rise with the increase of the nutrient level and light during spring and summer, and decrease with the narrowing of the conditions during winter. The conditions of the eutrophic (red line) and oligotrophic (blue line) lakes can be compared in figure 4, where it should be noticed that in eutrophic lakes that contain more nutrients, the phytoplankton biomass is greater and the quality of water is worse in comparison with oligotrophic lakes. The results of these experiments explain that seasonal environmental conditions are significant factors in defining the structure and abundance of the phytoplankton community during various seasons.

Limitations

This study is limited by the relatively small sample size, as it only includes data from three lakes across distinct trophic conditions. The study's geographic focus on specific freshwater lakes may limit the generalizability of the findings to other regions with different environmental conditions. Additionally, the temporal scope of the study was confined to a single year, which may not capture long-term variations in phytoplankton dynamics that could occur over multiple years. Further studies with expanded geographic coverage and longer study durations would provide more comprehensive insights into the seasonal variability of phytoplankton communities.

Conclusion

To sum up, seasonality is very crucial in the structure of the phytoplankton community in the freshwater lakes, as highlighted in this paper. As revealed in the findings, the environmental conditions, temperature, light intensity, and nutrient availability have been reported to have a significant influence on the abundance, diversity, and species composition of phytoplankton. The statistical analysis provided that the abundance and the diversification of all three groups (diatoms, green algae, and cyanobacteria) were greater during the warmer months, and the cell counts were up to 12,000 cells/mL during the summer months, after the abundance and the counts of cells had reached

7,500 cells/mL during the spring. This increase is linked with the increase of light and nutrients, particularly nitrogen, phosphorus, and silicates, which were at 1.2 mg/L in summer, enhancing the development of phytoplankton. Importantly, the taxonomic change that occurred during this period was characterized by the establishment of cyanobacterium as one of the leading dominant taxa, which at first was replaced by the start of the winter with low levels of light and lower nutrient (4,000 cells/mL phytoplankton, 1000 Lux, and 0.5mg/L nitrogen). Besides, the sampled data indicated that the prevalence of specific species in winter seasons such as the diatoms which comprised up to 58 % of the community and maximum prevalence of the cyanobacteria in the summer seasons indicated the significant degree of seasonality in the community structure. Particularly in the ecosystem health and water quality management, such community structural changes are of particular importance, and predictive models are required to forecast harmful algal blooms. These trends can be applied to come up with management tools that can be used to regulate quality of water as well as to end ecological disruptions in the freshwater systems.

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