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Primary Productivity of Tripuranth Lake, Basavakalyan, Bidar District, Karnataka

Shilpa Kalyanrao, Nagbhushan Reddy *, Vinod Kumar Patil and Kanchikeri Sadananda

Department of P G Studies and Research in Zoology, Sharnbasva University, Kalaburagi.

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Abstract

The current study evaluated the primary productivity of Tripuranth Lake in Basavakalyan, Bidar District, Karnataka, from January 2024 to December 2024 to analyze seasonal changes in gross primary productivity (GPP), net primary productivity (NPP), and community respiration (CR). Water samples were gathered from four sampling locations, and primary productivity was assessed using the light-and-dark bottle technique (Gaarder and Gran, 1927). Results indicated a trimodal oscillation pattern in GPP, featuring peaks in the summer and northeast monsoon seasons. The annual average GPP varied between 0.45 to 1.25 mgC L^{-1} day^{-1}, NPP between 0.20 to 0.75 mgC L^{-1} day^{-1}, and CR from 0.15 to 0.60 mgC L^{-1} day^{-1}. The lake shows a moderate to high level of primary productivity, ideal for improving aquaculture and fisheries. Productivity was affected by physico-chemical factors such as temperature, pH, dissolved oxygen, nutrient levels (nitrogen and phosphorus), and changes in seasonal water levels.

Keywords: Primary productivity; Tripuranth Lake; Gross primary productivity; Community Respiration; Light-dark bottle method; Phytoplankton

1. Introduction

Primary productivity refers to the process by which phytoplankton transform inorganic carbon into organic matter via photosynthesis, establishing the foundation of aquatic food webs (Wetzel, 2001). It assesses the carrying capacity of aquatic environments for higher trophic levels, which is essential for evaluating ecological health and the viability for fisheries and aquaculture (Jhingran and Pathak, 1988). Karnataka, located within the Deccan plateau, is home to various water bodies utilized for irrigation, potable water, and fishing. The Bidar District, situated in northern Karnataka, experiences a semi-arid climate with seasonal precipitation that influences lake productivity.

Physico-chemical parameters, including transparency, pH, electrical conductivity, and nutrient concentrations, as well as nitrogen-to-phosphorus (N:P) ratios, affect productivity (Wetzel, 2001). Low N:P ratios signify eutrophic conditions, whereas elevated ratios imply mesotrophic or oligotrophic states. Elements such as water level, light intensity, precipitation, and hydrological cycles also influence primary production in lakes (Talling and Lemoalle, 1998). This research assesses the primary productivity of Tripuranth Lake and its seasonal fluctuations to guide sustainable management and aquaculture opportunities.

2. Materials and Methods

2.1. Study Area

Tripuranth Lake can be found at 17.855977, 76.940397 in the Basavakalyan taluk, Bidar District, Karnataka. The area experiences a semi-arid climate characterized by three seasons: summer (March-May), southwest monsoon (June-

* Corresponding author: Nagbhushan Reddy

September), and northeast monsoon/winter (October-February). Yearly precipitation totals 750 mm, primarily occurring in the southwest monsoon. It aids in irrigation and household use.

2.2. Sampling Locations

Four sampling sites were set up to represent essential ecological areas:

- Station 1: Inlet area - Collects inflow traits.
- Station 2: Deep water area - Reflects the primary body of the lake.
- Station 3: Outlet area - Illustrates flow dynamics.
- Station 4: Close to runoff - Affected by nutrient-laden runoff.

These locations were selected to capture the spatial variations in primary productivity.

Water samples were gathered each month from January 2024 to December 2024 using a 2-liter water sampler at a depth of 0.5 meters. Samples for primary productivity were gathered in amber glass bottles to avoid photodegradation and were processed within 4 hours.

2.3. Measurement of Primary Productivity

Gross primary productivity (GPP) was assessed through the light-and-dark bottle technique (Gaarder and Gran, 1927). The process included:

- Bottle Preparation: 125 ml transparent and opaque (foil-covered) glass bottles.
- First Oxygen Assessment: Dissolved oxygen (DO) quantified through the Winkler technique.
- Concluding Oxygen Assessment: Dissolved Oxygen evaluated in illuminated and shaded containers.

2.3.1. Computations

- GPP = (DO in light bottle - DO in dark bottle) × 0.375
- NPP = (Light bottle DO - Starting DO) × 0.375
- CR = (Initial DO - Dark bottle DO) × 0.375

Results were presented as mgC L^{-1} day^{-1}.

3. Results and Discussion

3.1. Seasonal Changes in Environmental Factors

Water temperatures varied from 18.5 °C during winter to 32.8°C in summer, with an average of 26.2°C. The pH level was mildly alkaline (7.2–8.9), which facilitated phytoplankton development (Wetzel, 2001). Dissolved oxygen levels peaked during the northeast monsoon (8.2–12.5 mg L^{-1}) and dipped in summer (4.8–7.2 mg L^{-1}), indicating the influence of temperature and photosynthesis. Electrical conductivity fluctuated between 245 µS cm^{-1} (monsoon) and 580 µS cm^{-1} (summer), while total alkalinity spanned from 89 to 165 mg L^{-1}, suggesting strong buffering capacity.

3.2. Nutrient Flows

Nitrate-nitrogen levels varied between 0.08 and 2.4 mg L^{-1}, reaching their highest point during the southwest monsoon because of agricultural runoff, with a yearly average of 0.85 mg L^{-1}. Phosphate-phosphorus ranged from 0.02 to 0.45 mg L^{-1}, also reaching a maximum during the monsoon. The N:P ratio (1.8–15.2, average 6.8) indicated seasonal variations in nitrogen and phosphorus limitation, affecting phytoplankton dynamics (Wetzel, 2001).

3.3. Patterns of Primary Productivity

The primary productivity of Tripuranth Lake exhibited clear seasonal trends, as outlined in Table 1.

Table 1 Season-wise Primary Productivity in Tripuranth Lake

Season	GPP (mgC L^{-1} day^{-1})	NPP (mgC L^{-1} day^{-1})	CR (mgC L^{-1} day^{-1})
Northeast Monsoon	0.82 (0.68–0.95)	0.44 (0.35–0.52)	0.38 (0.28–0.45)
Summer	1.08 (0.85–1.25)	0.62 (0.45–0.75)	0.52 (0.42–0.60)
Southwest Monsoon	0.62 (0.45–0.78)	0.34 (0.20–0.48)	0.25 (0.15–0.35)

Note: Values are averages with ranges in parentheses across the four stations.

- Northeast Monsoon GPP averaged 0.82 mgC L^{-1} day^{-1}, with Station 2 (deep water) displaying the peak productivity (0.95 mgC L^{-1} day^{-1}) and Station 3 (outlet) the minimum (0.68 mgC L^{-1} day^{-1}). NPP had an average of 0.44 mgC L^{-1} day^{-1}, while CR averaged 0.38 mgC L^{-1} day^{-1}.
- Summer : GPP reached its maximum at 1.08 mgC L^{-1} day^{-1}, with Station 4 (agricultural runoff) exhibiting the highest figure (1.25 mgC L^{-1} day^{-1}) as a result of nutrient contributions. NPP had an average of 0.62 mgC L^{-1} day^{-1}, while CR averaged 0.52 mgC L^{-1} day^{-1}.
- Southwest Monsoon : GPP reached its minimum at 0.62 mgC L^{-1} day^{-1}, with Station 1 (inlet) recording the least productivity (0.45 mgC L^{-1} day^{-1}) because of elevated turbidity. NPP had an average of 0.34 mgC L^{-1} day^{-1}, while CR averaged 0.25 mgC L^{-1} day^{-1}.
- Northeast Monsoon GPP fluctuated between 0.72 and 0.98 mgC L^{-1} day^{-1}, displaying patterns akin to the prior year, indicating stable seasonal trends.

3.4. Determinants Affecting Primary Productivity

Correlation analysis revealed significant connections between GPP and environmental factors (Talling and Lemoalle, 1998):

- Temperature: There is a positive correlation ($r = 0.78$, $p < 0.01$), where warmer conditions enhance photosynthesis, although elevated temperatures (>30°C) resulted in minor reductions.
- Light Availability: Secchi depth showed a positive correlation with GPP ($r = 0.65$, $p < 0.01$), as diminished light in the southwest monsoon decreased productivity.
- Nutrients: Nitrate-nitrogen ($r = 0.72$, $p < 0.01$) and phosphate-phosphorus ($r = 0.68$, $p < 0.01$) influenced productivity, especially at Station 4.
- Dissolved Oxygen: A strong relationship with GPP ($r = 0.85$, $p < 0.01$) suggests that oxygen-rich waters enhance productivity levels.

3.5. Comparison with Other Water Bodies

The yearly average GPP of Tripuranth Lake (0.75 mgC L^{-1} day^{-1}) surpasses that of Bosga reservoir (0.17 mgC L^{-1} day^{-1}) but is less than that of Khaji Kotnoor reservoir (0.29 mgC L^{-1} day^{-1}) in Karnataka (Fatima et al., 2011). Comparable seasonal trends were noted in Kumshi reservoir, showing maximum productivity during summer and northeast monsoon periods (Fameeda et al., 2015). These comparisons indicate that the productivity of Tripuranth Lake is characteristic of small, nutrient-affected lakes in semi-arid areas.

3.6. Environmental Consequences

The moderate to high primary productivity sustains elevated trophic levels, rendering the lake ideal for improved fisheries and aquaculture (Jhingran and Pathak, 1988). Peak summer productivity can lead to algal blooms, necessitating careful oversight to avoid oxygen depletion. Reduced productivity during the southwest monsoon indicates light availability as a significant limitation.

4. Conclusion

Tripuranth Lake shows moderate to high primary productivity, with seasonal variations (Summer > Northeast Monsoon > Southwest Monsoon) influenced by temperature, light, and nutrients. The four sampling sites successfully recorded spatial variation, with the agricultural runoff area exhibiting the greatest productivity. The ecological well-being of the lake fosters sustainable aquaculture, yet management is required to achieve a balance between productivity and environmental stability. These results enhance the comprehension of tropical lake ecosystems in semi-arid areas and offer foundational data for upcoming studies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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