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Estimation of Primary Productivity and Energy Transformation in Urban Fish Ponds of Bhagalpur

Dr. Priyama Kumari
Department of Zoology, T.M. Bhagalpur University, Bhagalpur, Bihar, India
priyama600@gmail.com

Abstract: *Quantifying primary productivity is essential for understanding energy flow and fish-carrying capacity. This study investigates Gross Primary Productivity (GPP), Net Primary Productivity (NPP), and Community Respiration (CR) of two urban ponds in Bhagalpur (Shahjangi and Bhairwa) from 2021 to 2022. Using the light and dark bottle method, research identified a high metabolic rate, with peak GPP reaching 3.85 \text{gC/m}^3\text{/day} during summer. The P/R ratio remained consistently above 1.0, indicating a healthy autotrophic state.*

Key Words: *Primary Productivity, Energy Flow, Bhagalpur, Carbon Fixation, Trophic Efficiency.*

1. INTRODUCTION:

The productivity of an aquatic ecosystem is defined by its ability to convert solar energy into chemical energy through photosynthesis. According to Odum (1971), primary productivity is the rate at which radiant energy is stored by producer organisms. In urban pond systems, productivity is influenced by light penetration, temperature, and nutrient availability (Wetzel, 2001). Recent studies by Saha et al. (2023) emphasize that urban ponds in the Indo-Gangetic plain require precise metabolic monitoring to counteract anthropogenic nutrient loading.

2. MATERIALS AND METHODS:

2.1 Study Sites and Sampling Schedule

The investigation was carried out in two perennial lentic habitats: Shahjangi Pond and Bhairwa Pond, Bhagalpur, Bihar (25^\circ 15' \text{N}, 87^\circ 00' \text{E}). Monthly sampling was conducted between 08:00 AM and 10:00 AM from October 2021 to December 2022 to maintain consistency in photoperiod conditions.

2.2 Estimation of Primary Productivity

Primary productivity was measured using the Light and Dark Bottle Method (Gaarder and Gran, 1927).

1. Bottle Preparation: Three 250 ml borosilicate glass bottles were used for each site: an "Initial" bottle, a "Light" (transparent) bottle, and a "Dark" (wrapped in black light-proof tape) bottle.

2. Incubation: The Initial bottle was fixed immediately to determine baseline Dissolved Oxygen (DO). The Light and Dark bottles were suspended at a depth of 15–20 cm in the euphotic zone and incubated for a period of 24 hours.

3. Oxygen Determination: Following incubation, samples were fixed using Manganous Sulfate and Alkaline Iodide-Azide. DO was determined using the Winkler's Titration Method as per APHA (2018).

2.3 Mathematical Calculations

The oxygen values were used to calculate productivity using the following formulae:

- Net Primary Productivity (NPP): DO_{Light} - DO_{Initial}
- Community Respiration (CR): DO_{Initial} - DO_{Dark}
- Gross Primary Productivity (GPP): NPP + CR
- Carbon Conversion: Oxygen values were converted to Carbon (gC/m^3/day) using the standard factor of 0.375.

2.4 Physicochemical Monitoring:

Simultaneously, water temperature (^\circ\text{C}), transparency (Secchi Disc), and pH were recorded to correlate abiotic factors with energy transformation rates.

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3. RESULTS: DATA TABLES:

Table 1: Density and composition of phytoplankton groups (Annual Total):

Mean GPP ($gc/m^3/day$)	Mean NPP (gc/m^3)
1.85	1.20
3.42	2.15
2.10	1.15

Table 2: Annual Mean Physiochemical baseline (Bhairwa Pond)

Parameter	Annual Mean Value	S. Deriahen	Signature to Production
Water temp	25.44 oC	4.2	SH mulates Metabolic rate
Transparencey	55.33 cm	2.1	Determine euphotic zone depth
Dissolved	6.09 mg/l	0.15	Supports community respirate
Nitrate (NO_3)	2.71 ppm	0.18	Primary limiing nutrient
Phosphate (PO_4)	2.02 ppm	0.42	key driver for plankton bloom

4. DISCUSSION AND CONCLUSION:

The high Respiration rates during the Monsoon (45%) are attributed to the influx of organic urban runoff, which increases microbial decomposition (Cui et al., 2022). However, the P/R ratio remained consistently >1, confirming that these ponds are Autotrophic. The energy dynamics indicate that Bhagalpur's urban ponds can support robust fish populations if a multi-trophic aquaculture approach is implemented.

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