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***Research article***

# Seasonal variation of the primary productivity of Foy's Lake in Chattogram, Bangladesh

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A B S T R A C T

The present study was conducted to estimate the primary productivity of Foy's Lake in Chattogram, Bangladesh. Gross primary productivity, net primary productivity, and critical respiration were estimated in pre-monsoon, monsoon, and post-monsoon, respectively. Primary productivity was estimated 0.39 $gCm^{-3}h^{-1}$ in pre-monsoon, 0.31 $gCm^{-3}h^{-1}$ in monsoon, and 0.61 $gCm^{-3}h^{-1}$ in post-monsoon, respectively. The lowest primary productivity was estimated 0.30 $gCm^{-3}h^{-1}$ in April and the highest primary productivity was estimated 0.61 $gCm^{-3}h^{-1}$ in September. The study showed that the primary productivity varies with seasons indicating that the highest primary productivity was estimated in post-monsoon while the lowest was in monsoon. The data of primary productivity of Foy's Lake showed that the lake has a good nutrient profile and is suitable for aquaculture.

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## 1. INTRODUCTION

Primary production is the total amount of organic matter made from inorganic matter by the photosynthesis process. Primary producer means producers can synthesize inorganic matter through the photosynthesis process. Primary producers need to enliven some crucial inorganic components such as nitrogen, magnesium, zinc, iron, phosphorous, etc. In the aquatic environment, the main types of producers are phytoplankton, periphyton, and macrophytes. Measurement of the primary production is important to understand and assess the fish production potentiality of a lake ecosystem (Melack et al., 1976; McConnell, 1988; Oglesby, 1977). The study of primary production is the basic need for the forecasting about water quality and fisheries of a lake (Wondie et al., 2007). The primary production of an aquatic ecosystem could be measured through the measurement of net primary productivity (NPP) or gross primary productivity (GPP). NPP accounts for losses such as respiration and excretion while GPP includes the total amount of fixed carbon. Factor influences primary productivity such as solar radiation, water transparency, and fluctuations in the water level and nutrient contents (Tailing, 1957; Priscu et. al., 1982). The present study is aimed to determine the seasonal variations of the primary productivity of Foy's Lake.

## 2. MATERIALS AND METHODS

### Study area

Foy's lake is located in Pahartali, Chattogram, Bangladesh. It is situated at an altitude of 9178 ft and lies between 22°22′06.90″–22°22′38.28″N latitude and 91°47′11.81″–91°47′50.86″E longitude (Figure 1). The lake is V-shaped and surrounded by hills on all sides except the dam. The catchment area is approximately 320 acres with a maximum depth of 6 meters in the dry season. The study was carried out from June to December of 2019. Three research stations were set to conduct the research i.*e.* S1 (22°22'09.2"N, 91°47'45.8"E), S2 (22°22'11.1"N, 91°47'31.7"E) and S3 (22°22'27.5"N, 91°47'31.2"E).


Figure-1: study area

**Design of the experiment**

The experiment was conducted to determine the seasonality of the primary productivity of Foy’s Lake. In order to determine the seasonality of the primary productivity, sampling was done in the six consecutive months. Sampling occurred among the three research stations and each sample contained three replications. Based on the sampling month, seasonality of the primary productivity was determined. Table 1 represents the sampling design of the experiment.

Table 1: Sampling months and seasons

| Month | Season name |
|---|---|
| April-May | Pre monsoon |
| June-July | Monson |
| August-September | Post Monson |

**Determination of the primary productivity**

Primary productivity was measured by using the methods of Gaarder and Gran (1927). The primary productivity has been expressed as gross primary productivity (GPP) and net primary productivity (NPP), and community respiration (CR).

Gross primary productivity (GPP) $= \frac{LB-DB}{Time of exposure} \times \frac{0.375}{PQ} \times 1000$ $mgCm^{-3}h^{-1}$

Net primary productivity (NPP) $= \frac{LB-IB}{Time of exposure} \times \frac{0.375}{PQ} \times 1000$ $mgCm^{-3}h^{-1}$

Community respiration (CR) $= \frac{DB-IB}{Time of Exposure} \times \frac{0.375}{PQ} 1000$ $mgCm^{-3}h^{-1}$

Where,
LB = dissolve oxygen content of light bottle,
DB = dissolve oxygen content of dark bottle,
IB = dissolve oxygen content in the initial bottle,
Time of exposure = 1h,
0.375 = conversion factor (1 g of oxygen is equal to 0.375 g of carbon),

PQ (Photosynthetic quotient) = 1(PQ $= \frac{release of oxygen during photosynthesis}{assimilation carbon dioxide during photosynthesis}$).

**Statistical analysis**

Experimental data were collected, summarized and analyzed by using Microsoft Excel (Version-16). Mean value of the primary productivity of each sampling stations was obtained and thus statistical comparison of the seasonality of the primary productivity was determined.

## 3. RESULTS

**Gross primary productivity**

Gross primary productivity (GPP) ranged from 0.30 $gCm^{-3}h^{-1}$ to 0.60 $gCm^{-3}h^{-1}$, 0.30 $gCm^{-3}h^{-1}$ to 0.65$gCm^{-3}h^{-1}$ and 0.30$gCm^{-3}h^{-1}$ to 0.65$gCm^{-3}h^{-1}$ from $S_1$, $S_2$, and $S_3$, respectively (Figure 2). Highest gross primary productivity (GPP) was recorded in $S_2$ and $S_3$ in September. Lowest gross primary productivity was recorded from all three stations in April.

**Net primary productivity**

Net primary productivity (NPP) ranged from 0.25$gCm^{-3}h^{-1}$ to 0.45$gCm^{-3}h^{-1}$ in $S_1$ and $S_2$, and 0.24 $gCm^{-3}h^{-1}$ to 0.40 $gCm^{-3}h^{-1}$in $S_3$(Figure 3). The highest net productivity was estimated in $S_1$ and $S_2$ in September and the lowest net productivity was estimated in $S_3$ in June.

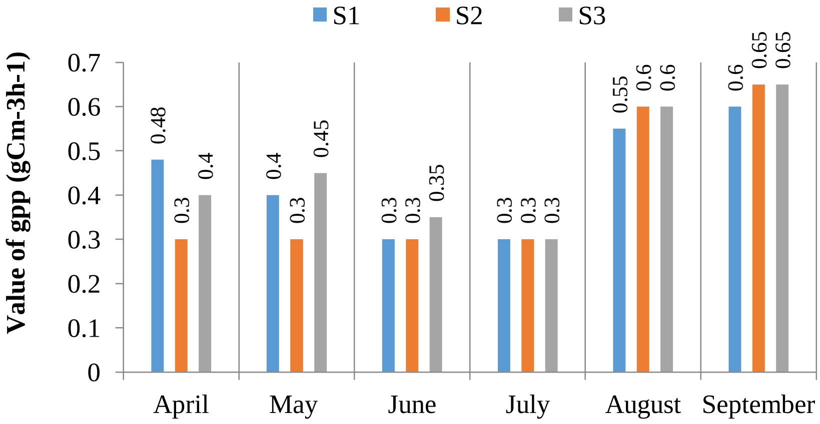


Figure 2. Comparative estimation of gross primary productivity

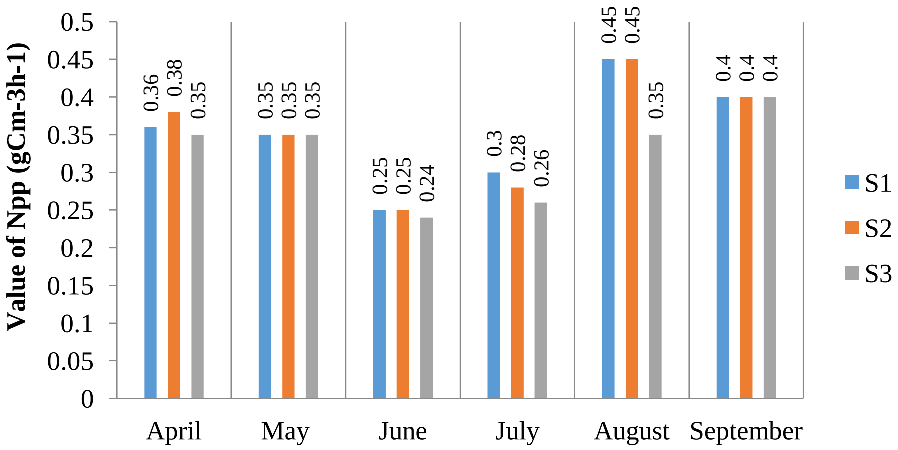


Figure 3. Monthly variation of net primary productivity

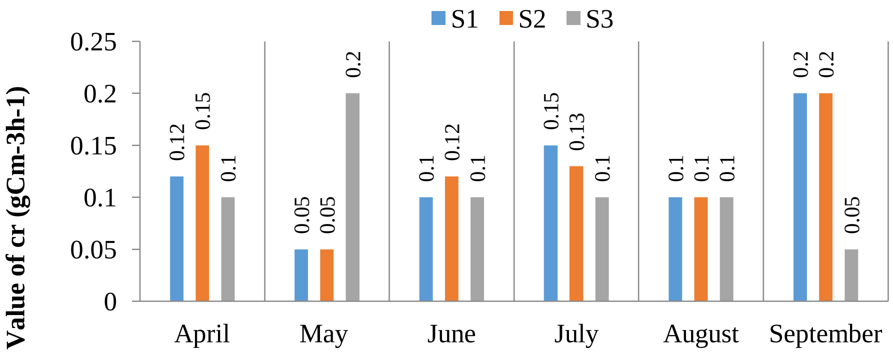


Figure 4. Monthly variation of Community respiration

**Community respiration**

Community respiration ranged from 0.1 gCm$^{-3}$h$^{-1}$ to 0.2 gCm$^{-3}$h$^{-1}$, 0.05 gCm$^{-3}$h$^{-1}$ to 0.18 gCm$^{-3}$h$^{-1}$and 0.05gCm$^{-3}$h$^{-1}$ to 0.2gCm$^{-3}$h$^{-1}$in $S_1$, $S_2$, and $S_3$, respectively (Figure 4). The lowest community respiration was estimated in $S_2$ and $S_3$ in August and the highest community respiration $S_1$ in September.

**Seasonal variation of gross primary productivity**

Average gross primary productivity was estimated 0.39gCm$^{-3}$h$^{-1}$, 0.31gCm$^{-3}$h$^{-1}$ and 0.61 gCm$^{-3}$h$^{-1}$ in pre-monsoon, monsoon, and post-monsoon, respectively (Figure 5). The highest gross primary productivity was estimated in post-monsoon and the lowest gross primary productivity was estimated in monsoon.

**Seasonal variation of net primary productivity**

Value of net primary productivity was estimated 0.35 gCm$^{-3}$h$^{-1}$, 0.26 gCm$^{-3}$h$^{-1}$ and 0.41 gCm$^{-3}$h$^{-1}$ in pre-monsoon, monsoon, and post-monsoon, respectively (Figure 6). The highest net primary productivity was estimated in post-monsoon and the lowest net productivity was estimated in monsoon.

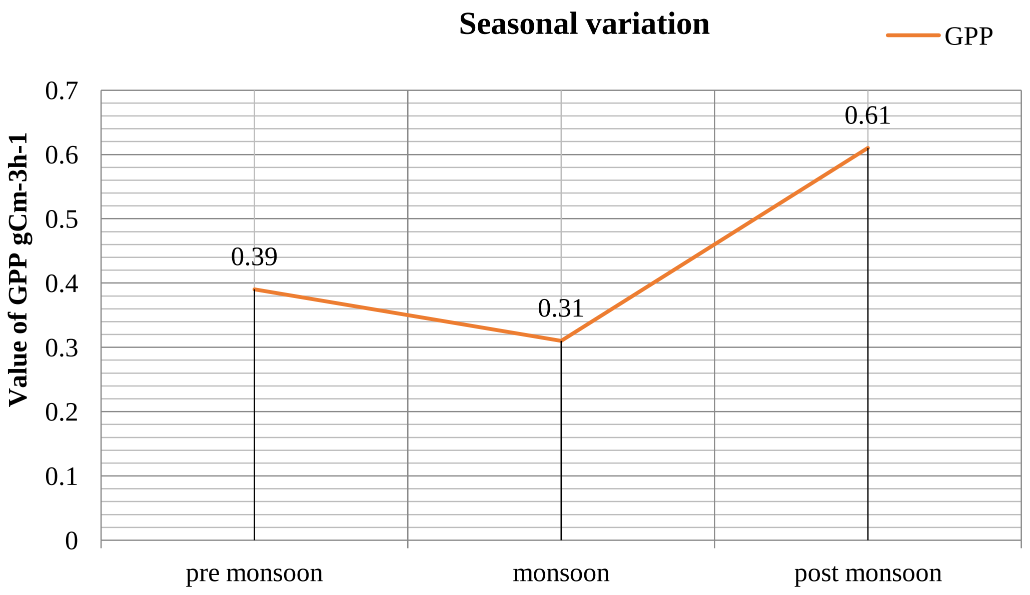


Figure 5. Seasonal variation of gross primary productivity

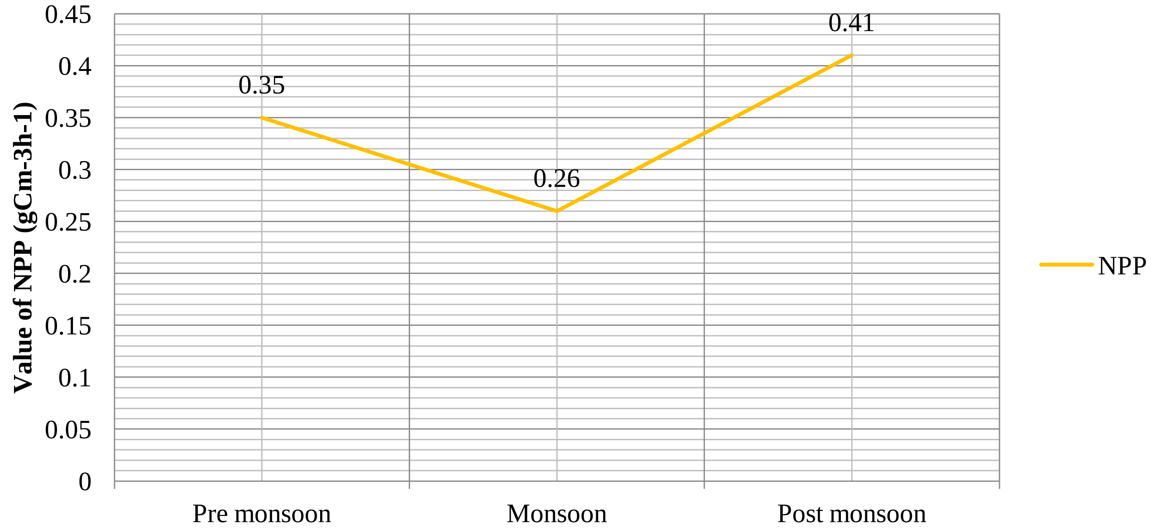


Figure 6. Seasonal variation of net primary productivity

## 4. DISCUSSION

Gross primary productivity and net primary productivity were minimum in monsoon and maximum in post-monsoon. The lowest amount of productivity during monsoon might be due to inadequate sunlight, cloudy weather, higher water depth, and turbidity by suspended solid resulting from soil erosion from adjacent hills (Sontakke and Mokashe, 2014).

The highest productivity in post-monsoon could be due to sufficient sunlight, temperature, and photoperiod. Subtracting net productivity from gross productivity and converted into carbon dioxide is the community respiration or breathing. The present study showed that community respiration was higher in summer, the reason for this is likely due to higher amount of decomposition and water temperature, because it can be assumed that the decomposition rate becomes higher with the increase of temperature (Stuart and Ueland, 2017)

However, it obvious from the present study that the recorded highest gross primary productivity being 0.65 $gCm^{-3}h^{-1}$ in September and lowest (0.30 $gCm^{-3}h^{-1}$) in April, respectively. The study found the highest net primary productivity (0.45 $gCm^{-3}h^{-1}$) in September and the lowest (0.24 $gCm^{-3}h^{-1}$) in June. Bhouyain and Sen found the highest net primary productivity (66.93 $mgCm^{-3}h^{-1}$) in April and the lowest (1.87 $mgCm^{-3}h^{-1}$) in July. The highest gross primary productivity (105.72 $mgCm^{-3}h^{-1}$) was recorded in April and the lowest (18.14 $mgCm^{-3}h^{-1}$) being in July. Mathew (1975) observed a range of net primary productivity 0.002$gCm^{-3}hr^{-1}$to 0.14 $gCm^{-3}hr^{-1}$ and gross primary productivity 0.045 $gCm^{-3}hr^{-1}$ to 0.17 $gCm^{-3}hr^{-1}$. Sreenivasan (1964) reported the lowest value of primary productivity (0.25 $gCm^{-3}hr^{-1}$) in a pond without artificial fertilization. Hepher (1962) found a range of primary productivity 0.17 to 0.41 $gCm^{-3}hr^{-1}$ at suitable light conditions in a fish pond in Israel, which is coincided with the present study. Saha et al. (2001) found mean values of gross productivity (GPP), net primary productivity (NPP) and community respiration (CR) ranged from 0.51 to 1.16 $gCm^{-3}hr^{-1}$, 0.27 to 0. 92 $gCm^{-3}hr^{-1}$ and 0.09 to 0.37 $gCm^{-3}hr^{-1}$, respectively, which also close to the present study findings.

The temperature affects seasonal variations of the primary productivity of a lake stated by the previous investigators (Ichimura and Argue, 1958, Goldman and Wetzel, 1953) agreed with the present study. Sontakke and Mokashe (2014) found minimum gross and net primary productivity in monsoon, and maximum in summer at Mombatta and in winter at Kagzipura Lake, Maharashtra, India. The reason for maximum productivity in summer might be due to high temperature, and the minimum was in monsoon likely due to low light intensity and temperature. Mitsch et al. (2015) reported that values of gross and net primary productivity show an increasing trend both in winter and summer and decreasing during monsoon. Prabhakar et al. (2009) observed high primary productivity in winter and low in monsoon from the Khadakwasla reservoir of Pune. Clear water and more light penetration might be the reasons for the increased value of primary productivity in winter. It is likely that increased turbidity, floating slit content and soil erosion from surrounding hills might be the key reasons for lower productivity in monsoon (Sontakke and Mokashe, 2014), which agree with the present study.

## 5. CONCLUSION

From an overview of the result obtained in this study revealed that the maximum primary productivity observed in post-monsoon and the lowest being in monsoon. So it can be concluded from the result that the primary productivity of Foy[s Lake sounds satisfactory enough to introduce fish culture smoothly.

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