*J. Indian Fish. Assoc., 33: 83-93, 2006* 

# SEASONAL FLUCTUATION IN PRIMARY PRODUCTION IN RELATION TO THE PHYSICOCHEMICAL PARAMETRS OF TWO WEED-INFESTED PONDS OF KALYANI, WEST BENGAL

**Abhijit Paul, Bipul Kumar Das* and Rupam Sharma**
*College of Fisheries (Central Agricultural University), Lembucherra, Agartala – 799 210, India*
**Faculty of Fishery Science, West Bengal University of Animal and Fishery Sciences, Mohanpur – 741 252, India*

## ABSTRACT

**Kalyani lake ($P_1$), a weed infested recreational water body and a weed chocked derelict water body ($P_2$) in the heart of Kalyani city of West Bengal were studied for a period of one year for their primary productivity and other physicochemical parameters. Very low primary productivity (GPP = 360 – 1237 mg C $m^{-2}$ $d^{-1}$; NPP = 157 – 787 mg C $m^{-2}$ $d^{-1}$) was recorded in $P_2$ in spite of having a high concentration of nutrients ($PO_4$-P = 0.052 – 0.260 mg $l^{-1}$; $NO_3$-N = 0.110 – 0.412 mg $l^{-1}$). On the other hand, moderate primary productivity (GPP = 1687 – 3195 mg C $m^{-2}$ $d^{-1}$; NPP = 900 – 2700 mg C $m^{-2}$ $d^{-1}$) was found in $P_1$ with comparatively low range of nutrients ($P0_4$-P = 0.010 – 0.058 mg $l^{-1}$; $NO_3$-N = 0.032 – 0.118 mg $l^{-1}$). After studying the other physicochemical parameters (temperature, transparency, dissolved oxygen, free carbon dioxide, pH, alkalinity and macrophytic biomass), it was found that the overall hydrobiological conditions of the weed-chocked derelict water body ($P_2$) is not congenial for biological production as compared to Kalyani lake ($P_1$). Kalyani lake may be used for fish culture with proper management practices.**

**Keywords: Physicochemcial parameters, primary productivity, water body, Kalyani lake, West Bengal**

## INTRODUCTION

Primary productivity is one of the important sources of energy input in freshwater ecosystem. It is also an index for aquatic production as well as the biodiversity of an ecosystem that is directly or indirectly controlled by the biotic and abiotic factors, and the nutrient status of the water body. The capacity of an ecosystem to sustain a fishery largely depends on the level of primary productivity of that ecosystem. The processes that contribute to primary productivity exhibit complex environmental relationships where radiant energy is converted to chemical energy with the help of other physicochemical factors. The productivity greatly depends on the nutrient status of the aquatic body in relation to other physicochemical parameters (Moss *et al.,* 1980). West Bengal being the highest fish producer contributes a lot to the Indian economy. The state has vast resources like rivers, lakes, ponds, *beels, bheries,* etc., where both culture and capture fisheries are being practised. There are quite a large number of water bodies in the state which are being used for waste disposal, recreation purposes, immersion of holy idols, etc. The state has 155,369.74 ha of natural water bodies (Bhattacharayya *et al.,* 2000), out of which about 71,380 ha remain unutilized for fish culture. If such huge water bodies are utilized for fish culture, the total production of fish in the state would increase many folds.

Hence, a study was made on two of such unutilized water bodies to know their primary productivity level with reference to other hydrobiological parameters and also to see the present condition of these two water bodies to find out the possibilities of utilizing these for fish culture.

## MATERIAL AND METHODS

The study was conducted in the Kalyani lake ($P_1$) and a derelict water body ($P_2$) which are situated in the heart of Kalyani township of West Bengal (latitude, 22° 57' to 22° 59' N; longitude, 88° 26' to 88° 29'E). Kalyani lake ($P_1$) with an area of 160,000 $m^2$ is mainly used for recreational purposes (boating, picnic, gardening, lotus cultivation, etc.) and as shelter for migratory birds. Presently, the lake is under the control of Kalyani Municipality and no organized fish culture is practised. Besides other aquatic vegetation, *Nelumbo nucifera* and *Potamogeton* sp. are the two major aquatic weeds, which are cultivated for commercial purposes by the lake authorities.

The other water body, which is a derelict one ($P_2$), is situated beside the Kalyani lake with an area of about 4000 $m^2$ and is mainly used for idol immersion during Durga Puja, and occasionally, for waste disposal. This water body remains weed-infested throughout the year except October - January when the aquatic weeds are removed from this water body manually for immersion of Durga idols.

A 12-month study was conducted during the period of July 2002 to June 2003 to assess the primary productivity of these two water bodies in relation to other physicochemical parameters. Samples were collected early in the morning (between 08.00 and 10.00 h) during the last week of every month following the composite sampling method and five sampling stations were selected in each sampling site using random sampling methods. The temperature was recorded following the method given by Adoni *et al.* (1985), while transparency was measured using the Secchi disc method. Parameters like dissolved oxygen (DO), free $CO_2$ and total alkalinity were estimated in the field itself following APHA (1995). For the other parameters like $PO_4$-P and $NO_3$-N, samples were fixed in the field and brought to the laboratory, where it was estimated following APHA (1995).

The primary productivity was estimated following the light and dark bottle method (Winberg, 1963) and for the estimation of macrophytic biomass, samples were collected using one-metre quadrates. The results were statistically analyzed for the significance of variance among the water bodies during the different seasons of the year through the two-factor analysis of variance based on randomized complete block design given by Gomez and Gomez (1984).

## RESULTS

From the present study, it was found that there is no significant variation ($P<0.05$) of water temperature in both the water bodies. Maximum temperature was 32.12 ± 0.08°C during summer and minimum was 11.18 ± 0.11°C during winter (Table 1). In $P_1$, transparency ranged from 28.70 ± 0.27 to 45.90 ± 0.23 cm, while in $P_2$, the highest transparency was recorded as 120.00 ± 7.91 cm during January and the lowest of 20 ± 0.00 cm during November (Table 1). The pH was recorded in the range of 6.69 ± 0.10 to 7.44 ± 0.06 in $P_1$ and $P_2$, respectively. It was comparatively low ranging from 5.38 ± 0.05 to 6.69 ± 0.01 (Table 1). DO in $P_1$ fluctuated in the range of 4.08 ± 0.11 to 6. 88 ± 0.1 mg $l^{-1}$, which was higher than in $P_2$, where it was recorded in the range of 2.24 ± 0.00 to 4.88 ± 0.1 mg $l^{-1}$ throughout the year (Table 1).

Free $CO_2$ content was found to be varying significantly during the different periods of the study in both the water bodies (Table 1). In $P_1$, free $CO_2$ content was higher during June – October with the maximum value of 16.80 ± 1.10 mg $l^{-1}$ in June. The lower values were observed during November – May with the minimum of 15.00 ± 1.00 mg $l^{-1}$ in July and August in $P_2$ during the study period.

As far as total alkalinity is concerned, in $P_2$, it ranged from 48.8 ± 1.10 mg $l^{-1}$ to 217.60 ± 2.19 mg $l^{-1}$, where the high value was recorded during November and the low value in April (Table 1). In $P_1$, it ranged from 62.8 ± 9.96 mg $l^{-1}$, which was the minimum value in January to 122.4 ± 2.19 mg $l^{-1}$, the maximum value recorded in June during the study period.

$PO_4$-P values in $P_1$ were comparatively less than in $P_2$ (Table 2). In $P_1$, the highest concentration of 0.058 ± 0.01 mg $l^{-1}$ was in July and the lowest of 0.010 ± 0.00 mg $l^{-1}$ during December. On the other land, in $P_2$, it was at its maximum with a value of 0.260 ± 0.00 mg $l^{-1}$ in December and the minimum of 0.052 ± 0.01 mg $l^{-1}$ in September. A similar trend of seasonal fluctuation was also observed in the $NO_3$-N values (Table 2). It was ranging from 0.026 ± 0.01 to 0.118 ± 0.01 mg $l^{-1}$ in $P_1$ and in $P_2$, it was from 0.110 ± 0.01 to 0.412 ± 0.01 mg $l^{-1}$ with the lowest in May and highest in November.

Very interesting fluctuation in terms of macrophyte infestation was noted in $P_2$ (Table 2). During the period October – November, it was completely

**Table 1: Seasonal fluctuation in physicochemical parameters of $P_1$ and $P_2$ (mean ± SD)**

| Month | Temperature (°C) | | Transparency (cm) | | pH | | DO (mg l⁻¹) | | Free $CO_2$ (mg l⁻¹) | | Total alkalinity (mg l⁻¹) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ |
| July | 31.10 ± 0.01 | 31.00 ± 0.00 | 29.00 ± 0.00 | 62.60 ± 0.22 | 7.10 ± 0.00 | 6.68 ± 0.05 | 4.88 ± 0.11 | 3.20 ± 0.00 | 14.40 ± 0.55 | 16.20 ± 0.83 | 115.2 ± 1.79 | 78.4 ± 13.27 |
| August | 28.76 ± 0.17 | 28.82 ± 0.05 | 45.80 ± 0.27 | 62.50 ± 0.00 | 6.80 ± 0.00 | 6.54 ± 0:21 | 6.28 ± 0.17 | 3.44 ± 0. 09 | 14.00 ± 0.00 | 15.00 ± 1.00 | 118.8 ± 1.4.82 | 86.8 ± 3.35 |
| September | 29.98 ± 0.13 | 30.00 ± 0.00 | 43.20 ± 0.27 | 62.00 ± 0.00 | 7.04 ± 1:0.00 | 6.04 ± 0.06 | 5.44 ± 0.09 | 3.5 ± 0.11 | 13.20 ± 1.10 | 17.20 ± 1.1 0 | 109.6 ± 3.58 | 90.0 ± 0.00 |
| October | 26.82 ± 0.08 | 26.96 ± 0.06 | 44.00 ± 0.00 | 20.20 ± 0.27 | 7.10 ± 0.05 | 5.70 ± 0.07 | 6.04 ± 0.09 | 2.40 ± 0.00 | 12.00 ± 1.22 | 18.40 ± 0.89 | 100.8 ± 11.0 | 185.2 ± 1.79 |
| November | 20.20 ± 0.10 | 20.54 ± 1.06 | 45.10 ± 0.22 | 20.00 ± 0.00 | 7.38 ± 0.05 | 5.38 ± 0.05 | 6.12 ± 0.11 | 2.24 ± 0.22 | 7.80 ± 0.45 | 26.40 ± 1.67 | 94.4 ± 8.30 | 217.6 ± 2.19 |
| December | 18.84 ± 0.13 | 19.20 ± 0.00 | 40.10 ± 0.22 | 32.00 ± 0.00 | 7.44 ± 0.06 | 5.44 ± 0.06 | 6.12 ± 0.11 | 4.88 ± 0.17 | 8.20 ± 0.45 | 20.80 ± 1.10 | 72.4 ± 7.66 | 186.0 ± 3.46 |
| January | 11.18 ± 0.11 | 11.46 ± 0.09 | 35.20 ± 0.27 | 120.0 ± 7.91 | 7.10 ± 0.00 | 5.63 ± 0.11 | 6.88 ± 0.11 | 4.44 ± 0.22 | 8.60 ± 0.55 | 19.20 ± 1.10 | 62.8 ± 9.96 | 104.8 ± 1.79 |
| February | 19.74 ± 0.11 | 20.32 ± 0.05 | 32.00 ± 0.00 | 30.00 ± 0.00 | 7.14 ±0.06 | 6.14 ± 0.06 | 5.40 ± 0.00 | 3.96 ± 0.22 | 9.40 ± 0.55 | 16.80 ± 1.10 | 76.8 ± 5.02 | 76.0 ± .00 |
| March | 24.70 ± 0.00 | 24.84 ± 0.06 | 45.90 ± 0.22 | 44.80 ± 0.27 | 6.90 ± 0.00 | 6.24 ± 0.06 | 6.00 ± 0.00 | 3.76 ± 0.22 | 9.00 ± 1.00 | 16.40 ± 0.85 | 85.6 ± 14.9 | 54.0 ± 0.00 |
| April | 29.66 ± 0.66 | 29.80 ± 0.00 | 44.00 ± 0.00 | 50.00 ± 0.00 | 7.28 ± 0.05 | 6.28 ± 0.05 | 5.64 ± 0.17 | 3.48 ± 0.11 | 9.20 ± 0.45 | 16.00 ± 0.00 | 102.4 ± 15.4 | 48.8 ± 1.10 |
| May | 30.06 ± 0.06 | 31.04 ± 0.06 | 40.30 ± 0.27 | 55.20 ± 0.27 | 7.36 ± 0.06 | 6.36 ± 0.06 | 4.28 ± 0.22 | 3.32 ± 0.11 | 8.20 ± 0.45 | 15.20 ± 1.10 | 117.6 ± 7.07 | 64.8 ± 5.02 |
| June | 32.08 ± 0.08 | 32.00 ± 0.00 | 28.70 ± 0.27 | 56.20 ± 0.27 | 6.68 ± 0.00 | 6.68 ± 0.10 | 4.00 ± 0.11 | 3.08 ± 0.11 | 16.80 ± 1.10 | 15.00 ± 0.71 | 122.4 ± 2.19 | 78.7 ± 1.79 |

**Table 2: Seasonal fluctuation in nutrient and biological parameters in $P_1$ and $P_2$ (mean ± SD)**

| | $PO_4$-P (mg $l^{-1}$) | | $NO_3$-N (mg $l^{-1}$) | | GPP (mg C $m^{-3}$ $d^{-1}$) | | NPP (mg C $m^{-3}$ $d^{-1}$) | | Macrophyte biomass (g $m^{-2}$) Wet weight | | Macrophyte biomass (g $m^{-2}$) Dry weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_1$ | $P_{1-2}$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ | $P_1$ | $P_2$ |
| July | 0.058 ± 0.01 | 0.094 ± 0.01 | 0.116 ± 0.01 | 0.172 ± 0.01 | 3105 ± 61.62 | 787 ± 0.00 | 2700 ± 0.00 | 405 ± 61.62 | 1600 | 4260 | 130 | 540 |
| August | 0.030 ± 0.01 | 0.070 ± 0.02 | 0.052 ± 0.01 | 0.166 ± 0.01 | 2767 ± 61.62 | 720 ± 61.62 | 1642 ± 61.62 | 495 ± 61.62 | 1850 | 4080 | 140 | 530 |
| September | 0.022 ± 0.01 | 0.052 ±.01 | 0.054 ± 0.01 | 0.160 ± 0.01 | 2857 ± 61.62 | 810 ± 94.10 | 1687 ± 0.00 | 405 ± 61.62 | 2450 | 4530 | 210 | 542 |
| October | 0.016 ± 0.01 | 0.192 ± 0.01 | 0.050 ± 0.01 | 0.150 ± 0.00 | 2205 ± 100.60 | 450 ± 0.00 | 1395 ± 61.62 | 276 ± 61.62 | 1950 | 00 | 180 | 00 |
| November | 0.012 ± 0.01 | 0.232 ± 0.01 | 0.032 ± 0.01 | 0.412 ± 0.01 | 1935 ± 123.20 | 360 ± 50.30 | 1057 ± 61.62 | 157 ± 61.62 | 1750 | 00 | 165 | 00 |
| December | 0.010 ± 0.00 | 0.260 ± 0.00 | 0.040 ± 0.01 | 0.392 ± 0.01 | 1800 ± 0.00 | 450 ± 0.00 | 900 ± 0.00 | 225 ± 0.00 | 1800 | 675 | 140 | 55 |
| January | 0.056 ± 0.01 | 0.214 ± 0.01 | 0.110 ± 0.01 | 0.330 ± 0.01 | 1687± 79.50 | 695 ± 50.30 | 945 ± 61.62 | 382 ± 61.62 | 1550 | 850 | 115 | 64 |
| February | 0.054 ± 0.01 | 0.188 ± 0.02 | 0.112 ± 0.01 | 0.270 ± 0.02 | 2452 ± 94.10 | 1147 ± 53.30 | 967 ± 61.62 | 742 ± 61.62 | 1650 | 2650 | 125 | 254 |
| March | 0.030 ± 1.01 | 0.158 ± 1.02 | 0.026 ± 0.01 | 0.138 ± 0.01 | 2812 ± 79.50 | 1137 ± 0.00 | 1390 ± 61.61 | 787 ± 0.00 | 1510 | 3150 | 112 | 310 |
| April | 0.018 ± 0.01 | 0.132 ± 0.01 | 0.084 ± 0.01 | 0.120 ± 0.00 | 2925 ± 79.50 | 855 ± 61.60 | 1687 ± 0.00 | 607 ± 61.62 | 1800 | 3800 | 185 | 378 |
| May | 0.014 ± 0.01 | 0.102 ± 0.01 | 0.098 ± 0.01 | 0.110 ± 0.01 | 3082 ± 100.60 | 832 ± 61.60 | 2332 ± 61.61 | 495 ± 61.62 | 2100 | 3720 | 205 | 396 |
| June | 0.046 ± 0.01 | 0.090 ± 0.01 | 0.118 ± 0.01 | 0.180 ± 0.00 | 3195 ± 61.60 | 855 ± 61.62 | 2542 ± 61.62 | 450 ± 0.00 | 2250 | 4100 | 208 | 535 |

free from any macrophyte infestation due to the manual removal of *Eichhornia crassipes* for immersion of Durga idols. From December, a little infestation by *Azolla pinnata* (30%) was observed, which was completely replaced by *Lemna minor* (100%) in January. From January onwards, *L. minor* was gradually replaced by *E. crassipes* along with *Pistia stratiotes* and in April, the whole water body was completely covered by hyacinth (100%). The maximum biomass (wet weight - 4350 g; dry weight - 542 g) was recorded in September. On the other hand, $P_1$ was more or less infested (50-75%) throughout the year. The biomass was maximum (wet weight - 2450 g; dry weight - 210 g) in September and minimum (wet weight - 1510 g; dry weight - 112 g) in February.

Remarkable variations in both gross primary production (GPP) and net primary production (NPP) were observed between the two water bodies, which are presented in Table 2. In $P_2$, the productivity was minimum (GPP - 360 ± 50.30 mg C $m^{-2}$ $d^{-1}$; NPP - 157 ± 61.62 mg C $m^{-2}$ $d^{-1}$) in November and maximum (GPP - 1237 ± 0.00 mg C $m^{-2}$ $d^{-1}$; NPP - 787 ± 61.00 mg C $m^{-2}$ $d^{-1}$) in March, whereas in $P_1$, GPP was 1687 ± 79.5 to 3195 ± 61.6 mg C $m^{-2}$ $d^{-1}$ and NPP from 94561.62 to 2700.00 mg C $m^{-2}$ $d^{-1}$ with maximum in June and minimum in January.

## DISCUSSION

Temperature is an important factor influencing the hydro-biological processes of an aquatic system. Higher temperature values were recorded during summer, *i.e.,* May to July (31.20 ± 0. 00 to 32.12 ± 0.08°C) and lower values were during winter, *i.e.,* December to February (11.08 ± 0.11 to 20.46 ± 0.01°C). Rana *et al.* (1990) also recorded the surface water temperature in between 24.7 and 32.2°C in the same water body. In the present investigation, the transparency of $P_2$ was higher and showed its maximum value of 120.00 ± 7.06 cm during January, which may be due to less planktonic organisms and higher sedimentation process. The transparency of water has been considered to be an important parameter for assessing the primary productivity of a water body (Agarwal, 1987). A very low range of transparency (28.70 ± 0.27 – 45.90 ± 0.22 cm) was recorded in $P_1$ with the minimum in summer (June-July), which may be due to the availability of nutrient and subsequent growth of plankton, and high suspended matter. The maximum was observed during March in $P_1$ due to the availability of fish food organisms (plankton). Dutta *et al.,* (1985) observed high transparency during March – June. The low values of transparency correspond to increasing turbidity due to planktonic growth in summer and the input of large quantities of suspended matter during the rainy season (Zutshi *et al.,* 1980).

In $P_1$, the pH value ranged between 6.69 ± 0.11 and 7.44 ± 0.06. This water body has some diversified uses except scientific fish culture. So, sometimes the pH value decreased in summer due to the natural decomposition processes and the accumulation of organic debris through human activities. It was reported that most of the *beels* of West Bengal possess alkaline pH (6.8 to 9.8) and few possess acidic pH (6.05 to 6.75) (CICFRI, 2000). Hutchinson (1957) reported that the normal range of pH of inland waters is between 6.00 and 9.00, and the present pH value is in this range. The derelict water body ($P_2$) has an acidic range of pH (5.38 ± 0.05 to 6.69 ± 0.03) throughout the year. This water body is mainly utilized for the immersion of huge numbers of Durga idols during September – October. Therefore, the decomposition of the organic matter (straw, bamboo, jute, wood, different types of paints and papers, etc.) increased the free $CO_2$ and simultaneously, the pH value decreased. Besides, the dumping of city debris and its decomposition also contributed to the acidic pH of the water body. Kumar (1998), and Ayyappan and Gupta (1980) opined that the low pH might be due to the surplus quantity of free $CO_2$ on account of stagnation and the accelerated rate of decomposition during summer months.

In $P_2$, a low range of DO (2.24 ± 0.22 to 4.88 ± 0.18 mg $l^{-1}$) has been observed throughout the year. This water body was covered by macrophytes almost throughout the year except October – November. Therefore, there was very little chance for the growth phytoplankters, which are the major producers of DO in any aquatic system. In addition, the maximum DO of this water body was utilized towards the decomposition of organic matter that was accumulated through idol immersion during September – October. The rate of diffusion of $O_2$ in water is very low. Therefore, photosynthesis by the phytoplankton is the primary source of $O_2$ generation in aquatic system (Boyd, 1974). In $P_1$, DO was low during summer, which may be due to the accelerated rate of decomposition of huge number of aquatic macrophytes. The low concentration of DO might be due to the low photosynthetic activity that resulted due to the decrease in organic matter decomposition (Chaudhuri *et al.*, 2001). Free $CO_2$ of 15.00 ± 0.71 mg $l^{-1}$ to 26.40 ± 1.67 mg $l^{-1}$ was very high in $P_2$, which might be due to the higher decomposition of organic debris. Goel and Trivedy (1984) opined that the increase in organic matter resulted in high chemical and biological demands, decreasing DO level, which correlates with the present findings of $P_2$. In $P_1$, as the chances of organic deposition and the subsequent decomposition are less, free $CO_2$ was less compared to that in $P_2$.

In present study, total alkalinity showed a wide range of variation. It was minimum during April (48.80 ± 1.00 mg $l^{-1}$) and maximum during November (217.60 ± 2.19 mg $l^{-1}$) in $P_2$, while it was in the range of 62.80 ± 9.96 to 122.40 ± 2.19 mg $l^{-1}$ in $P_1$. Rana *et al.* (1990) observed an alkalinity range of 68.75 to 145.50 mg $l^{-1}$ in Kalyani lake, which confirms the alkalinity values recorded in $P_1$ and $P_2$ in our work. Boyd (1979) stated that the desirable level of total alkalinity for fish culture falls within the range of 20-300 mg $l^{-1}$.

Phosphorus is always available in the form of phosphate ($PO_4$-P) in natural waters and generally, occurs in low to moderate concentrations. Banerjea (1967) opined that phosphate below 0.05 mg $l^{-1}$ results in poor production and should be considered as undesirable. In the present study, it was ranging from 0.050 ± 0.00 to 0.260 ± 0.00 mg $l^{-1}$ in $P_2$ due to anthropogenic activities and religious offerings. In comparison to $P_2$, the chances of $PO_4$-P accumulation in $P_1$ are very less. That is why $PO_4$-P concentrations were less (0.01 ± 0.00 to 0.05 ± 0.01 mg $l^{-1}$) in the Kalyani lake throughout the year. In addition, the low values of $PO_4$-P may be due to the large quantities of nutrients accumulated and locked up by macrophytes and thus removed from circulation (Acharjee *et al.*, 1999).

$NO_3$-N is considered to be one of the limiting nutrients because of its regulatory influence on organic production in aquatic system. Banerjea (1967) stated that the water having less than 0.1 mg $l^{-1}$ of $NO_3$-N is unproductive. In the present investigation, its values were ranging from 0.026 ± 0.01 to 0.440 ± 0.00 mg $l^{-1}$ in both the water bodies. The lowest concentration (0.026 ± 0.01 mg $l^{-1}$) was recorded in $P_1$ and this water body was less productive probably due to the lower accumulation and/or decomposition of nitrogenous organic matter as well as rapid absorption of $NO_3$-N for the excessive growth of macrophytes. Though the derelict water body ($P_2$) was fully covered by different species of macrophytes round the year (except October-November), $NO_3$-N concentration was higher than that in $P_1$ probably due to the excessive input of nitrogenous organic matter and successive nitrification process which compensated the $NO_3$-N losses occurred due to the excessive macrophytic growth. Saha *et al.* (1990) reported the variation of $NO_3$-N values from 0.08 to 1.8 mg $l^{-1}$ during their study (1981-82) in Kulia beel of West Bengal which were closely similar to those in the present study. The abrupt increase in $NO_3$-N is observed after heavy shower or continuous rainfall (Bhowmik, 1987). Higher macrophytic biomass was recorded in the derelict water body ($P_2$) than the Kalyani lake ($P_1$), This may be due to the fact that in $P_2$, *E. crassipes* was the dominant macrophyte during most parts of the study period, which absorbs nutrients faster and grows very dense. On the other hand in $P_1$, the dominant macrophytes were *N. nucifera* and *Ipomoea aquatica,* which grow less dense as compared to those in $P_2$. Moreover, human interference in $P_1$ is more than that in $P_2$, which lowers the infestation in $P_1$. So, the biomass is more in $P_2$ than in $P_1$.

In the present investigation, both NPP and GPP showed its maximum levels during summer and monsoon periods (March – September) and the minimum levels were recorded during winter periods (October – February) in both the water bodies. A significant direct relationship of productivity with temperature is established by several authors in some freshwater ponds (Arvola, 1983; Eloranta and Salminen, 1984; Verma and Mohanty, 1994). Since in these two water bodies, no application of manure or fertilizer was done to augment productivity, the sources of nutrients were restricted only from autochthonous release and sometimes allochthononus inputs through human activities. So, the productivity of these two water bodies varied due to the seasonal fluctuation in temperature corresponding with the availability of nutrients. In addition, major parts of these water bodies were covered by dense macrophytes during most parts of the year, which impaired the penetration of light into the water body and also obstructed the production of phytoplankton. For these reasons, in spite of enriched nutrients, the primary productivity of these two water bodies was very limited.

## CONCLUSION

The detailed study round the year shows that all the physicochemical conditions of $P_1$ were within or closely approached the optimal condition for fish culture. But the conditions in $P_2$ were not favourable for fish culture. In the above study, it was also found that in spite of the high nutrient level, the primary productivity of the derelict water body was very less than that of the Kalyani lake. So, the present work reveals that besides the physicochemical factors, biological factors, especially macrophytes, play a vital role in aquatic primary productivity in natural water bodies.

Now, after studying all the hydro-biological parameters, it can be concluded that the condition of the Kalyani lake is comparatively better for fish culture than the derelict water body. A little management effort can make $P_1$ a productive and healthy water body for fish culture and contribute to the total fish production of the state. But the condition prevailing in the derelict water body is so bad that immediate protection and management are necessary for the conservation of this water body. A well organized management practice is the need of the hour for the upliftment of the ecology of such unutilized water bodies so that these resources can be utilized for fish production in the state.

## REFERENCES

**Acharjee, B., Dutta, A. and Chaudhury, M.**, 1999. Role of physico-chemical parameters in the evaluation of productivity of Dighali beel, Assam. *Environ. Ecol.*, **13(3):** 660-662.

**Adoni, A. D., Joshi, G., Ghosh, K., Chaurasia., S. K., Vaisha, A. K., Yadava, M. and Verma, H. G.**, 1985. Work Book on Limnology. Praibha Publisher, Sagar, 216 pp.

**Agarwal, H. P.**, 1987. Hydrobiology of Jabalpur Cantonment tank. *Environ. Ecol.*, **5(1):** 87-89.

**APHA**, 1995. Standard Methods for the Examination of Water and Wastewater (19[th] edition). American Public Health Association, Washington, DC, 1135 pp.

**Arvola, L.**, 1983. Primary production and phytoplankton in two small polyhumic forest lakes in Southern Finland. *Hydrobiologia,* **101**: 105-110.

**Ayyappan, S. and Gupta, T. R. C.**, 1980. Limnology of Ramsamudra tank bottom sediments. *Mysore J. Agric. Sci.,* **14(3)**: 408-420.

**Banerjea, S. M.**, 1967. Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian J. Fish.,* **14(1&2)**: 115-144.

**Bhattacharayya, S., Mukhcrjee, K. and Garg, J. K.**, 2000. Wetlands of West Bengal. Institute of Wetland Management and Ecological Design, Calcutta, 134 pp.

**Bhowmik, M. L.**, 1987. Fluctuation of plankton population and some hydrobiological factors of the Kalyani lake, West Bengal. *Environ. Ecol.,* **5(1)**: 46-52.

**Boyd, C. E.**, 1974. Lime Requirements of Alabama Fish Ponds. Auburn University Agricultural Experiment Station, Auburn, 19 pp.

**Boyd, C. E.**, 1979. Water Quality in Warm Water Fish Ponds. Craft Master Printers Inc., Opelike, 358 pp.

**Chaudhuri, U. S., Johari, S. and Chaudhari, P. R.**, 2001. Trophic status of Chari lake in the vicinity of Amravati city. *Indian J. Environ. Hlth,* **43(3)**: 135-137.

**CICFRI**, 2000. Ecology and Fisheries of Beels of West Bengal. Central Inland Capture Fisheries Research Institute, Barrackpore, 53 pp.

**Dutta, N. C., Mandal, N. and Bandyopadhyay, B. K.**, 1985. Seasonal variation in primary productivity in relation to some physico-chemical properties of a fresh water pond, Calcutta. *Int. J. Acad. Ichthyol.,* **5(1&2)**: 113-120.

**Eloranta, P. V. and Salminen, R.**, 1984. Phytoplankton in eutrophic cooling water pond. *Hydrobiologia,* **118**: 267-274.

**Goel, P. K. and Trivedy, R. K.**, 1984. Some conservation on sewage disposal fresh waters and resultant effects. *Poll. Res.,* **3(1)**: 7-12.

**Gomez, K. A. and Gomez, A. A.**, 1984. Statistical procedures for agricultural Research (2[nd] edition). A Wiley-interscience Publication, New York, 680 pp.

**Hutchinson, G. E.**, 1957. A Treatise on Limnology, I. Geography, Physics and Chemistry. John Wiley and Sons, Inc., New York, 1015 pp.

**Kumar, A.,** 1998. Impact of coal mining effluents on the limnology of wetlands in tribal zone of south Bihar, India. *Indian J. Ecol.,* **18(4):** 984-987.

**Moss, B., Wetzel, R. G. and Lauff, G. H.,** 1980. Annual productivity and phytoplankton changes between 1969 and 1974 in Gull lake, Michigan. *Freshwat. Biol.,* **10:** 113-121.

**Rana, G. C., Sengupta, K. K. and Santra, S. C.,** 1990. Limnological characteristics of beels with reference to fish yield in tropics. *Inland Fish. Soc. India,* **28(1):** 59-66.

**Saha, S. B., Bhagat, M. J. and Pathak, V.,** 1990. Ecological changes and its impact on fish yield of Kulia beel in Ganga basin. *J. Inland Fish. Soc. India,* **22(1&2):** 7-11.

**Verma, J. P. and Mohanty, R. C.,** 1994. Primary productivity and its correlation with certain selected physico-chemical and bio-community parameters. *Environ. Ecol.,* **12(3):** 625-629.

**Winberg, G. G.,** 1963. Primary Production of Bodies of Water. United States Atomic Energy Commission, Washington, DC, 5692 pp.

**Zutshi, D. P., Subla, B. A., Khan, M. A. and Wangano, A.,** 1980. A comparative limnology of nine lakes of Jammu and Kashmir Himalayas. *Hydrobiologia,* **72:** 101-112.