SJEPS Vol. 1, Issue 7, Page: 15-20, July 2019, ISSN: 2676-2722
Impact Factor (SJIF): 8.113
Journal DOI: 10.15373/22501991
International Peer Reviewed & Refereed Journal with Indexed Journal Platforms

web: www.damaacademia.com
email: editor@damaacademia.com
Download from Journal site
https://damaacademia.com/sjeps/

Author(s)
Syeed A. Untoo1 | M.D. Gagloo | S. Sarvar
Department of Zoology, Islamia College of Science and Commerce, (ICSC) Srinagar Jammu and Kashmir-190001, India

Correspondence
Syeed A. Untoo1
Department of Zoology, Islamia College of Science and Commerce, (ICSC) Srinagar Jammu and Kashmir-190001, India
Email: abadje@yahoo.co.uk

Primary Production in Tropical Wetlands of Aligarh Region, Northern India: A Limnological Study

Syeed A. Untoo[1] | M.D. Gagloo[2] | S. Sarvar[3]

Abstract
Primary production has been used as a potential index of productivity of a given aquatic ecosystem. Rich wealth of primary producers constitutes a significant position in trophic levels of wetlands. Primary production studies in these wetlands showed fluctuations in net and gross primary production along with community respiration and chlorophyll content. These parameters showed bimodal fluctuations in primary productivity showing peaks of higher rates of net primary productivity during summer and post monsoon seasons except at one wetland during investigations where it shows peaks during summer, monsoon and post-monsoon periods. Seasonal fluctuations in the rate of primary production do not remain same throughout the year.

Keywords: *Primary production, wetlands, trophic levels and seasonal fluctuations*

I. INTRODUCTION

The inland freshwater ecosystem of India harbors a rich wealth of primary producers both microphytes and macrophytes which constitute a significant position in the trophic levels of aquatic ecosystem. Biological productivity of any wetland depends largely on its ability to support the growth of photoautotrophic organisms consisting mainly of higher plants and algae (Kumari and Kumar, 2002). An accurate knowledge of primary production in natural water bodies is central concern of limnology (Schwoerbel, 1987). Primary production studies are of paramount important in understanding eutrophic nature, nutrient status, and standing crop of any wetland ecosystem. Solar energy is trapped by chlorophyll bearing plants, which transform it into chemical energy, which is stored by green plants in the form of plant tissues and is called as primary productivity. Thus, the primary productivity is the basis of whole metabolic cycle in the wetlands or any natural ecosystem.

Based on production potentialities, wetlands can be categorized as *oligotrophic*, *mesotrophic*, *eutrophic* and *dystrophic* (Goldman and Horne, 1983; Untoo *et.al*.,2002). Many workers have correlated nutrients availability in determining the trophic status of wetlands. It is well known that these nutrients help in synthesis of chlorophyll and act as carriers of essential substances. It becomes necessary in limnological studies to estimate the amount of major nutrients and their role in determining the aquatic primary productivity (Paul and Verma, 1999). A deficiency or excess of these nutrients leads to destruction of healthy status of wetlands. A considerable work has been done in this regard so far within and outside India. Ferris and Tyler (1985) documented relationship between chlorophyll and phosphorus.

Comita (1985) reported seasonal cycles of primary production. Khan *et al*., (1988, 2002) and Untoo *et.al*., (2002) also reported relationship between nutrients and primary productivity. High rate of production both in natural and man-made ecosystems occur when physico-chemical factors are favorable. Biological production is the key to the extent to which natural wetland resources may be utilized for whatever purpose (Bohra and Kumar, 2002). Due to galloping increase in population of India, fish production in wetlands and other water bodies is gaining importance to combat and fulfill animal protein needs. This demand can only be fulfilled by increasing the fish production in several utilized wetlands and other water habitats with diverse geological and climatic features of India. This can be achieved only by increasing the primary production in these wetlands as it forms the basis of increasing production at the next trophic level. The present study gives an account of primary production in three tropical wetlands of Aligarh region of northern India. The study of primary production includes gross primary productivity (*G.P.P*), the rate of transformation of radiant energy to chemical energy and is the total production i.e production as well as respiration, net primary productivity (*N.P.P*), the net production left after expenditure in respiration and community respiration

(*C.R*), the rate of loss of fixed energy in respiration. Organic matter is accumulated when *G.P.P* exceeds *C.R* and therefore *N.P.P* can also be used as an index of secondary productivity (Brylinsly, 1980).

II. MATERIAL AND METHODS

Studies were made at monthly basis on three wetlands of Aligarh i.e. Chaarat Pond-1 (CP-1), Chaarat Pond-2 (CP-2) and Medical Pond (MP). Primary production was estimated by measuring the changes in the dissolved oxygen (D.O.) concentration in light and dark bottles after following methodology of Gaarder and Gran (1927) and Vollenweider (1969). D.O. was determined on the site in the field itself using Wrinkler's modified technique as described in APHA (1992). Chlorophyll was estimated after following methodology given by Trivedy and Goel (1984).

III. RESULTS

Wide ranges of fluctuations were noted in the net and gross primary production along with community respiration and chlorophyll, 'a' pigment content. The values of the results are shown in (Table 1). At CP-1, the values of net primary production, NPP were found to vary between 0.6870gC/m³/hr as recorded in January, 2014 and 1.7320gC/m³/hr recorded in November, 2014.

At CP-2, the values of net primary production, NPP were found to vary between 0.5640gC/m³/hr as recorded in January 2014 and 1.6660gC/m³/hr recorded in the month of August, 2014. Further, at MP ranges of net primary production, NPP results varied between 0.5640gC/m³/hr as recorded in February, 2014 and 1.8360gC/m³/hr recorded in July, 2014.

The monthly observations of gross primary productivity, GPP showed temporal fluctuations. At CP-1, the values of gross primary productivity, GPP were found to vary between 0.8230gC/m³/hr as recorded in January, 2014 and 2.1300gC/m³/hr recorded in June, 2014. At CP-2, the values of gross primary productivity, GPP were found to vary between 0.7260gC/m³/hr as recorded in January, 2014 and 1.9530gC/m³/hr recorded in November, 2014.

Whereas in case of MP, gross primary productivity, GPP were found to vary between 0.6750gC/m³/hr as recorded in February, 2014 and 2.2400gC/m³/hr recorded in July, 2014. Similarly, community respiration (CR) rates were also found to fluctuate in all the three wetlands of Aligarh region in different months of investigations (Table 1).

At CP-1, community respiration (CR) rates were found to vary between 0.0470gC/m³/hr as recorded in March, 2014 and 0.4050gC/m³/hr recorded in June, 2014. At CP-2, community respiration (CR) rates were found to vary between 0.0081gC/m³/hr as recorded in December, 2013 and 0.9260gC/m³/hr recorded in June, 2014. In the case of MP, community respiration (CR) rates were found to vary between 0.0110gC/m³/hr as recorded in November, 2014 and 0.6781gC/m³/hr recorded in August, 2013.

Variations in chlorophyll, 'a' pigment content have been noted from all the three studied wetlands of Aligarh region under present study showing variations are shown in (Table 18). At CP-1, chlorophyll, 'a' pigment content shows variation from 0.562mg/L in February, 2014 and 3.262 mg/L in October, 2013. At CP-2, chlorophyll, 'a' pigment content varies from 0.7220mg/L in January, 2014 and 3.2410 mg/L in August, 2013. In the case of MP, chlorophyll, 'a' pigment content shows variation from 0.7860mg/L in February, 2014 and 3.7951 mg/L in October, 2014.

IV. DISCUSSION

The primary production involves chaemo-autotrophic processes, forming the base of energy flow in the ecosystem. In the present study of primary production in these wetlands of Aligarh region of Northern India, *Gross Primary Productivity* (GPP), *Net Primary Productivity* (NPP) and *Community Respiration* (CR) are more or less similar at CP-1, CP-2 and at MP. Seasonal fluctuations in the rate of primary production were recorded, which appears that the production rate does not remain same throughout the course of study similar finding was reported by other workers too in tropical waters (Hulbert, *et al*., 1960; Menzel and Ryther, 1961; Prasad and Nair, 1963 and Ali and Khan, 1979).

As it is clear from the (Table 1), the values recorded of gross production were always found higher than the values of net primary production. It was due to the fact that phytoplankton cells lose an appreciable amount of assimilated amount of carbon during different metabolic activities particularly through respiration and excretion (Fogg *et al*., 1973 and Haque, 1991). A large population under unfavorable conditions may have a low rate of production, whereas a small population under favorable conditions may have high rate of production (Bohra and Kumar, 2002).

In the present investigations bimodal fluctuations were recorded in the primary productivity showing peaks of higher rates of NPP during summer, and post monsoon seasons at all the three wetlands except at MP wetlands where it shows peaks during summer, monsoon and post monsoon periods. The variation in the rates of production as noted might be due to favorable and unfavorable physico chemical conditions during different months of investigations in these wetlands of Aligarh region. A higher rate of production indicates that these wetlands are primarily rich in nutrients with enough lighted zone and energy content. The maximum rate of NPP, during summer periods of investigation was probably due to high temperature and appreciable phytoplankton density.

Prasad and Nair (1963), Khan and Siddique (1971) and Gaur (1998) have reported high value during summer and at the time of good plankton production. Higher values of primary production during some months of post monsoon and monsoon, in these wetlands were found to be due to increased concentration of nutrients added along with the sewage and surface run-off. Sreenivasan (1964) and Ayyappan and Gupta (1985) have also reported higher rates of primary production during summer and monsoon months. Low values of primary production in these three wetlands of Aligarh region of northern India may be due to low temperature, less photoperiod and low intensity of light due to dense fog cover and less sunshine or visibility.

The photosynthetic rate of phytoplankton and other green algae has been noticed to be in higher value at some intensity between extremes of mid-day irradiance at the surface (Lewis Jr.,1974). When statistically analyzed, GPP and NPP values were found to be significant positive with chlorophyll 'a' (Fig.1) and with water temperature (Table 2) at all the three wetlands under present study but with phytoplankton, the values showed a non-significant positive correlation at CP-1 and negative correlation at CP-2 and MP wetlands of Aligarh region of northern India (Table 2).

Community Respiration (CR), the rate of plankton respiration was also estimated in terms of $gC/m^3/hr$. The values of C.R. were found to vary from season to season and from one wetland to another wetland of Aligarh region of northern India during the course of this study. It may be because of high rate of decomposition of organic matter in these wetlands and some turbid conditions during different months of investigations.

Further, all the three wetlands showed wide fluctuations in the study of Chlorophyll 'a' content (Table 1). Looking at the variations in Chlorophyll 'a' readings which is a measure of standing crop of phytoplankton, Welch (1952). The spatial variations in the values of Chlorophyll 'a' showed almost the same trend as exhibited by NPP. Hutchinson (1975c) considered transparency as an index of productivity, according to Clarke (1941) the availability, extent and intensity of light are the most important factors governing the photosynthetic activity of chlorophyll bearing organisms in aquatic ecosystems. Higher values of Chlorophyll 'a' occurred when transparency was low and vice-versa. The high values of GPP and NPP in these wetlands of Aligarh region of northern India were obtained at the time of high concentration of Chlorophyll 'a' and vice-versa. A correlation analysis also showed significant direct relationship between Chlorophyll 'a' and GPP and NPP in these wetlands of Aligarh region of northern India (Table 2).

V. CONCLUSION

These wetlands were found to be highly productive showing peaks during summer and post monsoon seasons. Higher rates in productivity as compared to reported ones, indicates that these wetlands are primarily rich in nutrients with enough lighted zones and energy content. Being productive in nature and free from pollution load, except sewage input. These wetlands of Aligarh region of northern India can very well be used intensively for pisciculture or even for integrated fish farming after following the modern technology used and recommended by CIFA, Kaushalyaganga, Bhubneshwar, Odissa for their proper management.

VI. ACKNOWLEDGMENTS

The authors are thankful to the Chairman, department of Zoology, A.M.U. Aligarh for providing necessary laboratory facilities. Also, the authors are also thankful to Principal, ICSC for his kind assistance provided during the investigations of this study.

References

1. A.P.H.A. (1992) *Standard Methods for Examination of Water and Wastewater* (18th ed.), American Public Health Association, AWWA, WPCF, Washington, D.C.

2. Ali, M and Khan A, A (1979) Limnological studies on sewage fed pond of Aligarh. *Science and Environment* **10**(2):1985-199.
3. Bohra,C and Kumar,A (2002) Primary productivity of sewage fed aquatic ecosystem. *In*. *Ecology and Ethology of Aquatic Biota*. (*Ed*. A. Kumar) Daya Publishing House, Delhi 373-392.
4. Comita,G.L (1985) The seasonal primary productivity cycles, their normal distribution and the associated chemical and physical cycles in freshwater impoundment. *Arch. Hydrobiol. Suppl. Biol.,* **72**(1): 1-48.
5. Clarke, G.L. (1941) Observation on transparency in south western section of North Atlantic Ocean. *J. Mar. Res.*, **4**: 221-230.
6. Ferris, M.J. and Tyler, P.A. (1985) Chlorophyll- total phosphrous relationships in lake Burrangorang, New south Whales and some southern hemisphere lakes. *Aust. J. Mar. fresh. Res.,* **36**:157-168**.**
7. Fogg, G.E., Stewart,W.D.P., Fay,P. and Walsby, A.E. (1973) *The Blue-Green Algae*. Academic Press, London and New York, 459pp.
8. Gaur, R.K. (1998) *Limnology of a Leachate Reservoir Receiving Effluents from a Thermal Power Plant.* Ph.D. Thesis, AMU, Aligarh, India.
9. Goldman, C.R. and Horne, A.J. (1983) *Limnology.* McGraw-Hill Intl. Book Co., London, 464pp.
10. Haque, N. (1991) *Studies on Hydrobiology of Some Polluted Ponds of Aligarh Region. Ph.D Thesis*,AMU Aligarh, India
11. Hulbert, E.M., Ryther,J.H. and Gullard, R.R.L. (1960) The phytoplankton of the Sargasso Sea of Bermuda. *J.Cons.Perm.Int. Explor.Mer.,* **25**:115-128.
12. Hutchinson, G.E. (1975) *A Treasure on Limnology.***3**: *Limnological Botany*. John Wiley and Sons Inc., New York
13. Khan, I.A., Khan, A. A. and Haque, N. (1988) Primary Production in Seikhajheel at Aligarh. *Environment and Ecology*, **6**(4): 858-862.
14. Khan, A. A., Untoo, S. A. and Parveen, S. (2002) *Limnology of a Reservoir Receiving, Effluents from a Thermal Power Plant. In Ecology of Polluted Waters(Ed. A. Kumar)*A.P.H. Publishing House, Delhi.1109-1117.
15. Kumari, P. and Kumar, A. (2002) Periodicity and biomass potentials of macrophytes in polluted aquatic environment of Jharkhand. *In Ecology of Polluted Waters*, A.P.H. Publishing House, Delhi.759-772.
16. Lewis, Jr. W.M.(1974) Primary production in the plankton community of a tropical Lake. *Ecol. Monogrph*, **44**:377-409.
17. Menzel, D.W and Ryther, J.H. (1961) Annual variation in primary production of Sargasso Sea of Bermuda. *Deep Sea Res*., **7**: 282-288.
18. Paul, R. and Verma, S. (1999) Hydrobiological studies of a tropical standing water body with special reference to nutrient status and primary production. *In: Fresh water Ecosystem of India* (*ed*. K. Vijaykumar) Daya Publication, Delhi, 255-286.
19. Prasad, R.R. and Nair, P.V.R. (1963) Studies on organic production. I. Gulf of Mannar. *J.Mar. Bio. Ass. India*. **5**: 1-26
20. Schwoerbel, J. (1987) *Handbook of Limnology*. Ellis Horwood Limited, West Sussex,.O. 191 EB, England, 221pp.
21. Sreenivasan, A., Sounderaraj, R. and Antomy, F. (1964) Limnological studies of tropical impoundment. II. Hydrological features and plankton of Bhavani sagar reserviour, Madras for 1960-61. *Proc. Nat. Acad. Sci*. India. **59**(B): 53-71.
22. Trivedi, R.K. and Goel, P.K. (1985) *Chemical and Biological Methods for Water Pollution Studies*. Environmental Publications, Karad, India, 215pp.
23. Untoo, S.A., Khan, A. A., and Parveen, S. (2001) Two hundred years old laal diggi pond at Aligarh approaching towards grassland ecosystem. *Asian.J. of Microbiol. Biotech. Eniv. Sc*., **3**(4): 379-380.

Table 1

Monthly Variations in Primary Productivity, Community Respiration and Chlorophyll a in CP-1, CP-2 and MP Wetlands of Aligarh region of northern India.

Months↓	**Net Primary Productivity** NPP (g C/m³/hr)			**Gross Primary Productivity** GPP (g C/m³/hr)			**Community Respiration** CR (g C/m³/hr)			**Chlorophyll 'a'** (mg/L)		
Wetlands→	**CP-1**	**CP-2**	**MP**	**CP-1**	**CP-2**	**MP**	**CP-1**	**CP-2**	**MP**	**CP-1**	**CP-2**	**MP**
August,2013	1.628	1.567	1.437	1.717	1.806	2.115	0.089	0.239	0.678	2.452	3.241	3.317
September,2013	1.329	1.367	1.322	1.492	1.511	1.473	0.163	0.149	0.151	2.708	2.591	2.683
October,2013	1.482	1.482	1.472	1.693	1.514	1.561	0.211	0.032	0.089	3.262	2.816	3.685
November,2013	1.632	1.371	1.622	1.952	1.731	1.734	0.320	0.360	0.112	3.252	2.146	2.945
December,2013	1.121	1.453	1.351	1.242	1.416	1.442	0.121	0.008	0.091	1.348	2.322	2.545
January,2014	0.687	0.564	0.892	0.823	0.726	1.064	0.136	0.162	0.172	0.831	0.722	2.075
February,2014	0.923	0.675	0.564	1.023	0.783	0.675	0.100	0.108	0.111	0.562	0.892	0.786
March,2014	1.372	1.264	1.320	1.419	1.375	1.421	0.047	0.111	0.101	2.610	2.590	2.832
April, 2014	1.572	1.464	1.532	1.713	1.642	1.604	0.141	0.178	0.072	2.920	2.846	2.715
May,2014	1.638	1.575	1.746	1.823	1.713	1.834	0.186	0.138	0.088	3.130	2.824	3.146
June,2014	1.725	1.214	1.260	2.130	2.140	1.673	0.405	0.926	0.413	3.210	3.360	3.340
July,2014	1.523	1.428	1.836	1.813	1.924	2.240	0.290	0.496	0.404	3.070	3.035	2.315
August,2014	1.617	1.666	1.448	1.816	1.917	2.106	0.199	0.251	0.658	2.561	3.139	3.328
September,2014	1.219	1.288	1.331	1.501	1.602	1.462	0.282	0.314	0.131	2.819	2.703	2.784
October,2014	1.391	1.372	1.482	1.581	1.703	1.572	0.190	0.331	0.090	3.151	0.915	3.795
November,2014	1.732	1.280	1.732	1.831	1.953	1.842	0.099	0.673	0.011	3.261	2.064	1.735
December,2014	1.142	1.343	1.242	1.231	1.354	1.286	0.089	0.011	0.044	1.437	2.465	2.473

Table 2

Statically Briefs of Various Parameters of GPP, NPP and Chlorophyll 'a' in CP-1, CP-2 and MP, Wetlands of Aligarh, northern India.

Parameters	Parameters	Wetlands/Sites	Coefficient of Correlation (r Value)	Significant at ($p<0.05$)
Gross Primary Productivity (GPP)	Chlorophyll 'a'	CP-1	0.887	√
		CP-2	0.704	√
		MP	0.536	√
	Phytoplankton	CP-1	0.005	-
		CP-2	0.570	√
		MP	0.138	-
	Water Temperature	CP-1	0.663	√
		CP-2	0.693	√
		MP	0.703	√
Net Primary Productivity (NPP)	Phytoplankton	CP-1	0.044	-
		CP-2	0.445	-
		MP	0.162	-
	Chlorophyll 'a'	CP-1	0.865	√
		CP-2	0.742	√
		MP	0.497	√
	Water Temperature	CP-1	0.611	√
		CP-2	0.633	√
		MP	0.526	√
Chlorophyll 'a'	Phytoplankton	CP-1	0.133	-
		CP-2	0.333	-
		MP	0.031	-

Chaarat Pond-1 (CP-1), Chaarat Pond-2(CP-2) and Medical Pond (MP)