Macrophytic Features of Wular Lake (a Ramsar Site) in Kashmir

Showkat Subhan Mir and Ashok K. Pandit
P.G. Department of Environmental Science, Centre of Research for Development, University of Kashmir, Srinagar – 190 006, J&K, India

ABSTRACT

The paper deals with the macrophytic composition and production of Wular Lake, Kashmir. The macrophyte dominated lake is of open drainage type with permanent inflow and outflow channels. The lake, being marshy in the littorals, is well-buffered, alkaline in nature, following the same sequence of major ions as $HCO_3^- > Ca^{++} > Mg^{++} > Cl^-$ like other Kashmir Himalayan water bodies. The ecosystem supports aquatic plant communities (emergents, rooted floating leaf type, free floating leaf type, submergeds) marked by striking variability in composition, frequency and extent of colonization. The net annual primary production of macrophytes recorded during the study period was 9.47 $gm^{-2}yr^{-1}$. The important invasion of a tropical macrophytic species (*Azolla pinnata*) into the wetland of International Importance is a great concern for the management of the ecosystem.

***Key words*:** Macrophytes, *Azolla pinnata*, *invasion, Ramsar Convention, wetland, Kashmir*

INTRODUCTION

Wular lake, like other inland lakes of Kashmir Himalaya, is the vital resource to provide water, food and recreation for human beings as well as habitat for many species of plants and animals. Being the largest freshwater lake of Indian sub-continent it has been designated as Ramsar Site in 1990 (ICUN - Ramsar Convention 1971). It is a rural lake in the north-west of Kashmir, about 35 km from Srinagar city and lies in the flood-plains of River Jhelum between 34° 16′-34° 20′ N latitude and 74° 35′-74° 44′ E longitudes and at an altitude of 158m (a.m.s.l). The present paper deals with the macrophytic composition, production and there has been a recent invasion of a biological species (*Azolla pinnata*), being tropical in nature.

MATERIAL AND METHODS

Macrophytes were collected throughout the study period (March, 2002 to February, 2004) and were brought to laboratory for floristic studies which followed Zutshi and Gopal (2000). For biomass calculation quadrat method was applied in which plants were first washed and then extra moisture content removed with filter paper for estimating fresh weight and then oven dried at 105°C for 24 hours for calculating dry weight biomass. For biomass estimation, the measurements were made for each species according to procedures described by Milner and Huges (1968).

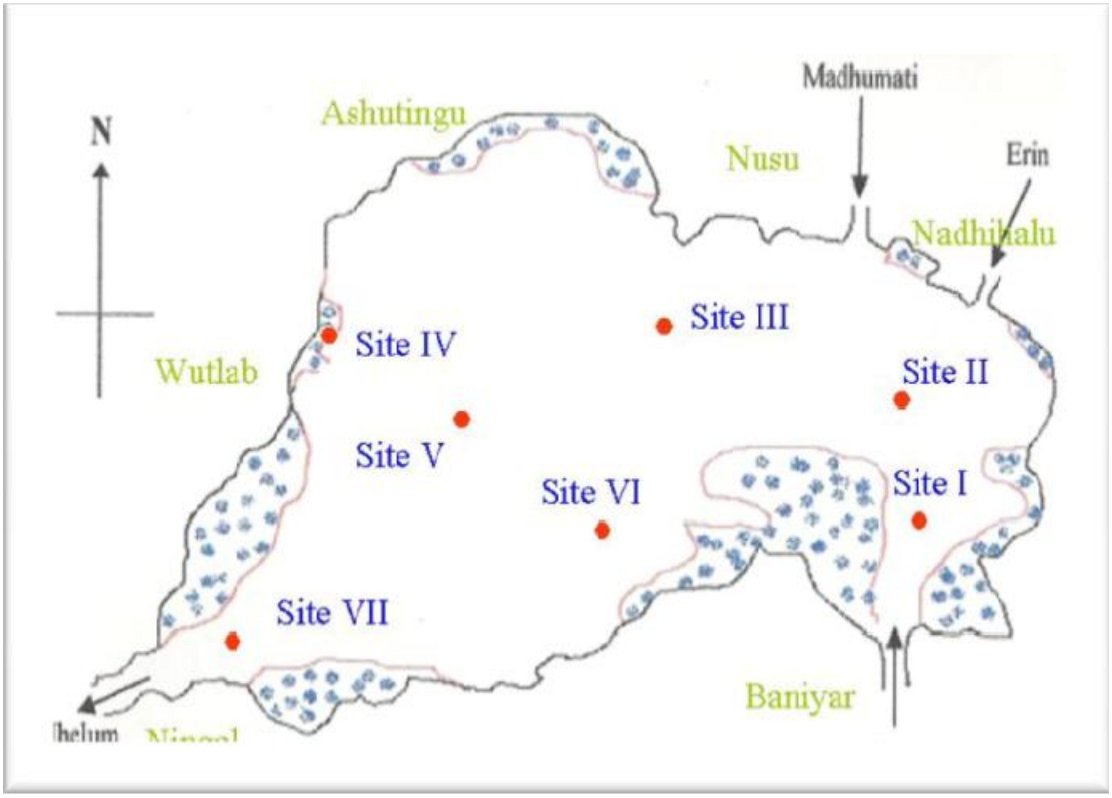

Fig. 1. Map showing various study sites

RESULTS AND DISCUSSION

Macrophytic Composition and Distribution

Wular, a wetland of International Importance, is represented by about 25 macrophytic species belonging to 17 families (Table 1). The vegetation does not form monospecific meadows but grows intermixed resulting in complex physiognomy. There were, however, variations in dominance pattern of various species in different vegetation stands.

The macrophytic vegetation in the wetland can be classified into four distinct groups: emergents, rooted-floating type, free floating leaf type and submergeds.

(i) Emergents

The whole littoral region of the wetland is fringed with diverse emergent macrophytes. The emergent community of the wetland was represented by nine species, which include *Alisma plangtago aquatica, Carex* sp., *Myriophyllum verticillatum, Nasturtium officinale, Phragmites australis, Polygonum amphibium, Sagittaria sagittifolia, Sparganium ramosum* and *Typha angustata.*

(ii) Rooted floating-leaf type

The shallow waters of the wetland are dominated by rooted floating leaf type community represented by six species namely *Hydrocharis dubia, Nelumbo nucifera, Nymphoides peltatum, Potamogeton natans* and *Trapa natans*.

(iii) Free floating type

The distribution pattern of free-floating types of macrophytes is mainly determined by hydrological fluctuations and patterns of water flow. This type of aquatic flora form thick, mat-like scum, which dominate the side channels of the wetland rich in organic matter. The high water level helped by wave action drifts the species towards the littorals, through water flow favours their accumulation at the semiclosed main outlet at Ningali (Sopore). The free floating community was represented by *Lemna gibba, Lemna minor, Salvinia natans* and the newly introduced tropical exotic species of *Azolla pinnata* reported for the first time from the waterbody (Mir, 2007).. The thick mat of the exotic species in certain areas totally hinders the penetration of sunlight into the waterbody, which restricts the submerged growth, thus creating an alarming situation for the wetland.

(iv) Submergeds

The submerged type of macrophytic community was again represented by six species namely *Ceratophyllum demersum, Hydrilla verticillata, Myriophyllum spicatum, Potamogeton crispus, Potamogeton lucens* and *Potamogeton pucillus.*

Table 1: Macrophytic species recorded from Wular lake during the study period (March 2002 to February 2004)

S.No	Name of Species	Family
Emergents		
1	*Alisma plantago-aquatica* L.	Alismataceae
2	*Carex* sp.	Cyperaceae
3	*Myriophyllum verticillatum* L.	Haloragaceae
4	*Nasturtium officinale* R. Br.	Brassicaceae
5	*Phragmites australis* Trin.	Poaceae
6	*Polygonum amphibium* L.	Polygonaceae
7	*Sagittaria sagittifolia* L.	Alismataceae
8	*Sparganium ramosum* Huds.	Sparganiaceae
9	*Typha angustata* Bory and Chaub	Typhaeceae
Rooted floating -leaf type		
10	*Hydrocharis dubia Bacquer*	Hydrocharitaceae
11	*Nelumbo nucifera Gaertn.*	Nelumbonaceae
12	*Nymphaea alba* L.	Nymphaecceae
13	*Nymphoides peltatum Kuntze*	Menyanthaceae
14	*Potamogeton natans* L.	Potamogetonaceae
15	*Trapa natans* L.	Trapaceae
Free floating type		
16	*Azolla pinnata*	Salviniacea
17	*Lemna gibba*	Lemnaceae
18	*Lemna minor*	Lemnaceae
19	*Salvinia natans* L.	Salviniaceae
Submergeds		
20	*Ceratophyllum demersum L.*	Ceratophyllaceae
21	*Hydrilla verticillata* Royle	Hydrocharitaceae
22	*Myriophyllum spicatum* L.	Haloragaceae
23	*Potamogeton crispus* L.	Potamogetonaceae
24	*Potamogeton lucens* L.	Potamogetonaceae
25	*Potamogeton pucillus* L.	Potamogetonaceae

Biomass and Production

Macrophytic biomass per unit area was worked out on monthly basis throughout the growing season (March to October). Very significant temporal as well as spatial variations were observed in biomass accumulation in the wetland. In general, irrespective of sites, the lowest biomass was recorded in March and the highest values were recorded during August (Table 2).

The net annual primary production was worked out on the basis of biomass calculated over the growing season for the whole study period. The lowest net annual production of 7.42 $gm^{-2}yr^{-1}$ was registered for site VI as against a highest of 12.5 $gm^{-2}yr^{-1}$ at site III. The net annual primary production a site I, II, IV and V during the study period was 8.58 $gm^{-2}yr^{-1}$, 8.17 $gm^{-2}yr^{-1}$, 9.0 $gm^{-2}yr^{-1}$ and 11.17 $gm^{-2}yr^{-1}$ respectively (Fig. 2). *Azolla pinnata* was not so scarce as it contributed both to biomass as well as production.

Table 2: Monthly variation in macrophytic biomass and annual primary production at different selected sites of Wular lake during 2003

	Macrophytic Biomass (gm^{-2})					
Year 2003	**Site I**	**Site II**	**Site III**	**Site IV**	**Site V**	**Site VI**
March	37.00	54.00	41.00	72.00	47.00	68.00
April	39.00	58.00	62.00	76.00	70.00	87.00
May	52.00	79.00	91.00	103.00	81.00	96.00
June	75.00	112.00	119.00	127.00	106.00	115.00
July	97.00	137.00	154.00	172.00	147.00	128.00
August	123.00	129.00	178.00	168.00	157.00	133.00
September	134.00	118.00	142.00	139.00	125.00	108.00
October	101.00	87.00	93.00	78.00	81.00	69.00
Net annual primary productivity ($gm^{-2}yr^{-1}$)	8.58	8.17	12.50	9.00	11.17	7.42

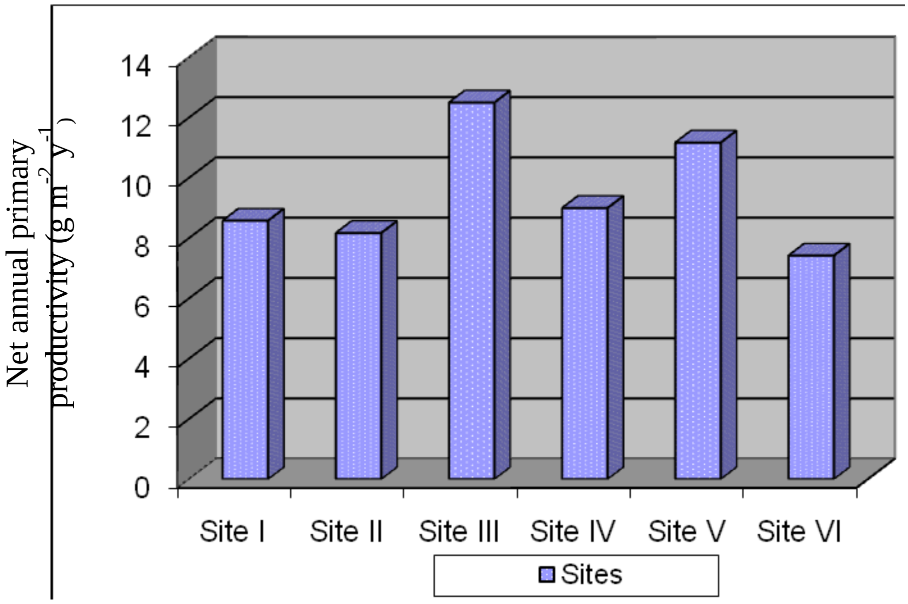

Fig. 2. Macrophytic variations in net annual primary prodoctivity (gm^{-2}yr^{-1}) in Wular lake at seven selected sites during the year 2003

Wular, lake having a greater littoral area, sustains a dense growth of macrophytes (Fig.3-6). In all 25 macrophytic species belonging to 17 families were encountered from the lake. The macrophyes does not form monospecific meadows especially towards the littorals but grow intermixed resulting in complex physiognomy. Among the four life classes, the emergents out numbered all other classes throughout the study period. Structure and species composition of the wetland is purely governed by various ecological stresses including flooding, erosion and depletion. The accumulation of heavy loads of silt, as a result of excessive and frequent flooding in the previous few years (Pandit, 1991; 1999), seems to be a quite reasonable attribute for fast spreading of some macrophytes in the wetland.

Though open water areas of the wetland exhibited the growth of all the four types of macrophytes growing intermixed, the rooted floating leaved species and a few emergents dominated throughout the growing season, which is purely attributed to the decreasing depth of the wetland. Despite moderate water depth in the wetland submergeds except a few did not show any luxuriant growth probably because of greater water turbidity during the growing season.

Fig. 3. Luxuriant growth of macrophytes (rooted floating-leaf types and emergents) growing in the littorals of Wular near Watlab site

Fig. 4. Lake littorals with rooted floating leaf vegetation (*Hydrocharis dubia*)

Fig.5. Free floating vegetation in open water areas of the lake

Fig. 6. Macro–vegetation chocking the littorals of the lake

However, *Ceratophyllum demersum* showd a vigorous growth being adapted to the low irradiation (Vandervalk and Bliss, 1971). Pandit, 1999 related the growth and abundance of *Ceratophyllum demersum* to the eutrophic conditions of water.

The abundant growth of free floating exotic species *Azolla pinnata* even blocks the navigation channels. The introduction of the species may be due to the heavy motorable boats shifted from other waterbodies of the country to the Kashmir lake, an observation made by Mir (2007). The exotic species to so expanding in growth that it will become a serious threat for the indegenic species if not controlled immediately.

Macrophytic productivity yet forms another important criterion to establish the dominance of any species in an ecosystem. Macrophytic productivity is most commonly evaluated by measuring changes in biomass (Westlake, 1965). In general, irrespective of sites, the lowest biomass (37gm^{-2}) was recorded in March and the maximum (178 gm^{-2}) during the month of August (Table 2).

Macrophytes have been used as indicators of water pollution by various workers including Wetzel (1978), Varshney (1981) and Pandit (1984). The most commonly used method for biological assessment of water pollution in aquatic ecosystem are based on the kind of species present, number of species, abundance, productivity etc. (Cairns *et al.*, 1979). In the present study many such indicator species of macrophytes were recorded including *Sparganium ramosum, Myriophyllum verticillatum, Potamogeton lucens, Potamogeton crispus, Potamogeton pucillus, Alisma plantogo aquatica, Lemna* sp. and *Salvinia natans*. Pandit (1984) envisaged the presence of these species to eutrophic conditions of the waterbody. Kaul (1984) also correlated *Lemna-Salvinia* association with excessive eutrophication bringing about the replacement in underwater vegetation.

ACKNOWLEDGEMENTS

The author is highly thankful to Head, P.G. Department of Environmental Science, University of Kashmir, Srinagar for providing necessary laboratory facilities.

REFERENCES

Cairns, J. J., Patil, G. P. and Waters, W. E. 1979. *Environmental Biomonitoring Assessment Prediction and Management Vol. II.* International Cooperative Publishing House, U.S. A. I.U.C.N., 1971. Ramsar Convention on Wetlands: http: www.ramsar.org

Kaul, V. 1984. Conservation of plant resources in aquatic ecosystems with references to some aquatic habitats of Kashmir. p. 118-131. In: *Conservation of Tropical Resources* (S. K. Jain and K. L. Mehra, eds.). Botanical Survey of India and DOE, India.

Milner, C. and Hyges, R. E. 1968. *Methods for the Measurement of the Primary Production of Grasslands*. IBP Handbook No. 6. Oxford Blackwell.

Mir, S. S. 2007. *Trophic Status of Wular Lake, Kashmir.* Ph.D Thesis, University of Kashmir, Srinagar, J&K, India.

Olson, S. 1950. Aquatic plants and hydrospheric factors. 1. Aquatic plants in SW Juteland, Denmark. *Svensk Botanisk Tidskrif*, **44**: 1-34.

Pandit, A. K. 1984. Role of macrophytes in aquatic ecosystems and management of freshwater ecosystems. *J. Environ. Manage.*, **18:** 73-88.

Pandit, A. K. 1991. Conservation of wildlife resources in wetland ecosystems of Kashmir, India. *Journal of Environmental Management* (London), **33**(2): 143-154.

Pandit, A. K. 1999. *Freshwater Ecosystems of the Himalaya.* Parthenon Publications, New York, London.

Vandervalk, A. G. and Bliss, L. C. 1971. Hydrarch succession and net primary production of oxbow lakes in Central Alberta. *Can. J. Bot.*, **49**: 1177-1199.

Varsheny, C. K. 1981. Macrophytes as indicators of water quality. p. 53-59. In: *Proceedings of the WHO Workshop on Biological Indicators and Indices of Environmental Pollution*. (A. R. Zafar, K. R. Khan, M. A. Khan and G. Seenayya, eds.).Cent. Bd. for Prev. Cont. and Water Poll. / Osmania University, Hyderabad, U.P.

Westlake, D. F. 1965. Some basic data for investigations of the productivity of aquatic macrophytes. *Proc. Bot. Symp. Pr. Productivity Aquat. Environs. Mem. Ist. Ital. Idrobiol.,* **18** *(Suppl)*.: 229-248.

Wetzel, R.G. 1978. *Limnology*. W.R. Saunders Co., Philadephia, U.S.A.

Zutshi, D. P. and Gopal, B. 2000. State of biodiversity in lakes and wetlands of Kashmir valley. p. 51-68. In: *Environmental, Biodiversity and Conservation* (M. A. Khan, ed.). A.P.H. Pub., Corp., New Delhi.