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On the fish diversity, conservational management and rehabilitation aspects of Wular Lake, Kashmir India

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ABSTRACT

Biodiversity and conservation are regarded as one of the major issues of enabling sustainable use of natural resources. This contribution focuses on fish population and their conservation aspects in the freshwater Wular Lake in Kashmir. It was a valuable fishery resource of the region but due to anthropogenic pressures such as encroachment over open water area and entry of sewage and disturbance in the catchment area have affected water quality and consequently its fishery potential adversely. The fish fauna of Kashmir is appreciably different from rest of the country and is mainly represented by the cold water *Schizothoracine* group of fishes. It is observed that some of the *Schizothorax* species have almost disappeared from the scenario. The study revealed the occurrence of sixteen fish species belonging to three orders namely Cypriniformes (81%), Siluriformes (12.5%) and Cyprinodontiformes (6.25%) and 5 families includes Cyprinidae (62.5%), Balitoridae (12.5%), Sisoridae (12.5%), Cobitidae (6.25%) and Poeciliidae (6.2%).

KEY WORDS: DIVERSITY, ECOSYSTEM, EXOTIC, INDIGENOUS, KASHMIR AND WULAR

INTRODUCTION

Freshwater fish are one of the most threatened taxonomic groups (Darwall and Vie, 2005) because of their high sensitivity to the quantitative and qualitative alteration of aquatic habits (Laffaille *et al.*, 2005; Sarkar *et al.*, 2008; Kang *et al.*, 2009). Fish is sensitive to changes in water chemistry due to different anthropogenic activities from their catchment. Fish responses to environmental disturbances, including hydro-morphological factors are different in time and space in comparison to simpler organisms, as they tend to be integrated

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over larger intervals. Fish have been identified as suitable for biological assessment due to its easy identification and economic value (Silas 1951; Smith *et al.,* 1999, Siligato and Bohmer 2001, and Vibhute 2016).

Fish have been regarded as an effective biological indicator of environmental quality and anthropogenic stress in aquatic ecosystems (Simon and Lyons, 1995; Bhat, 2003; Jayalekshmy and Sanalkumar, 2012) not only because of their iconic value, but also because of sensitivity to subtle environmental changes. They represent a wide range of tolerance at community level. Today the fish diversity and associated habitats management is a great challenge (Dudgeon *et al.,* 2006). Conservation measures to mitigate the impact of the pressures have largely been slow and inadequate and as a result many of the species are declining rapidly (Venkateshwarlu 2014).

MATERIAL AND METHODS

Wular Lake, a rural lake in the north-west of Kashmir about 55 km from Srinagar city, is lying in the flood plains of River Jhelum. Its recognition of its biological, hydrological and socio-economic values, the lake was included in 1986 as a wetland on national importance under the wetlands programme of the Ministry of Environment and Forests, Government of India for intensive conservation management purposes. Subsequently in 1990, it was designated as a wetland of International importance under the Ramsar convention.

The average maximum depth of the lake is reported 5.8m (Pandit, 2002). The lake is situated at an altitude of 1,580 m (AMSL) lying between 34°16′- 34°20′N latitudes and 74°33′-74°44′E longitudes. The lake is becoming steadily shallower as a result of continuous deposition of silt brought from its catchment area through its main tributaries (Erin, Madhumati, Ashtung, Hartal, etc.), and the River Jhelum. River Jhelum is the main feeding channel entering the lake basin at Gurur, it is further drained at Ningli (Sopore) in the north-east by the only single outlet in the form of River Jhelum. The lake is situated between Bandipore and Sopore. Bandipore is situated in its eastern bank and is popularly known as port of Wular, the Madhimati and Erin Nallas flow into the lake on its eastern side

For studying the fish biodiversity, various data and information where collected by physical verification and interview with the local fisherman of the study area. The sampling was carried out on monthly basis, 10 attempts were made by fisherman/day. The collected samples where immediately dipped into 10% formalin in a large container that allowed proper separating of their fins. Then the specimens were examined and classified into families, which were carried in separate container each container was labeled properly against the physical data sheet of sampling and brought to the laboratory for further examine exercise. Identification of fishes was done with the help of standard taxonomic works of Day (1878), Hora (1936), Mukerji (1936), Talwar and Jhingran (1991), Kullander *et al.,* (1999). In the present study, diversity has been measured by number of species and by using indicies. They are given below:

1. Simpson's diversity index (D)

Diversity within the benthic macro invertebrate community was described using the Simpson's diversity index ("D"), which was calculated as:

$$D = 1 - \sum_{i=1}^{s} (p_i)^2$$

Where, "pi" is the proportion of individuals in the "ith" taxon of the community and "s" is the total number of taxa in the community (Simpson, 1949).

2. Shannon-Weiner diversity index ($H^/$)

Species diversity was determined after Shannon-Weiner (1949) as:

$$H^{/} = -\sum_{i=1}^{i=s}\left(\frac{ni}{N}\right)\log e\left(\frac{ni}{N}\right)$$

Where: $H^/$ = Index of species diversity
n_i = Density of one species
N = Density of all the species
e = Base of natural logarithm of $\log e\left(\frac{ni}{N}\right)$ = 2.303 $\log_{10}\left(\frac{ni}{N}\right)$
S = Addition of the expression for values of *i* from *i* = 1 to *i*

3. Evenness Index

Evenness Index an important component of the diversity indices. Evenness index expresses how evenly the individuals are distributed among the different species for a particular area.

4. Margalef Index

It is a measure of species diversity, calculated from the total number of species present and the abundance or total number of individuals. The higher the index the greater the diversity.

Margalef's richness index: (S-1)/ln (n), where S is the number of taxa, and n is the number of individuals.

5. Berger-Parker diversity index

It is simple measure of the numerical importance of the most abundant species. Berger-Parker diversity indices were determined by PAST software.

RESULTS AND DISCUSSION

Present study standardizes the fishing status along the different sites of Wular Lake, which yielded sixteen fish species viz, Cyprinus carpio specularis, Cyprinus carpio communis, Carassius carassius, Schizothorax niger, Schizothorax esocinus, Schizothorax curvifrons, Schizothorax labiatus, Schizothorax plagiostomus, Crossocheilus diplochilus, Puntius conchonius, Botia birdi, Triplophysa kashmirensis, Triplophysa marmorata, Gambusia affinis, Glyptothorax kashmirensis, Glyptothorax pectinoptrus belonging to three orders namely Cypriniformes (81%), Siluriformes (12.5%) and Cyprinodontiformes (6.25%) and 5 families includes Cyprinidae (62.5%), Balitoridae (12.5%), Sisoridae (12.5%), Cobitidae (6.25%) and Poeciliidae (6.2%).

Out of sixteen species of fishes Cyprinus carpio comminus was dominant. Cyprinus carpio comminus seems to be well established and may pose a threat to the endemic lake dwelling species in competing for space and food. Das (1978) and Mir and Shahnawaz (2006) reported introduction of exotic fishes like common carp decline the catch as well as the diversity of indigenous fishes of Kashmir lakes. Khan et al., (2016) also reported that introduction of exotic fish species in freshwater ecosystems of Punjab and Pakistan is in great risk of decline due to their vigorous reproductive potential and feeding competitions with the native fish fauna.

The introduction of exotic species is the second leading cause, after habitat degradation, of species extinction in freshwater systems (Hill *et al.,* 1997). A survey of 31 studies of fish introductions in Europe, North America, Australia, and New Zealand found that in 77% of cases native fish populations were reduced or eliminated following the introduction of exotic fish. Fotedar and Qadri (1974) considered *Cyprinus carpio* to present serious competition to local origins like *Schizothorax niger, Schizothorax esocinus, Schizothorax curvifrons, Sxhizothorax labiatus* and*Crosschelius diplochilus*, whose number would be dwindling for this reason. The species which were rare are *Schizothorax plagiostomus, Puntius conchonius, Botia birdi, Triplophysa kashmirensis, Triplophysa marmorata, Gambusia affinis, Glyptothorax kashmirensis* and *Glyptothorax pectinoptrus*. The population of *Schizothracine* fishes in Wular Lake has considerably decreased over the years particularly after the introduction of common carp in 1956 (Fotedar and Qadri 1974; Vass *et al.,* 1984). The fish species like *Schizothorax richardsonii and Bangana diplostoma* once abundant and even caught in commercial quantities, which has now disappeared. Similarly, the indigenous fishes of Lake Sone of Assam are being fast replaced

Table 1: Fish diversity in Wular Lake of Kashmir

Scientific name of fish	Local name	Occurance
Cyprinus carpio specularis	Gang gad	Abundant
Cyprinus carpio communis	Gang gad	Less Abundant
Carassius carassius	Gung gad	Abundant
Schizothorax niger	Ale gad	Less Abundant
Schizothorax esocinus	Churun	Moderately Abundant
Schizothorax curvifrons	Satter gad	Less Abundant
Schizothorax labiatus	Chush	Moderately Abundant
Schizothorax plagiostomus	Khont	Moderately Abundant
Crossochelius diplochilus	Zub	Less Abundant
Puntius conchonius	Gang gad	Moderately Abundant
Botia birdi	Rama gurun	Very Rare
Triplophysa kashmirensis	Ara gurun	Very Rare
Triplophysa marmorata	Ara gurun	Very Rare
Gambusia affinis	Mahi gad	Less Abundant
Glyptothorax kashmirensis	Nayid gad	Rare
Glyptothorax pectinoptrus	Nayid gad	Rare

by the introduction of exotic carp, *Cyprinus carpio* (Kar *et al.,* 2006).

The *Cyprinus carpio* has not only flourished well in the aquatic habitats of the Wular Lake but also provides the maximum fish catch.Another factor responsible for decline in indigenous fishes is the encroachment of the shallow areas of the lake for agricultural activities which became the most dangerous practice which causes harm to some species of indigenous fishes, used to breed in shallow areas of the lake. Use of artificial fertilizers, pesticides and herbicides in apple orchards and paddy fields from nearby areas have also effected the indigenous fishes due to increase of nutrients in water which in turn increases growth of algal blooms and other macrophytes in the lake. The excess nutrients may originate from fertilizers that are applied to land for agricultural or recreational purposes. These nutrients can then enter watersheds through water runoff (Lathrop et al. 1998).

When phosphates are introduced into water systems, higher concentrations cause increased growth of algae and plants. Algae tend to grow very quickly under high nutrient availability, but each algae is short-lived, and the result is a high concentration of dead organic matter that starts to decay. The decay process consumes dissolved oxygen in the water, resulting in low oxygen conditions. Without sufficient dissolved oxygen in the water, animals, and plants die off in large numbers. Over the past decades, excessive nutrient loading has emerged as an important direct driver of freshwater ecosystem change. World consumption of nitrogenous fertilizers grew nearly eightfold between 1960 and 2003, from 10.8 million tons to 85.1 million tons (Millennium Ecosystem Assessment 2005).

Leveque (2008) also reported overexploitation, flow modification, destruction of habitats, and invasion by exotic species, pollution and eutrophication as major threats to fish biodiversity. Wular lake waters have achieved a high trophic status on account of nutrient enrichment from its catchment .Wular Lake is under eutrophic state as a result of human stress in the catchment area.

Shannon-Weaver index functions as a sensitive indicator for pollution. It is a combination of the number of species and the evenness of distribution of individuals among taxa (Klemm et al., 1990). Shannon index was very low indicating that fish diversity in Wular Lake is very poor due to pollution and other unfavorable environmental conditions. Simpson index and Evenness indicate that fish diversity of Wular is degrading day by day; same is true for Margalef index and Berger-Parker index.

CONSERVATIONAL MANAGEMENT AND REHABILITATION SUGGESTIONS

Freshwater biodiversity and freshwater ecosystems are seriously jeopardized by human activities in world. This is undoubtedly a consequence of growing human populations and economic development above everything else (Wu *et al*., 1999). Human activity can alter physical, chemical and biological processes and, thereby change the character of the lakes. The ecology and biodiversity of Wular Lake is under the impact of: (i) direct discharge of untreated sewage coming from highly populated villages and agriculture activities (ii) catchment runoff (iii) tourist pressure (iv) sand mining; channelization and impoundment; (v) illegal fishing. Combinations of these threat factors affect the biodiversity and puts freshwater biodiversity uniquely at risk as also stated by Hynes, (1960) in his study.

SUGGESTIONS

- Master plan should be developed for the treatment of all point source of pollution entering into the Wular Lake, especially for the sewage coming from the residential area of the Wular Lake which otherwise will affect the water quality and will deteriorate over all ecosystem health.
- Watershed management plan should be implemented along the catchment area of Wular Lake and construction and human habitation should be prohibited
- Deforestation and overgrazing should be properly controlled in order to prevent soil erosion and loss of biodiversity.
- Indiscriminate mining of sand should be restricted or minimized as this practice destroys the breeding grounds and dwelling place of Lake Fauna.
- Sustainable fisheries development to maintain/ restore fish diversity and yield.
- Control of invasive species and enhancing biodiversity.
- In order to protect the lake from silt problem brought in through main feeding channel-river Jhelum and other small streams like Madumati, Erin and Ningli settling basins need to construct near their points into the lake.
- Large areas of the lake have been illegally encroached and converted into paddy fields and vegetables gardens. The further encroachment in the lake must be stopped.
- Continuous deposition and pouring of domestic wastes, garbage and dead animals into the River Jhelum which ends at Wular be stopped under strict orders.
- We have done enough harm to our natural resources. In such situation eco-restoration is the way by which we can ameliorate the situation. There is need to create small decentralized decision making groups like Lake study groups, cooperative societies.

- Carry out environmental impact assessment periodically to ensure lake conservation and sustainable use of lake resources.
- Since the Lake is owned by various state government departments such as wildlife, fishery, urban environment engineering department, lakes and waterways development authority etc., there should be common consensus amongst these departments so that if the project is to be undertaken in the lake it should be with the consent of all the departments involved and not to disturb the ecology of lake.

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