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ICHTHYOFAUNAL DIVERSITY AND CPUE (Catch per unit effort) AT WATLAB GHAT, WULAR LAKE, KASHMIR

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ABSTRACT
The present work was aimed at having a detailed account of the fish diversity and Catch Per Unit Effort of Watlab Ghat (a major fish landing centre) in Wular Lake. In a one year study period, nine species of freshwater fishes ,both native and exotic belonging to two orders were recorded. Cyprinidae was observed to be the most dominant family. The minimum and maximum CPUE was recorded as 115 g/man-hour in the month of November and 2827.5 g/man-hour in the month of June respectively. As far as the diversity is concerned, the highest Shannon's diversity index was obtained as 1.74 in the month of December while as lowest was recorded as 1.07 in the month of February. Likewise, the highest and lowest Pielou's evenness indices were recorded as 0.75 and 1 in the months of August and November respectively. The highest values for Simpson's Dominance indices were recorded in the months of December and April as 0.82 and 0.65 respectively. The study revealed that there was a drastic decline in the native *Schizothorax* due to the introduction of exotic common carp, pollution and other anthropogenic disturbances.

INTRODUCTION

On a global level, mountains are the world's largest repositories of biological diversity. In India, the mountain regions are characterized by the presence of cold waters, many of which harbor fish and support subsistence fishery on a large scale. There are around 8,243 km long streams and rivers, 20,500 ha natural lakes, 50,000 ha of reservoirs, both natural and manmade, and 2500 ha brackish water lakes in the high altitude (Mahanta & Sarma, 2010). These vast and varied water resources in the uplands harbour rich ichthyofaunal diversity comprising large populations of indigenous and exotic, cultivable and non cultivable fish species (Sehgal, 1999). Out of the total fish fauna available in India, 17 % fishes have been documented from the mountain ecosystems establishing the status of the area as a center of origin and evolution of biotic forms (Ghosh, 1997).

Biodiversity studies have been carried out on a large scale both globally and locally as they provide an insight into the species. The earliest report on the fishes of Kashmir is that of Heckel (1839), who described sixteen species of fishes from the valley which were all new to science and thirteen of them belonging to family Cryprinidae. Since then a number of workers have reported on the ichthyofauna of the region (Day, 1877). Yousuf (1989) made an extensive study on the fish fauna of various lakes of Kashmir valley which included Manasabal, Anchar, Gangabal, Nundkhol, Malpursar and Khushalsar. The author reported 13 fish species out of which 8 belonged to order Cypriniformes, 2 to Siluriformes, and 1 each to Salmoniformes, Cyprinidontiformes and Beloniformes. Pandit (1993) reported *Cyprinus carpio* var. *communis* as the main fish in Nowgam, Haigam, Mirgund and Hokarsar wetlands, while *Cyprinus carpio* var. *specularis* was limited to Hokarsar and Mirgund. Yousuf (1996) reported forty two (42) species while Kullander *et al*., 1999 and Bhat *et al*. (2010) reported the present diversity of fishes in Kashmir region not more than twenty two (22) species.

A large number of lakes, wetlands and other water bodies in Jammu and Kashmir have been facing a threat from massive encroachments, thus affecting the biodiversity of flora and fauna dwelling in such ecosystems. In recent years, the wetlands have been lost on account of anthropogenic activities due to population pressures, unplanned development and shortsighted policies. In order to formulate an effective monitoring program involving suitable management strategies, it is important to gather baseline data related to the biodiversity of a particular water body. It is with this background that the current status of fish biodiversity of Watlab Ghat (an important fish landing centre in Wular Lake) was proposed to be taken up with the objectives of understanding the fish biodiversity and quantifying the fish yield (Catch Per Unit Effort) of this important landing centre.

Wular, one of the largest freshwater lakes of Asia is an open drainage type lake of fluviatile origin located in District Bandipora in the State of Jammu and Kashmir. The average maximum depth of the lake has been reported as 5.8 m (Pandit, 2002). However it is becoming steadily shallower as a result of continuous deposition of silt brought from its catchment area. The lake, along with its associated wetlands, supports a rich biodiversity of flora and fauna, besides providing important habitat for migratory water birds within Central Asian flyway.

Wular Lake is the largest fisheries resource in Kashmir valley, supporting livelihoods of large human population living along its fringes (Wetlands International, 2007).

Watlab Ghat, a major fish landing centre and fishing village in Wular Lake is located in Sopore, District Baramulla. It is located on the Western side of the lake between Kehnusa and Sopore Ghat. It has a profuse growth of macrophytes and water depth varies from 1 to 5.5 m.

MATERIALS AND METHODS

The present study was carried out from December, 2014 to November, 2015 for a period of one year. The collection of fishes was done on a monthly basis with the help of local fishermen who operated cast nets for catching fish in the morning hours. The total catch (number and weight) was recorded on site with help of a digital balance. The representative samples were brought to the laboratory at Faculty of Fisheries, Rangil, Ganderbal and preserved in 10 % formalin in separate jars according to the size (Misra, 1962; Munro, 2000). Identification of fish samples was done by using standard taxonomical works of Day (1877) and Kullander *et al*., (1999).

Biodiversity studies

Shannon's diversity index

The Shannon Diversity Index was computed with the help of the following formula (Shannon and Weiner, 1963)

$$H' = \sum^{s} pi \ln pi$$

i = 1

Where,

pi = probability of each species (*ni/N).*

N = total number of individuals in 'S' species.

ni = number of individuals in *ith* species.

Index of Dominance

The index of dominance was computed using the following formula (E.W.Simpson, 1949):

(ID) = ©$(Ni/ N)^2$

Where,

N = Total number of individuals.

Ni = Number of individuals in each species.

Evenness Index

The evenness index was computed with the following formula (E.C.Pielou, 1966):

$(J') = (H)/\log^2 S$

Where,

H = Species diversity index.

S = Total number of species.

Catch Per Unit Effort

It is the catch of fish by number or weight for a unit of fishing effort. CPUE was calculated according to Kurian and Wilmann (1982) by taking time of operation of gear as time of effort and expressed as grams/man-hour.

Statistical analysis

The results obtained for CPUE and biodiversity indices were interpreted with the help of statistical methods using Microsoft excel, SPSS (Statistical Package for the Social Sciences) for Windows and PAST (Paleontological Statistics) software respectively.

RESULTS

The CPUE at Watlab Ghat was recorded for a period of 1 year from December, 2014 to November, 2015 and is presented in Table 1. The highest CPUE of 2827.5 g/man-hour was recorded in the month of June while as the lowest CPUE of 115 g/man-hour was recorded in the month of November. The mean CPUE at Watlab Ghat was recorded as 1004.1 g/man-hour.

The highest Shannon's diversity index was obtained as 1.74 in the month of December while as lowest was recorded as 1.07 in the month of February. Likewise, the highest and lowest Pielou's evenness indices were recorded as 1 and 0.75 in the months of November and August respectively. The highest values for Simpson's Dominance indices were recorded in the months of December as 0.82 and lowest in April as 0.65.

DISCUSSION

Biodiversity studies

Ichthyofaunal diversity refers to the variety of fish species depending on context and scale; it could also refer to alleles or genotypes within a fish community and to species or life forms across aquatic regimes. Studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community. The "species diversity" includes two components: the number of species or richness and the distribution of individuals among species. Much of the early study on the freshwater systems of the Indian subcontinent started with the works of British officers working for the East India Company, who took great interest in the natural history of the region (Vijaylaxmi, C. and Vijaykumar, K., 2011). A large number of studies covering a wide variety of ecosystems and organisms suggest that species richness tends to vary strongly with ecosystem production and habitat heterogeneity. The rivers of the Kashmir valley harbor a number of indigenous fishes like *Schizothorax* spp., *Glyptothorax* spp., *Triplophysa* spp. etc and are also famous throughout the world for the exotic brown trout (*Salmo trutta fario*) and rainbow trout (*Onchorhynchus mykiss*) (Bhat *et al*., 2013). Many researchers have worked on the diversity of fish fauna of Jammu and Kashmir. The earliest attempt at describing the fish species of Kashmir was undertaken by Heckel in 1839, who identified sixteen species from this region. Day (1877) added two more species to the already existing list of Heckel and corrected the names of some of the species. Silas (1960) who described 28 fish species from Kashmir valley included only two exotic species, *Gambusia affinis* and *Salmo trutta fario*. Based on literature survey, Yousuf (1996) recognized only 37 species, which were represented by Cyprinidae,

Table 1: Catch per Unit Effort (CPUE) at Watlab Ghat, Wular Lake, Kashmir

Months	Total catch	Fishing Hours	Persons involved	Fishing effort (g/man-hour)
December	1.2	2	2	317.5
January	1.1	2	2	282.5
February	1.3	2	2	327.5
March	5.3	2	2	1327.5
April	3.6	2	2	910
May	2.8	2	2	710
June	11.3	2	2	2827.5
July	9.9	2	2	2492.5
August	6.6	2	2	1667.5
September	1.4	2	2	355
October	2.8	2	2	717.5
November	0.4	2	2	115
Mean	4.01			1004.1

Table 2: Biodiversity indices obtained at Watlab Ghat, Wular Lake, Kashmir

Months	Shannon-Wiener Index	Pielou's Evenness Index	Simpson's Dominance Index
December	1.74	0.95	0.82
January	1.33	0.94	0.72
February	1.07	0.98	0.65
March	1.26	0.88	0.69
April	1.19	0.82	0.65
May	1.4	0.82	0.72
June	1.4	0.85	0.74
July	1.5	0.79	0.74
August	1.6	0.75	0.76
September	1.2	0.84	0.65
October	1.2	0.89	0.7
November	0	1	0

Cobitidae, Siluridae, Poecilidae, Sisoridae and Salmonidae families. Some of the recent works on biodiversity of fishes of the region are that of (Balkhi *et al*., 2005; Chalkoo *et al.,* 2006; Arjumand *et al.,* 2006 and Bhat *et al*., 2010).

Shannon-Weiner diversity (*H'*) index considers both the number of species and the distribution of individuals among species. During the present study the highest Shannon's diversity index was recorded as 1.74 in the month of December while as the lowest (1.07) was witnessed in the month of February. According to Wilhm and Dorris (1966), Shannon's diversity index (*H'*) value ranging from Ã 3 indicates clean water, 1.00 to 3.00 indicates moderately polluted and Â 1.00 indicates heavily polluted conditions of water. According to this classification, Wular Lake falls in the category of moderately polluted waters. In another study on diversity as a measure of benthic macro invertebrate community response to water pollution, Godfrey (1978) observed the values of Shannon index ranging from 1.938 to 5.34. The value of Shannon-Wiener diversity index, *H'* increases when both the number of species and evenness, e increases. For a given number of species, the value of *H'* is maximized when all species are equally abundant. The value of *H'* usually falls between the values 1.5 and and 3.5, and it rarely surpasses the value 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species as was reported by (Bibi and Ali, 2013) while conducting a study on the measurement of diversity indices of avian communities at Taunsa barrage wildlife sanctuary, Pakistan. However, in the present study, the value of *H'* was found highest (*H'* = 1.47) in summer and lowest in autumn (*H'* = 1.19), which indicated a very low diversity. Biligrami (1988), while studying the biological monitoring of rivers in India, recommended better condition of water body for fish diversity when Shannon-Wiener diversity index ranged from 3.0 - 4.5. But in the present study diversity index ranged from 1.07 - 1.74, which means that the water body is less diversified and moderately polluted. This can be attributed to domestic discharge and poor water quality due to runoff of different insecticides and pesticides from the catchment areas. The non-available and less availability of some fish species which were reported in earlier studies indicates the alarming decline of the fish diversity in the study area. The present results are in agreement with the studies conducted by Welcomme, (1985); Bayley and Li, (1994); Granado, (2000); Slavik and Bartos, (2001); Hina, (2010) and Offem *et al*. (2011). Pielou's index (J') is an evenness measure index which measures the evenness by which individuals are divided among the taxa present. During the study period, the highest recorded evenness (J') value was found as 1 in November and lowest was reported as 0.75 in August. The values of this index were closer to 1 which suggests that the populations of fish that form the community were more evenly distributed as is also advocated by Emmanuel and Modupe (2010) who also made a similar observation while studying fish diversity in three tributaries of River Ore, South West, Nigeria. Murugan and Prabharan (2012) during their study on fish diversity in relation to physico-chemical

Plate 1: A view of Watlab Ghat

characteristics of Kamala Basin of Darbhanga, District Bihar, found highest evenness value (0.99) in late monsoon indicating an evenly distributed and rich fauna in the monsoon and post monsoon. Simpson's dominance index (1-D) measures the probability that two individuals randomly selected from a sample will belong to the same species. During the present investigation the highest Simpson's index was found as 0.82 in the month of December and the lowest as 0.65 in the months of February, April and September. The value of this index ranges between 0 and 1, greater the value, the greater the sample diversity. It can be inferred that the greater dominance of the species was in winter months and less dominance in autumn.

Catch Per Unit Effort is a single most useful index for long term monitoring of a fishery. It is an indirect measure of the abundance of a target species. Changes in CPUE are inferred to signify changes in the target species' true abundance. Declines in CPUE may mean that the fish population cannot support the level of harvesting. Increases in CPUE may mean that a fish stock is recovering and more fishing effort can be applied. In the present study, the mean Catch Per Unit Effort (CPUE) recorded at Watlab Ghat using cast net varied from a minimum of 115 g/man-hour to a maximum of 2827.5 g/man-hour. The highest CPUE was recorded in the month of June while as the lowest CPUE was recorded in November. Statistically there was a significant association between the species and season. CIFRI (1977), while conducting a survey on Dal Lake reported the Catch Per Unit Effort as 156 - 978 g at Saidakadal and 117 - 797 g at Hazratbal. Sunder *et al*. (1978) reported the mean CPUE of Dal Lake as 369 g/man-hour. Shah *et al*. (2003) studied the fishers of Dal Lake in Kashmir and reported that the summer mean catch per day (5.18 ± 0.69 kg) was more than the mean catch per day (2.85 ± 0.40 kg) while the total annual catch per person was 1195.56 ± 211.63 kg. Shafi *et al*. (2005) reported highest CPUE of 1015 g/man-hour in Nishat basin and lowest CPUE of 122 g/man-hour at Hazratbal. Yousuf *et al*. (2006) reported the fishing effort in river Jhelum as 173.2-360.1 g/man-hour. Khan *et al*. (2013) reported the mean fishing effort in Jhelum as 132.26-290.46 g/man-hour. The current findings on Catch Per Unit Effort would be useful in formulation of management strategies such as regulating fishing pressure and fishing effort.

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