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Ichthyofaunal Diversity of Halali Reservoir, Vidisha, Madhya Pradesh

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Abstract- The present study deals with the ichthyofaunal diversity of Halali Reservoir in Vidisha district, Madhya Pradesh. Ichthyofaunal studies were undertaken during February – September 2011. The results of present investigation reveal the occurrence of 29 fish species belonging to 7 orders, 10 families and 15 genera. The order Cypriniformes was found dominant (18 species) followed by Ophiocephaliformes (4 species), Clupeiformes and Mastacembeleformes (2 species) and Beloniformes, Perciformes and Siluriformes (1 species) each. The range of different physico-chemical parameters were observed such as air temperature 24oC - 37oC; water temperature 21oC - 28oC; TDS 120 – 150 ppm; Conductivity 245 – 280 µS/cm; pH 7.1 – 9; Free CO2 nil - 8.4 mg/l; Dissolved Oxygen 6 – 9.8 mg/l; Phenolphthalein alkalinity nil – 40.02 mg/l; Total alkalinity 56 – 236 mg/l; Total hardness 50 – 120 mg/l; Chloride 57.99 – 96.99 mg/l; Orthophosphate 0.122 – 1.06 mg/l and Nitrate 0.16 – 1.12 mg/l.

Index Terms- Ichthyofauna, Ichthyodiversity, Economic Value, Halali Reservoir, Physico-chemical parameters.

I. Introduction

Fishes exhibit enormous diversity in their morphology, in the habitats they occupy and in their biology. Unlike the other commonly recognized vertebrates, fishes are a heterogeneous assemblage (Forese and Pauly, 1998). Fishes constitute half of the total number of vertebrates in the world with over 22,000 species. Of these about 58 % are marine, 41% are freshwater species and 1 % move back and forth between salt and freshwater. As expected marine fishes are the most diverse because salt water covers 70 % of the earth.

Ichthyodiversity refers to the variety of fish species; depending on context and scale, it could refer to alleles or genotypes within fish population to species of life forms within a fish community and to species or life forms across aqua regimes (Burton *et al.*, 1992). Biodiversity is essential for stabilization of ecosystems, protection of overall environmental quality for understanding intrinsic worth of all species on the earth (Ehrlich and Wilson, 1991). Positive correlations between biomass production and species abundance have been recorded in various earlier studies (Nilkolsky, 1978). The species diversity of an ecosystem is often related to the amount of living, non living and organic matter present in it.

India is one of the mega biodiversity countries in the world and occupies the ninth position in terms of freshwater mega biodiversity (Mittermeier *et al.*,1997). In India there are 2,500 species of fishes of which 930 live in freshwater (Jayaram 1999) and 1,570 are marine (Kar *et al.*, 2003).

II. Study Area

Halali Reservoir is one of the most important reservoirs, about 40 km away from the Bhopal (capital city of Madhya Pradesh) situated between 23^0 30´ North latitude and 77^0 30´ East longitude with a catchment area of 699 sq. km, water spread of about 5259 ha with a maximum depth of about 30 m. It is perennial storage irrigation reservoir based on Halali River, which originates around Bhopal at an altitude of about 487.69 m above sea level and after travelling about 38 kms joins river Betwa, just downstream of Vidisha town. The reservoir has an earthern dam 945 m long and 39.27 m high across Halali River. The dam is located at about 50kms North East from Bhopal in Vidisha district of Madhya Pradesh. It was completed in 1977 but the construction of water distribution system comprising distributaries, minor and sub minors are still being completed in some areas. The river Halali in its later part in Vidisha district is known as Bais River. Water from river and drainage waste of Bhopal city through Patra Nallah joins the reservoir from South East and North East direction. Besides domestic discharge Nallah contains wastes from textiles, distillery and straw product factory of Bhopal are poured in Halali Reservoir. The Halali Reservoir has a gross storage capacity of 252.80 m.cum and live storage capacity of 266.09 m.cum. Halali River command area is bounded by Bah River in North. In the East the gross command area is spanning in 101 and 33 villages of Vidisha and Raisen district respectively. The annual potential of fish production of this reservoir is 846 quintals.

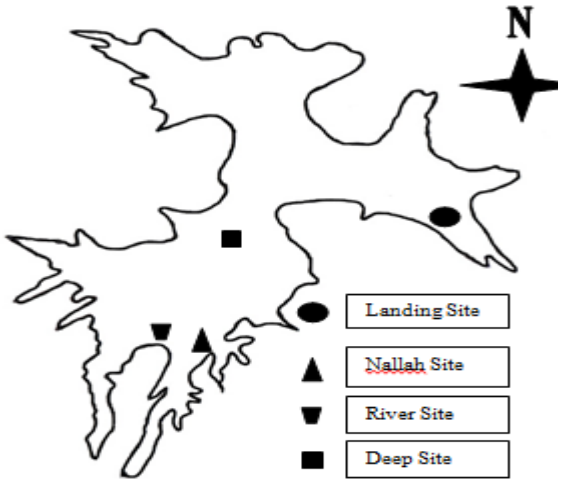

Fig. 1: Map of Halali Reservoir.

Table 1 Morphological features of Halali Reservoir.

Country	India
State	Madhya Pradesh
Year of construction	1973
Type of dam	Earthen
River	Halali
Basin	Betwa
Location/District	Raisen/Vidisha
Altitude	458m (asl)
Latitude	23^0 30´N
Longitude	77^0 30´E
Climatic region	Warmer humid
Catchment area (km2)	699.00
Water spread area(ha)	5959.00
Dead storage(ha)	2590.00
Gross command area(ha)	37419
Shoreline (km)	65
Maximum depth(m)	29.5
Mean depth(m)	5.3
Average rainfall(mm)	1108.00

III. Material and Methods

Water samples were collected from four sites in the months of February to September (2011). The sampling was usually carried out at 9:00 am to 2:00 pm. The water samples were collected directly from the surface layer in plastic canes as possible avoiding the unpredictable changes. The physico-chemical analysis of samples was done according to the procedure prescribed by APHA (1998) and Adoni (1985).

The fishes were collected mainly by using gill nets of different mesh sizes which varied from 10 to 100 mm with the assistance of local fishermen. Each catch was handled separately and sorted by species. All the specimens were counted and length and weight were taken. A discussion was made with the local fishermen to collect many types of information about fishes available in the reservoir. Immediately photographs were taken prior to preservation for the identification of fishes. The collected specimens were preserved in 5-10% formalin according to the size. Plastic jars were used to collect and preserve the fishes. Smaller fishes were directly placed in the formalin solution, while larger fishes were given an incision on the abdomen before they were fixed. The fishes collected and fixed were labeled by giving serial numbers, exact locality from where collected and the date of the collection. The common local name of fish used in this region was labeled in each jar containing the fish. The fishes were identified in laboratory using taxonomic keys of Jayaram (1981), Jhingran (1991) and Qureshi and Qureshi (1983). The identification of the species was done mainly on the basis of the colour pattern, specific spots or marks on the surface of the body, shape of the body, structure of various fins, mouth shapes etc.

IV. Results and Discussion

In the present ichthyofaunal study, a total of 29 fish species belonging to 10 families, 7 orders and 15 genera were recorded from the Halali Reservoir (Table 2). On the basis of percentage composition and species richness, order Cypriniformes was dominant (18 species) followed by Ophiocephaliformes (4 species), Clupeiformes and Mastacembeliformes (2 species) and Beloniformes, Perciformes and Siluriformes (1 species each). During the present investigation the order of dominance is as follows:

Cypriniformes > Ophiocephaliformes > Clupeiformes = Mastacembeliformes > Beloniformes = Perciformes = Siluriformes.

The ichthyofaunal diversity of Halali Reservoir comprises of 10 families namely, Belonidae, Notopteridae, Cyprinidae, Bagridae, Siluridae, Clariidae Mastacembelidae, Ophiocephalidae, Cichlidae and Heteropneustidae (Table 2 and fig. 2).

The sequence of dominance of encountered families is as follows:

Cyprinidae (41.37%) > Ophiocephalidae (13.79%) > Siluridae (10.34%) > Notopteridae (6.89%) = Bagridae (6.89%) = Mastacembelidae (6.89%) > Cichlidae (3.44%) = Heteropneustidae (3.44%) = Clariidae (3.44%) = Belonidae (3.44%).

The family Cyprinidae was represented by 12 species, *Catla catla, Cirrihinus mrigala, Ctenopharyngdon idella, Labeo rohita, Labeo calbasu, Labeo gonius, Labeo bata, Labeo pangusia, Puntius sarana, Puntius ticto, Oxygaster bacaila* and *Oxygaster gora.* Of these, *Labeo rohita* and *Labeo gonius* were found most abundant.

Table: 2 Ichthyofaunal diversity of Halali Reservoir.

S.No	Order	Family	Species
1	Beloniformes	Belonidae	*Xenentodon cancila*
2	Clupeiformes	Notopteridae	*Notopterus notopterus*
3			*Notopterus chitala*
4	Cypriniformes	Cyprinidae	*Catla catla*
5			*Cirrihinus mrigala*
6			*Ctenopharyngdon idella*
7			*Labeo rohita*
8			*Labeo calbasu*
9			*Labeo gonius*
10			*Labeo bata*
11			*Labeo pangusia*
12			*Puntius sarana*
13			*Puntius ticto*
14			*Oxygaster bacaila*
15			*Oxygaster gora*
16		Bagridae	*Mystus cavasius*
17			*Mystus seenghala*
18		Siluridae	*Ompok pabo*
19			*Ompok bimaculatus*
20			*Ompok pabda*
21		Clariidae	*Clarias batrachus*
22	Mastacembeleformes	Mastacembelidae	*Mastacembelus armatus*
23			*Mastacembelus panculas*
24	Ophiocephaliformes	Ophiocephalidae	*Channa gachua*
25			*Channa marulius*
26			*Channa punctatus*
27			*Channa stratus*
28	Perciformes	Cichlidae	*Oreochromis mossambicus*
29	Siluriformes	Heteropneustidae	*Heteropneuteus fossilis*

The family Notopteridae was represented by 2 species, Notopterus notopterus and Notopterus chitala in which Notopterus notopterus was found most abundant. Notopterus chitala was found very rare.The family Bagridae was represented by 2 species, Mystus cavasius and Mystus seenghala, both of which were found equally abundant.The family Mastacembelidae was represented by 2 species, Mastacembelus armatus and Mastacembelus panculas in which Mastacembelus armatus was found abundant.The family Ophiocephalidae was represented by 4 species, Channa gachua, Channa marulius, Channa punctatus and Channa stratus in which Channa gachua and Channa marulius were found abundant.The family Cichlidae was represented by only 1 species, Oreochromis mossambicus and was found abundant.The family Siluridae was represented 3 species, Ompok bimaculatus, Ompok pabo and Ompok pabda, in which Ompok pabo was found most abundant.The family Heteropneustidae was represented by only1 species, Heteropneuteus fossils and was found rare.The family Clariidae was represented by only 1 species, Clarias batrachus and was found rare. The family Belonidae was represented by only1 species, Xenentodon cancila and was found rare. Shinde et al., (2009) reported a total of 15 species belonging to 3 orders, 4 families and 12 genera in Harsool Savangi Dam Aurangabad (M. S) India. The order Cypriniformes was found dominant with 11 species, followed by Perciformes 3 species and Siluriformes with 1 species. Rankhamb (2011) reported the occurrence of 26 fish species belonging to 5 orders, 7 families and 15 genera in Godavari River at Mudgal. The members of the order Cypriniformes were dominated by 15 species, followed by Siluriformes with 5 species, Channiformes with 4 species and Mastacembeliformes and Perciformes 1 species each.

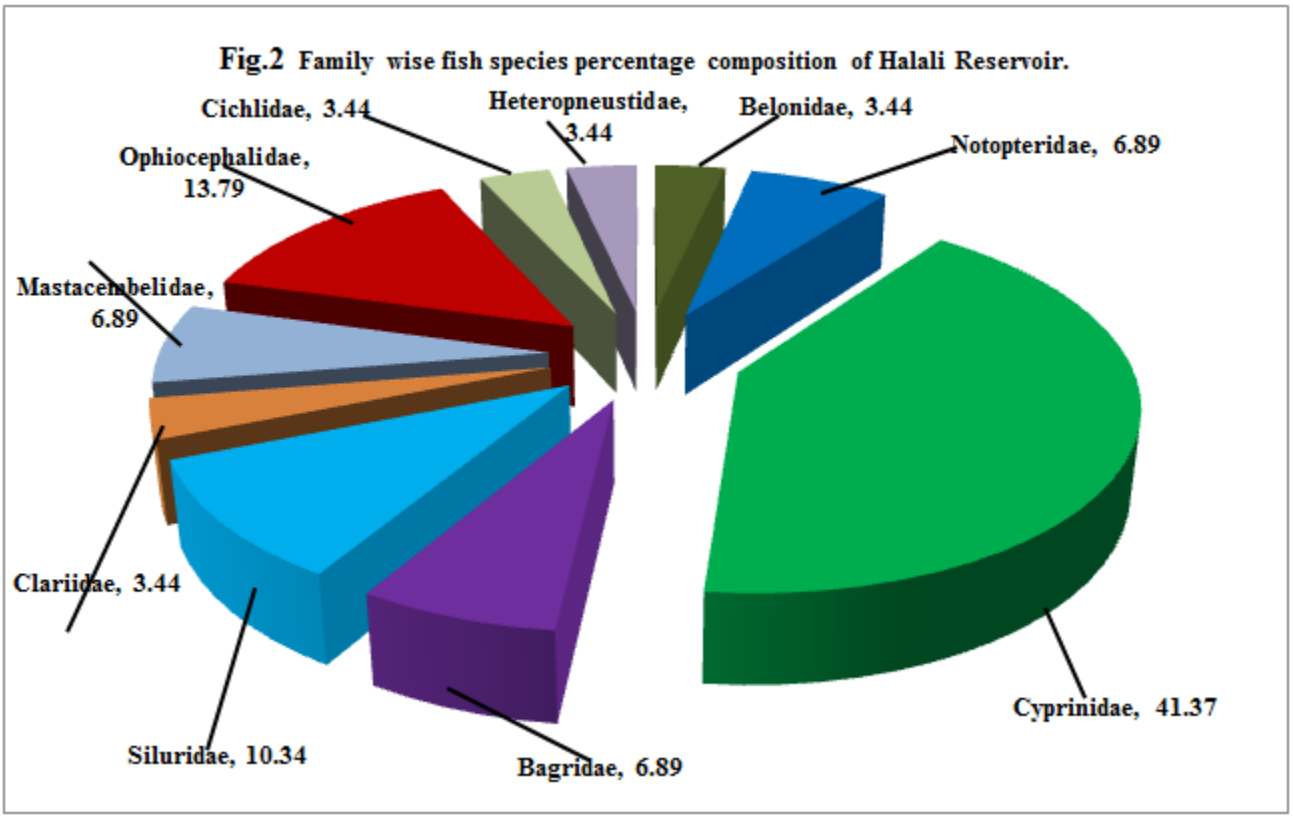

Fig.2 Family wise fish species percentage composition of Halali Reservoir.

Out of 29 fish species found in the Halali Reservoir, 12 species belong to the carp group. The carps, Catla catla, Cirrihinus mrigala, Ctenopharyngdon idella, Labeo rohita have highly commercial as well as economical importance while the other carps, Labeo calbasu, Labeo gonius, Labeo bata, Labeo pangusia, Puntius sarana, Puntius ticto, Oxygaster bacaila and Oxygaster gora are economically important. Arya et al., (2001) has reported 11 carp species and Karamchandani et al., (1967) has reported 10 carp species of economic importance.

Among the catfish group, Mystus cavasius and Mystus seenghala belonging to Bargidae family are of high economic importance while the Ompok bimaculatus, Ompok pabda and Ompok pabo belonging to family Siluridae have moderate economic value. The fishes Clarias batrachus and Heteropneustes fossilis belonging to families Clariidae and Heteropneustidae respectively carry high economic value. Maheshwari (2004) has reported 4 species in the catfish group while Arya et al., (2001) has reported 7 species and Karamchandani et al., (1967) has reported 8 fish species of economic importance.

Among the murrels, Channa marulius bears high economic importance while Channa gachua, Channa puntatus and Channa stratus have moderate economic importance. Among the family Mastacembelidae, Mastacembelus armatus bears high economic importance while Mastacembelus panculas has little economic importance. Among the family Notoperidae, Notopterus notopterus has high economic importance while Notopterus chitala bears moderate economic importance. The families Belonidae and Cichlidae representing Xenentodon cancila and Oreochromis mossambicus respectively have practically little economic importance. Arya et al., (2001) and Maheshwari (2004) has reported 4 species while Karamchandani et al., (1967) has reported 5 fish species of economic importance.

V. Physico-chemical Parameters

Physico-chemical analysis is the prime consideration to assess the quality of water for its best utilization like drinking, irrigation and fisheries and is helpful in understanding the complex processes, interaction between the climatic and biological processes in water. Marshal (1984) used physico-chemical data to predict ecology and fish yield in reservoirs. The range of variations in different parameters are as:

Air temperature	:	24^oC - 37^oC
water temperature	:	21^oC - 28^oC
TDS	:	120 – 150 ppm
Conductivity	:	245 – 280 µs/cm
pH	:	7.1 – 9
Free CO_2	:	nil - 8.4 mg/l
Dissolved Oxygen	:	6 – 9.8 mg/l
Phenolp. Alkalinity	:	nil – 40.02 mg/l
Total alkalinity	:	56 – 236 mg/l
Total hardness	:	50 – 120 mg/l
Chloride	:	57.99 – 96.99 mg/l
Orthophosphate	:	0.122 – 1.06 mg/l
Nitrate	:	0.16 – 1.12 mg/l.

During the present study the air temperature ranged from 24^oC to 37^oC. Sandwar and Tiwari (2006) reported air temperature ranges between 22^oC to 37.5^oC in Ganga River in North Bihar (Barauni Mokamah).

During the present study water temperature ranged from 21^oC to 28^oC. Das *et al.,* (2008) reported a range for water

temperature between 19.7°C to 29.5°C in Halali Reservoir. The variation in water temperature may be due to different timing of collection and influence of season (Jayaraman *et al.,* 2003).

TDS is an important physical factor which determines the solubility of drinking water. During the present study the values of TDS ranged between 120 – 150 ppm. Zacharia *et al.,* (2006) recorded a TDS value of 3 to 114 ppm while working on the physico-chemical parameters of seawater of Mangalore. Increasing value of TDS indicates pollution by extraneous resources (Aboo and Shastry, 1968).

Conductivity is an important parameter to assess water quality as it forms a measure of TDS. Conductivity is related to ionized substances present in solution. Any decrease or increase in concentration of substances will be reflected in corresponding increase or decrease in conductivity. According to Ellis (1937) the conductivity of the inland water should range between 150 to 450 µs/cm to flourish flora and fauna in waters. During the present study the values of Conductivity ranged between 245 to 280 µS/cm. Similar observations were reported by Das *et al.,* (2008).

pH (Hydrogen Ion Concentration) indicates acidity or alkalinity of water and plays a significant role in productivity of a water body. Water of Halali Reservoir was found alkaline in nature and range of pH varied from 7.1 to 9. Higher values of pH were recorded during summer months. This may be due to increased photosynthetic activity and decomposition of allochthonous matter present in the reservoir which increase the nutrient concentration at higher temperature. Input of sewage and agricultural waste are also responsible for higher values of pH in water. Similar observations were reported by Singh and Mahajan (1987), Tamot and Bhatnagar (1989). pH range from 6.4 to 8.3 is favourable for fish growth (Robert, 1940).

Free Carbon dioxide is the source of carbon that can be assimilated and incorporated into living matter of all the aquatic autotrophs. Free CO_2 is directly proportional to bicarbonates and inversely to carbonates. Availability of free carbon dioxide in natural surface water depends on temperature, pH, and amount of dissolved organic matter. During the present study the range of Free Carbon dioxide varied from nil to 8.4 mg/l. Presence or absence of free carbon dioxide in the surface water is mostly governed by algae during photosynthesis and also through its diffusion from air. Higher value of free carbon dioxide was noted in the month of April. This may be due to high rate of organic decomposition at higher temperatures. Praveen *et al.,* (2008) reported the Free CO_2 ranges between nil to 8mg/l in the Halali Reservoir.

Dissolved Oxygen in water is of great importance to all aquatic organisms and is considered to be the lone factor which to a great extent can reveal the nature of whole aquatic system. It is important in the production and support of life. It is also necessary for the decomposition and decaying of organic matter. This parameter can be used as an index for net production (Heyman, 1983). In the present study its range varied from 6 to 9.8mg/l. Praveen *et al.,* (2008) reported the D.O. values between 6.0 to 9.2mg/l in the Halali Reservoir. Higher values of dissolved oxygen were recorded during raining season due to churning of water by heavy wind action and mixing of monsoon rains (Tamot and Bhatnagar, 1989), Hannan *et al.,* (1978). Dissolved Oxygen has been attributed a great significance as an indicator of water quality especially the magnitude of eutrophication. Dissolved Oxygen concentration in water depends mainly upon temperature, dissolved salts, velocity of wind, pollution load, photosynthetic activity, and respiration rate Tamot *et al.,* (1990), Zutshi *et al.,* (1990).

The phenolphthalein alkalinity is the alkalinity due to hydroxides and carbonates (Adoni *et al.,* 1985). In the present investigation the value of phenolphthalein alkalinity ranged from nil to 40.02 mg/l. Unni (1992) recorded the range of phenolphthalein alkalinity between nil to 28 mg/l in the whole stretch of Narmada River.

The total alkalinity is the sum total of carbonates and bicarbonates alkalinity. Bicarbonates are mainly responsible for variation of total alkalinity concentration. Total alkalinity may be used as a tool for the measurement of productivity, conditions of water bodies. In the present investigation its range varied from 56 to 236 mg/l. Mandotiya *et al.,* (2004) reported total alkalinity values from 102 to 215 mg/l in Ramgarh Lake and indicating that the water is hard. On the basis of alkalinity values, water of Halali Reservoir can be considered as nutrient rich water.

The hardness of water is mainly governed by the content of Calcium and Magnesium salts, largely combined with bicarbonates and carbonates (temporary hardness) with sulphates, chlorides and other anions of minerals (permanent hardness). In the present study, its range varied from 50 to 120 mg/l. On the basis of hardness values, water of Halali Reservoir can be considered under moderately hard category (Taylor, 1949). Praveen *et al.,* (2008) reported total hardness range between 80 to 150 mg/l in the Halali Reservoir.

Chlorides occur naturally in all types of water. In natural fresh waters, however, their concentration remains quite low and generally less than that of sulphate and bicarbonate. High concentration of Chloride in water is considered to be the indicator of pollution especially due to higher organic waste of animal origin or industrial effluents. Higher Chloride content is due to contamination through large quantity of sewage input. Chloride values in Halali Reservoir varied from 57.99 to 96.99 mg/l. Halali Reservoir also receives domestic sewage from Bhopal City, which is also responsible for higher concentration of Chloride in water. Shukla *et al.,* (1989) reported Chloride ranges between 12.0 to 85.9 mg/l at Varanasi. Higher concentration of Chloride in water is an indicator of eutrophy (Kausik *et al.,* 1992).

Phosphate is considered as a chemical nutrient regulating the plant production in aquatic environments. In natural waters phosphate is utilized by the algae as it enters through surface runoff. Phosphate is also pointed out as an indicator of aquatic pollution by organic matter and phosphate is the principal causative agent for the eutrophication of water bodies and consequential degradation. During the present study the values of Phosphate ranged between 0.122 to 1.06 mg/l. Shukla *et al.,* (1989) reported phosphate values between 0.003 to1.27 mg/l in River Ganga at the polluted stretches.

In the present investigation the Nitrate values ranged from 0.16 to 1.12 mg/l. Shukla (1996) reported nitrate value ranged between 0.22 to 1.6 mg/l in Upper Lake, Bhopal. As in Halali Reservoir the higher values of Nitrate were observed in Feberuary and June. This may be due to the high decomposition of organic matter and concentration of nutrients owing to the

evapotranspiration of the reservoir water with subsequent increase in Nitrate values.

VI. Conclusion

During the present investigation, it was concluded that the maximum water parameters were not at the level of pollution. On the whole taking into account, Halali Reservoir is a tropical water body on the basis of temperature ranges. Water of Halali Reservoir is alkaline and is favourable for fish culture and other aquatic biota. On the basis of alkalinity and hardness values, water of Halali Reservoir can be considered as nutrient rich water and can be placed under moderately hard category. The nitrate values indicated that the water body is suitable for fish culture and irrigation. But it can be used for drinking purposes only after conventional treatment followed by disinfection.

In the present investigation, it was concluded that the Halali Reservoir is a healthy water body providing a habitat for fresh water fishes of diverse type. However, there is constant threat to fish population due to eutrophication and illegal fishing activities. The illegal fishing activities should be banned to prevent depletion of fresh water fish resources and further studies should be conducted to generate more details regarding seasonal production and ecology of fishes. In the light of present study of Halali Reservoir, it is time to make proper policies and take necessary steps to implement so that the future generation can get the fishes lively on earth rather than photographs in literature.

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