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DAM IMPACT ON WATER QUALITY AND MORPHOMETRIC CHARACTERISTIC OF SCHIZOTHORAX SPECIES IN BHAGIRATHI RIVER OF UTTARKASHI, UTTARAKHAND

Poonam Tiwari[1] and **Mahidhar Prasad Tiwari**[2]
[1]Assistant Professor**,** Department of Zoology ,[2]Assistant Professor, Department of Chemistry
R.C.U. Government Post Graduate College, Uttarkashi, Uttarakhand, India
Email: mptiwari90@gmail.com

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Abstract: *A study was conducted on the morphometric characteristics of Schizothorax species of fish on samples collected from Bhagirathi river in Uttarkashi district of Uttarakhand state. Samples were taken from the study sites to measure some important parameters of water quality, which greatly influenced the morphological characteristics of the fish. Morphometric features such as total length, pectoral, pelvic, anal, dorsal, head, caudal length of eyes, caudal width and weight were recorded. Significant effects of dam on fish are observed on the morpho-metric of Schizothorax sp. There was no change in the characters but the wall of the dam put the selection pressure. The maximum length, weight of fish was observed in the study area during winter season and minimum during rainy season. The maximum length and weight were found before the dam. Changes in habitat, physico-chemical parameters, less aquatic macro-invertebrates lead to shorter lengths of fishes. Proper management techniques should be required for the production of fish. This paper will provide knowledge of the impact of dam on the morphometric character of fish along with parameters of water quality. It also gives in-depth knowledge of proper management of river fisheries.*

Keywords: Morphometric Characters, Fluctuations of Water Level, Fish *Schizothorex* Spp., Population of Fishes

Introduction

The rivers of Garhwal in North India have a rich aquatic diversity. The endemic fish is a species of Schizothorax. A total of 68 species in its subfamily have also been found in worldwide(Chen 2006). Snow trout is an important cold-water fish distributed along the Himalayas in India, Pakistan, Bhutan, Nepal and Bangladesh . In India, snow trout species are found in the very cold waters of Jammu and Kashmir (Sundar and Bhagat 1979) and in the eastern Himalayas at an altitude of approximate 1180–3000 m above sea level (lunar set) of Bhutan and Sikkim(Huh. al., 2012). Anthropogenic activity especially several hydro-electric projects in the area and the introduction of exotic species into Uttarakhand can have an alarmingly adverse effect on the population of this species (Thapliyal 2013). Fish is the means of rural livelihood of the Uttarkashi .People go to the morning and evening and catch the fish using the net and other technique and sell it in the market. During sampling, it has been observed that the fishes in the areas after the dam wall are less in length and weight than before the dam. Fish of maximum length and weight are found in winter and minimum in rainy season. Changes in water quality parameters lead to changes in fish morphology. The dam affects the natural flow and can divert a river whose main channel of the river has a below normal flow. The temperature and the physico-chemical properties of the water changes with the construction of dam in the Bhagirathi river, and due to this, the native habitat of micro-organisms and flora ends. Sometimes, when multiple dams are built on tributaries of a river ecosystem, the cumulative effect of these dams has been observed to block the flow of nutrients originating from the lower reaches of the ecosystem to the catchment basin.

In addition geomorphologic conditions environmental parameters such as water velocity, depth, Substrate diversity and water temperature also Influence the structural and function morphology of fish .Damming sets a blockage to fish movement, upstream or downstream. In passing through the turbines, spillways or in the diversion, fishes are subjected to injury by physical contact, pressure change, shear force or eddies (Naidu. 1993). It may change the flow downstream by making it more irregular. The nature of the river bottom will change, the water quality may change too (Moss 1998,).The water temperature of Bhagirathi gradually increase from January to April . Air temperature depends on geographic location. Part of limiting distribution is based on tolerance limits. Temperature has an effect on metabolic rate in all organisms.

Morphometrics is a statistical module for analyzing fish size and it is an important part of information to understand the science of selected fish. In general, the size of the fish is usually more important biologically than the age of the fish because of its physiological significance. The factors are more size-dependent than age-dependent. The growth of fish body parts is related to the growth of its total length, so it is more important to analyze the statistical relationships between them for taxonomic studies of fish. Morphometric analysis is the easiest and most true method for the identification of samples. The connection between different part of body can also be used to evaluate the well-being of individuals in an ecosystem and also helps to distinguish between unit stocks of the same species (King, 2007). Fish show greater variation in morphological traits within populations than other vertebrates and are more influenced by the environment (Wimberger 1992). The Schizothorax species of snow trout is native to Central Asia. It is an endemic species of Himalayan region. The common fish of Uttrakashi in Bhagirathi river is snow trout cold-water species ,commonly known as "acella". It is elongated, slender-headed ,streamlined and sub-cylindrical in shape and has a wide distribution in the Indian Himalayas rivers. This sp. usually prefers to live in rivers or streams that covered with snow . It feeds mainly on periphyton, algae and plants. It is a migratory species and migrates up and down during the summer and winter seasons respectively. It is caught by the fishermen here from the river, they sell in Uttarkashi market, they more earn in winter seasons . It is economically important food fish in the cold-water region.

2172 species of fishes are threatened with extinction according to 2012, International union for conservation of nature List (Vishwanath 2018).In most cases, damming in rivers changes the biodiversity of fish, usually leading to a decline in the number of fish species. Species of long-distance migrating species have declined in species stocks, while those that prefer slow-moving water have increased in stock. Submerged trees increase the food supply for fish, trees complicate fishing and reduce fishing efficiency. Decay of submerged vegetation leads to deoxidation and acidification, which can lead to widespread death of native ravine populations in the lower layers of the water. An increase in minimal flow and less fluctuation in discharge can increase the diversity of fish, especially in riverine species (Travnichek 1995). Rudd had examined the downstream ecological impact after the dam in 2005. The effect of the changed amount of water and its timing leads to several effects such as (a). Less passage of alluvial mother, especially suspended sediments (Williams. and Wolman 1984; Rood and Mahoney 1990; Ligon F., 1995; Kondolph 1997; Magilligan 2003) and (b). fragmentation of river corridor& creation of barrier between upstream & downstream passage (Ward.& Stanford 1995a, 199b;). Various aspect of impact of dam on river flow has been studies only in respects of some river. Khanna 2013 and Mittra, 2013, have been studied fish diversity and their limnological status in river Ganges with study site in the region of Rishikesh and Haridwar. Occasionally, fishes can become concentrated after dam wall due to the attractive foraging opportunities there as well as due to seasonal grouping of migratory fishes.(Adeyemo O. *et al.,*2008).

Objectives

1. Study of morphometric characteristics of fish of Schizothorax spp.
2. Monitoring the changes in some water quality parameters.
3. Impact on fish morphometric by hydroelectric project.

Study Area

Our first study site was at Maneri near hydro project I. This study site is located 15 km from Uttarkashi. At this location, two sites were selected – one - before reservoir wall and, another - after reservoir wall. Second site was at Joshiyara, near the hydro-electric power project II. At this location, two sites were also selected – one - before reservoir wall and, another - after reservoir wall.

Figure 01: Maneri Site

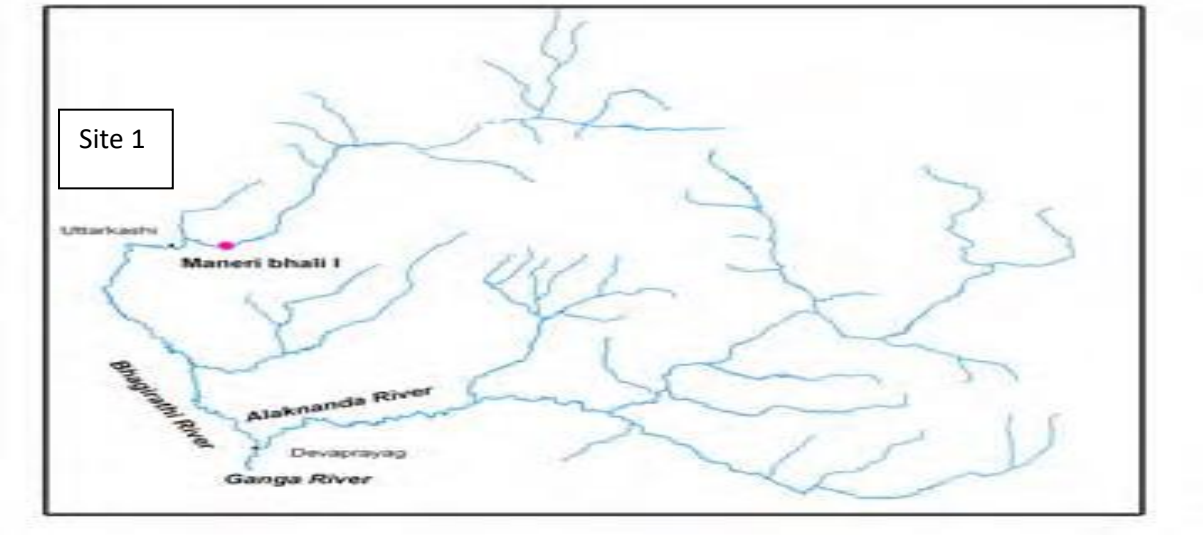
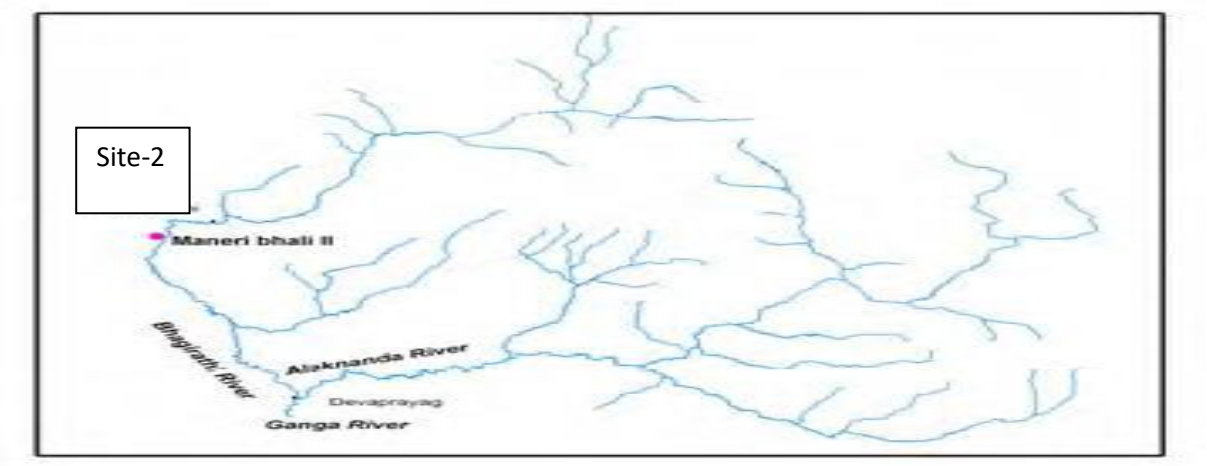


Figure 02: Joshiyara Site



Geology of the Study Area

The land in this study area is mainly covered by agricultural fallow lands, clear lands, scrub land, grazing land, deciduous forest, scrub forest water bodies (mainly river and reservoir) and settlement. The study area has different type of rock formations, *.e.,* white and cream coloured quartzite grading into talc-chlorite schist's along the thrust and migmatites, augen gneisses, garnetiferous mica-schist's and amphibolite's (Naithani and Rawat, 1991). The quartzite rock is inter-bedded with silts, metal-volcanoes and gases interactive (Reports of multipurpose and hydro-electric project organization, Irrigation Department Dehradun, Uttaranchal, 1985).The terrain and climate of Uttarkashi district provide uncongenial physical environment for human settlement. Yet undaunted by hazards and hardships this land was inhabited by hill tribes since ancient times bringing out the best in man his adaptive talents.

Materials and Methods

Collection of Samples:

The estimation of physico–chemical parameter was done at all the four study sites. Monthly sampling was done for obtaining data on physico-chemical environment of the sites before and after dam wall of Maneri and Joshiyara. Standard methods as outlined by Trivedi and Goel (1986), APHA (1995) and Dutta Munshi (1985) Welch(1952) were followed . Air and water temperature are taken one time and other's physico-chemical parameter taken three times.

- Physical Characteristics - The physical characteristic included temperature, conductivity, turbidity, total dissolve solids (TDS).
- Chemical Characteristics - The chemical characteristic included pH, dissolved oxygen(DO), biological oxygen demand (BOD).
- Fish sampling - Sampling of fishes were done in the Bhagirathi river of detach month for one year 2019-2020.Two sites were selected in Maneri and two another sites in Joshiyara for fish sampling, a stretch of approximately 600 to 700 meters after dam wall (with maximum variation in water level) and almost and a similar stretch about 600-700meters upstream before dam wall of both study area (Maneri and Joshiyara dam). Hired fisherman used nets for capturing the fish and the sampling was validated using the 3-pass technique where the population of the enclose area should decrease after each sampling. Scoop net were also used for the fish collection.

After each pass, fishes were counted and the data was tabulate in terms of length, weight, their morpho-metrics, species identification etc. (Zipping 1958). Same technique was used in all the sites. The fishes captured at each site were marked by a fin clipping so that these could be identified in other catches. Sampling was skipped during monsoon and peak summer months due to the tremendous increase in water volume. (so fish sampling data

should be omitted). During these months cast net was used to capture fishes from specific sites before and after dams.

Morphometric Measurements

Identification was done at species level that followed by Talwarand Jhingran (1991), Srivastava(1980) and Sunder,(1999). Fishes were counted and morphometric characteristics such total length (cm), total weight (gm), pectoral length (cm), pelvic length, anal length, caudal length, caudal width and head length (cm) eye diameter(mm) were measured for size class estimation. All fish caught in the net were released back into the water immediately after taking these measurements. Fish samples were kept in 10% formalin solution for identifications.

Result and Discussion

The site before the dam wall at Maneri site recorded a maximum depth temperature of 16^0C in the month of August 2019 and a minimum of 5^0C in the month of January, 2020. (Table 1,). At Maneri Site II, after dam wall, the maximum temperature in the month of July 2020 was 18^0C and minimum 7^0C in the month of January 2020. The temperature is one of the important physical factors, which affect the chemical & biological reaction in. The depth temperature at Joshiyara Site I (before dam) is maximum 16^0C in the month of July and minimum 5^0C in the month of January. After the dam wall at Joshiara site II, the depth temperature was maximum 16^0C in the month of July and minimum 8^0C in the month of February(table 1). From the study of Maneri site I,II and Joshiyara site I,II sites, a slight reduction in water temperature at S_2 was noticed it may be due to mixing of Muck in the water and removal of riparian vegetation (NTPC 2011).

The maximum turbidity before the dam wall at Maneri Site I was recorded at 160.3 ± 0.3 in the month of August, 2019 and the minimum at 0.9 ± 0.02 in the month of February in 2020 (Table 1,),and at Maneri Site II, after the dam wall, Turbidity maximum 162.7 ± 0.3 in the month of August 2019 and minimum 1.7 ± 0.09 in the month of February 2020 were found. The turbidity maximum at Joshiyara Site I (before the dam) was 115.5 ± 0.3 in the month of July and the minimum was found to be 0.9 ± 0.06 in the month of January. After the dam wall at Joshiara Site II, the turbidity was maximum 152±0.6 in the month of August and minimum of 1.3±0.03 in the month of November. The increase in turbidity during the monsoon is mainly influenced by silt sand soils and a variety of organic and inorganic materials that are washed away during heavy rainfall in the catchment area due to increased turbidity (Schmitz, 1961). The conductivity at Maneri Site I before the dam was found to be maximum 140.3 ± 0.3 in the month of April 2020 and minimum 83.3 ± 0.3 in the month of Aug-2019. At Maneri Site II, after the dam wall, the conductivity was maximum 148±.05 in the month of May 2020 and minimum 85.2±0.03 in the month of August 2019. The conductivity maximum at Joshiyara Site I (before the dam) was 134±0.6 in Feb. and the minimum in the month of August. After the dam wall at Joshiyara Site II, the conductivity maximum was found to be 136.5±0.1 in the month of October and the minimum of 101.7±0.5 in the month of August. Useful which was affected by anthropogenic disturbances (dam construction activities). In both the study areas, the conductivity of the dams was found to be higher than after the dam (Bhatt, 2011).

The TDS before dam wall at Maneri Bhali Site I was maximum 84.2 ± 0.1 in the month of February, 2020 and minimum 60.1 ± 0.1 in the month of August, 2019. At Maneri Site II, after the dam wall, the TDS maximum was 87.1 ± 0.06 in the month of March 2020 and the minimum was 65.2 ± 0.23 in the month of July 2020. The maximum TDS was found to be 85.1 ± 0.49 at Joshiyara site I (before dam) in Jan. and the minimum was found to be 59.8 ± 0.6 in the month of August. After the dam wall at Joshiyara site II, The maximum TDS was 86.2 ± 0.15 in the month of Feb. And the minimum was found to be 61.4±0.3 in the month of August. All sampling sites recorded high total dissolved solids values in winter and low in summer

(Poonam, 2019). TDS in both the study areas was found to be slightly higher at the dam than before the dam. The maximum DO record at Maneri Bhali site I before the dam wall was 13.2 ± 0.2 in the month of January in 2020 and minimum 9.5 ± 01.1 in the month of July, 2020. At Maneri Site II after the dam wall, the DO maximum was 9.47±0.05 in the month of July 2020 and the minimum was 8.1±0.05 in the month of January 2020. DO at Joshiara Site I (before dam) was 14.07±0.2 in the month of January and minimum at 8.4±0.06 in the month of April. After the dam wall at Joshiara Site II, the DO maximum in the month of January was 12.08±0.2 and minimum 8.5±0.05 was obtained in the month of December. It is one of the important parameters in the assessment of water quality and reflects the physical and biological processes in water. The value of dissolved O2 ranged from 8.2 to 14.6 mg/l. In summer, Do levels were very low in April and July. This is due to the low solubility of gases at high temperatures (Hynes 1978). The increase in DO during winter i.e. in the months of January may be due to the high solubility of O2 at low temperature (Verma 1984). In Maneri and Joshiyara's study, DO was found to be higher in S1 than in S2. Aquatic organism is effected by pH because most of their metabolic activities are pH dependent. The pH at Maneri site I was maximum 7.8±0.06 in the month of aug.2019 and minimum 7.0±0.12.1in the month of Jan. 2020 (Table 1,). At Maneri Site II, after dam wall, pH was maximum 7.9±0.03in the month of aug.2019 and minimum 7.2±0.06 in the month of dec. 2019. At Joshiyara site I (before dam) the pH was maximum 7.7±0.03in the month of sept. and minimum 7.1±0.09 in the month of Jan. After dam wall in Joshi Yara site II ,pH was maximum 7.9±0.09 in the month of July. and minimum 7.3±0.0 in the month of fib. In table I. In the present study of pH on the study sites was between 7.0 to 7.9 and pH increased during summer months and decrease during monsoon and winter maximum values during summer may be due to increase photosynthesis of the algal blooms resulting into precipitation of carbonates of calcium and magnesium from bicarbonate causing in pH during winter may be due to decrease in photosynthesis while during monsoon it may be due to greater in flow of water. pH was found slightly greater than before the dams compared after dam.

The BOD at Maneri Site I was maximum 4.1±0.06 in the month of aug.2019 and minimum 0.5±0.12.1in the month of Jan. 2020 (Table 1,). At Maneri Site II, after dam wall, BOD was maximum 4.5±0.12 in the month of aug.2019 and minimum 0.81±0.01 in the month of dec. 2019. At Joshiyara site I (before dam) the BOD was maximum 4.63±0.09 in the month of Aug. and minimum 0.54±0.01in the month of Jan. After dam wall in Joshi Yara site II ,BOD is maximum 4.83±0.07 in the month of Aug. and minimum 0.6±0.06 in the month of Jan.in table 1.The values of BOD clearly showed higher concentration during Monsoon respectively. BOD showed higher value during monsoon and comparatively low during winter respectively at Bhagirathi river (Sati. (2011). The BOD was observed higher after the dam .Same study was observed NTPC report 2011 upstream and downstream.

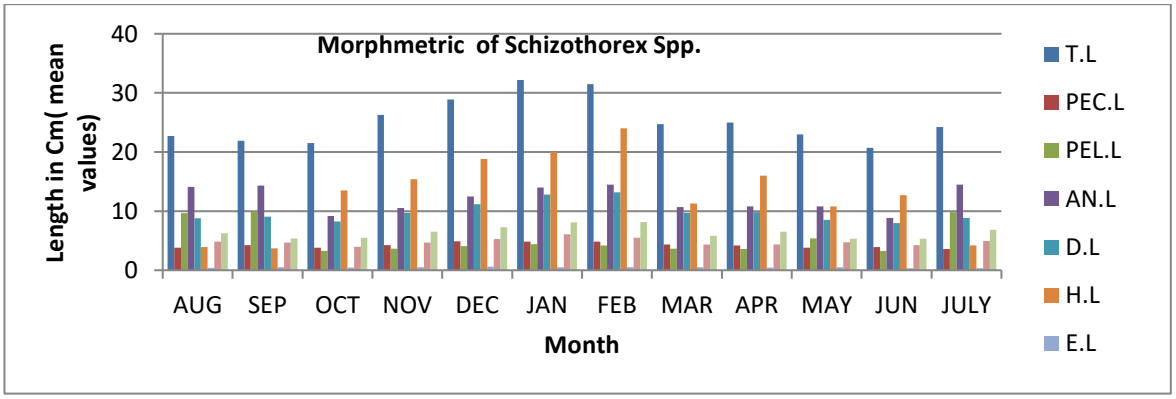
Length Dependent Summary of Data on *Schizothorax. sp.*

The length of Schizothorax spp. fish with a maximum mean value of 32.2 ± 4.79 (cm.) in the month of January and a minimum mean length of 20.7 ± 3.56 (cm.) was observed in the month of June and a maximum weight of 325 ± 109 (kg.) at the site of Maneri. I (before the reservoir) was observed in the month of February. The minimum weight mean value was 96.7 ± 26.1 (kg) in the month of July. Whereas in Site II of Maneri (post-reservoir), the maximum length of fish was found to be 30.33 ± 6.34 (cm) in the month of January and the minimum length average value was 20. 17 ± 3.01 in the month of July and the maximum weight average value 317 ± 137 was in the month of February and the minimum weight mean value was 87.7 ± 28.8 in the month of August (2019-20) in the graph No.-1, 2 and Table No. 2. The maximum length of fish *Schizothorex* Spp. was observed mean value 31.5 ± 4.54(cm.) in the month of December and minimum length mean value 19.6 ± 11.33 (cm) in the month of August, and maximum weight mean value 317±150(Kg.) was observed in the month of January and minimum

weight mean value 50 ± 28.9(kg.) was in the month of August at site I (before dam) of Joshiyara. While in the site II (after Reservoir)of Joshiyara, the maximum length of fish *Schizothorex* spp. was found mean value 26.5± 15.32 (cm) in January and minimum length mean value 21 ±3.26 was in the month of September and maximum weight was observed mean value 202 ± 64.7 in February and minimum weight mean value 59 ± 22 was in the month of August. (2019-20) graph no.3, 4 and tableno.2.

The variation in populations of fish of different sizes is almost the same for all size groups. The only part affected by the hydroelectric project is the number of these individuals. Many freshwater fish species are currently threatened by the direct and indirect effects of human activities, such as habitat destruction and fragmentation (Meir, 2013). The construction of dams on rivers specifically affects fish activities, which can restrict gene flow and lead to population differentiation (Meldgaard, 2003). Various factors such as food availability, salinity or temperature can affect fish morphology and result in the splitting of fish populations (Palma Andrade 2002). Variation in morphometric and meristematic character may range from interspecific variability to the influence of environmental parameters (Hub. 1921)., Vladikov 1934). Long effect on fish morphometric of Schizothorax spp. before and after Bhagirathi river reservoir at Maneri reservoir. The maximum length and weight were found in the winter season and the lowest in the rainy season. Maximum length and weight were found before the reservoir while a similar study was found in the comparison after the reservoir (Scouton 1998). Several studies suggest that many morphological traits in fish are influenced by the physico-chemical environment where they live (Balan 1986, Bourke 1997). Other studies suggest that water conductivity is an important factor in promoting good fish body condition in rivers (Dennis 1995).

Graph 01: Monthly recorded of Morphmetric of fish *Schizothorex* Spp. of Maneri site I (before reservoir) at Bhagirathi river (20019-2020)



Graph 02: Monthly recorded of Morph metric of Fish *Schizothorex* Spp. of Maneri site II (after reservoir) at Bhagirathi river (20019-20)

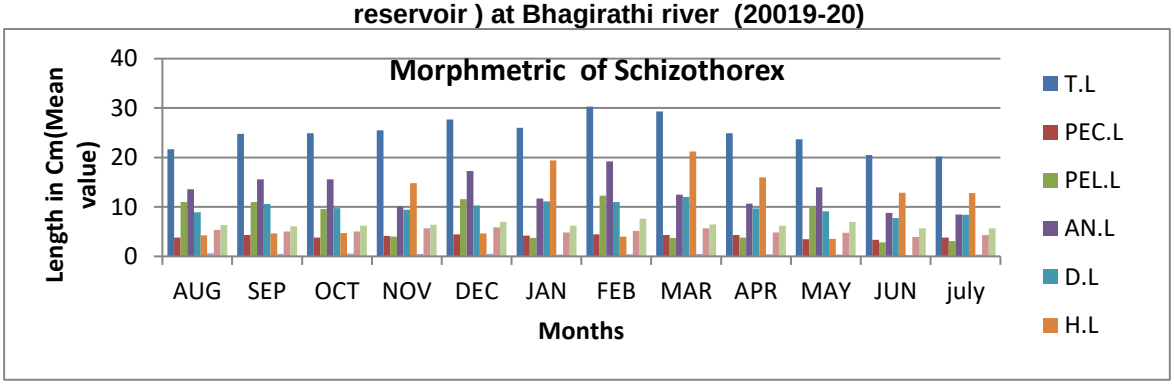


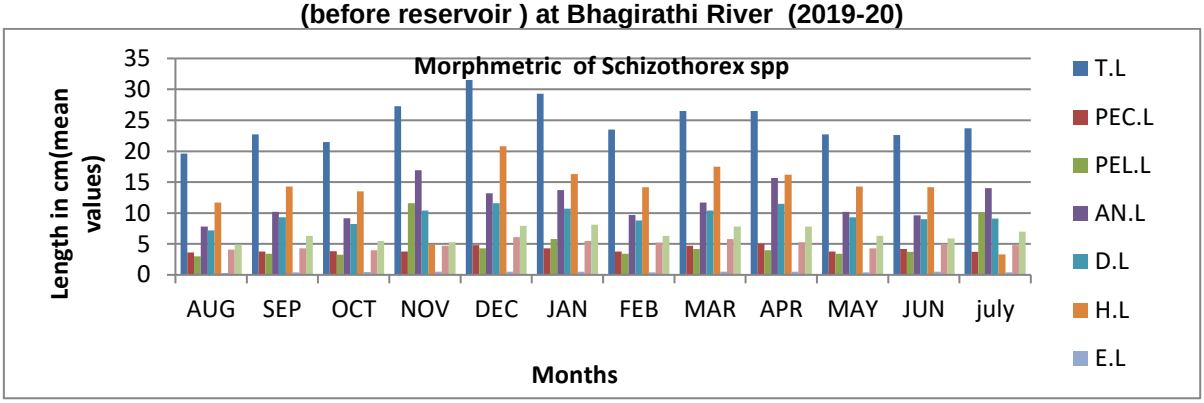
Table 01: Maximum and Minimum Value of Physico-Chemical Parameters of Maneri, Site I, Site II and Joshiyara Site I, Site II (Before and after the Reservoir) of Bhagirathi River in the Year 2019-20

	Maneri Site I				Maneri Site II				Joshiyara Site I				Joshiyara Site II			
Param.	Maximum Value in Month		Minimum Value in Month		Maximum Value in Month		Minimum Value in Month		Maximum Value in Month		Minimum Value in Month		Maximum Value in Month	Minimum Value in Month		
Water Tem.	16 ±0.00	Aug	5.0 ±0.0	Jan	18 ±0.00	Aug.	7.0 ±0.0	Jan	16 ±0.0	July	5 ±0.00	Jan	16 ±0.00	July	8.0 ±0.00	Feb
Turbi-dity	160.3 ±0.3	Aug	0.9 ±0.02	Feb	162.7 ±0.3	Aug.	1.7 ±0.09	Feb	115.5 ±0.3	July	0.9 ±0.06	Jan	152 ±0.6	Aug	1.3 ±0.03	Nov
Cond.	140.3 ±0.3	April	83.3 ±0.3	Aug.	148 ±.05	May	85.2 ±0.03	Aug	134 ±0.6	Feb	99.1 ± 0.5	Aug.	136.5 ±0.1	Oct.	101 ±0.5	Aug
TDS	84.2 ±0.1	Feb	60.1 ±0.1	Aug.	87.1 ±0.06	March	65.2 ±0.23	July	85.1 ±0.49	Jan	59.8 ±0.6	Aug.	86.2 ±0.15	Feb	61.4 ±0.3	Aug
DO	13.2 ±0.2	Jan	9.5 ± 0.1	July	9.47 ±0.05	July	8.1 ±0.05	Jan	14.07 ±0.2	Jan	8.4 ±0.06	April	12.08 ±0.2	Jan	8.5 ±0.05	Dec
pH	7.8 ±0.06	Aug	7.0 ±0.12	Jan.	7.9 ±0.03	Aug.	7.2 ±0.06	Dec.	7.7 ±0.03	Sep	7.1 ±0.09	Jan	7.9 ±0.09	July	7.3 ±0.0	Feb.
BOD	4.1 ±0.06	Aug.	0.5 ±0.12	Jan.	4.5 ±0.12	Aug.	0.81 ±0.01	Dec.	4.63 ±0.09	Aug	0.54 ±0.01	Jan	4.83 ±0.07	Aug	0.6 ±0.06	Jan

Table 02: Length and Weight data of *Schizothorex* Spp. of Maneri site I, II and Joshiyara site I, II (Before and after Reservoir wall) at Bhagirathi River (20019-20)

Month	**Maneri Site I (before the Reservoir wall)**		**Maneri Site II (After the reservoir wall)**		**Josiyara Site I (before the reservoir wall)**		**Joshiyara Site II (After the reservoir wall)**	
	Length	**Weight**	**Length**	**Weight**	**Length**	**Weight**	**Length**	**Weight**
Aug.	22.7±1.25	102±28	21.7±1.65	87.7±28.8	19.6±11.33	50±28.9	21.1±3.34	59±22
Sep.	21.9±1.6	113±43.9	24.8±3.6	102±49.9	22.7±2.74	125±46.5	21±3.26	98.3±34.5
Oct.	21.5±2.93	133±44.2	24.9±3.62	119±44.4	21.5±2.93	133±44.2	21.3±2.13	127±37.2
Nov.	26.3±4.26	200±66.2	25.5±2.02	173±39.4	27.3±1.8	300±28.9	23.7±2.62	147±49.2
Dec.	28.9±4.46	234±91.9	27.7±2.46	207±57.9	31.5±4.54	217±59.5	25.7±5.24	158±109
Jan.	32.2±4.79	303±113	26±4.05	202±64.7	29.3±5.7	317±150	26.5±15.3	193±111.73
Feb.	31.5±2.6	325±109	30.3±6.34	317±137	23.5±3.41	200±63	26±4.05	202±64.7
Mar.	24.7±3.18	193±81	29.3±1.09	267±16.7	26.5±0.76	200±28.9	26.5±3.26	167±33.9
April	25±1.45	162±31.7	24.9±1.02	125±14.5	26.5±15.32	193±111.73	24.8±1.3	170±20.6
May	23±2.39	117±44.2	23.7±1.74	117±16.7	22.7±2.78	125±46.5	22.7±2.19	122±35
June	20.7±3.56	100±51.4	20.5±3.61	127±61.8	22.6±1.69	118±43.4	25.7±0.88	150±5.78
July	24.2±2.09	96.7±26.1	20.2±3.01	93.3±48.5	23.7±1.74	117±16.7	23.3±1.77	113±31.8

Graph 03: Monthly recorded of Morph metric of fish *Schizothorex* Spp. of Joshiyara site I (before reservoir) at Bhagirathi River (2019-20)



Graph 04: Monthly recorded of Morph metric of fish *Schizothorex* Spp. of Joshiyara site II (After reservoir) at Bhagirathi river (2019-20).

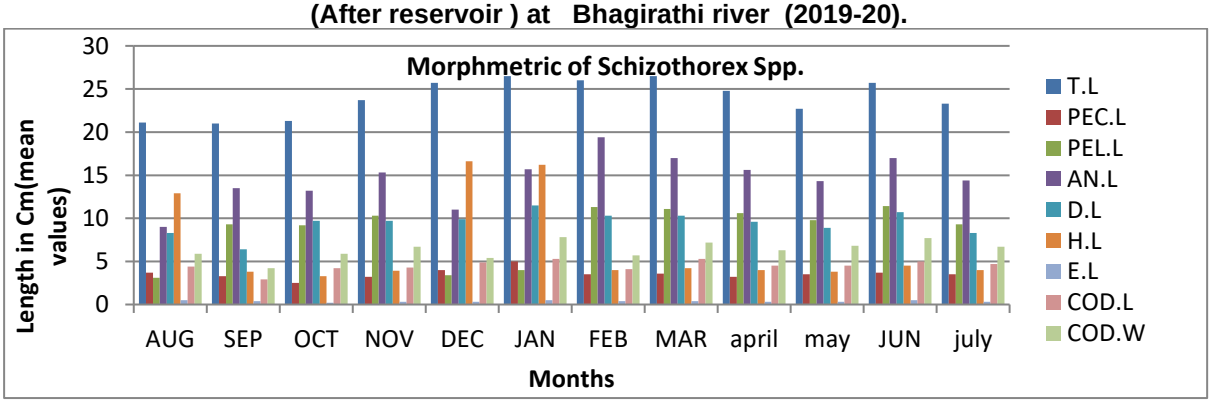


Figure 03: Morphometric Measurement of *Schizothorax sp.*

Conclusion

It is concluded from this present article that the construction of dam affects the ecosystem and the ecology of the river, we should try to conserve and manage the aquatic biodiversity of the river system. This is understandable because in all the sites after the reservoir wall , the water level decreases. We also suggest that there should be a critical level of water discharge that should be maintained in the main river channel after the reservoir wall of hydroelectric projects to maintain a regular flow of water in order to preserve aquatic biodiversity. But it is noteworthy that the Schizothorax spp. population is able to sustain even severe fluctuations of water level. This is one of the most surprising results suggested by our result. Therefore, in the present study, changes in physico-chemical parameters due to the effect of water level fluctuations after the dam wall have an effect on the schizothorax and morphometric characteristics as well. After summing up the data by size (length in cm), the results showed that the maximum fish numbers of individuals observed in Maneri before the reservoir site were related to a class interval of 20–30 cm that corresponded to the spring season. was seen. It can be assumed that the data shows that the number of fish is less and smaller in size in the places after the

reservoir wall. It has been suggested that the fragmentation of river ecosystems may result in changes in migration patterns among fish populations.

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