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Fish Diversity With Seasonal Variation Of Water Quality In Parasdoh Dam Tapti River At Betul District (M.P.)

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Abstract:
Present study aimed to identify the role of seasonal changes in physico-chemical parameters and its impact on fish diversity of Parasdoh dam in three seasons viz., Rainy, winter and summer of three consecutive sessions from July, 2021 to June, 2024. The water quality parameters, depth, water temperature, total ammonium nitrogen, and soluble reactive phosphorus were higher in summer season (152.0±2.4 cm, 30.2±0.9°C, 0.88±0.14 mg/L and 0.036±0.002 mg/L, respectively) whereas dissolved oxygen, total dissolved solids and electrical conductivity in winter season (4.5±0.3 mg/L, 140.7±0.4 mg/L and 275.6±0.4 µS/cm, respectively). The value of total nitrogen was higher in summer season (1.92±0.24 mg/L). The parameters Secchi disk visibility, pH, Total alkalinity, total phosphorus, nitrite and nitrogen were statistically similar in all three seasons. Water and fish sampling were done monthly from 5 different Stations (water inlet, mid part and near water outlet) of dam and gro
uped into three seasons and compared. A total of 27 fish species representing 5 orders and 9 families with 13 genera were found in dam. Cypriniformes was the dominating fish order representing a total of 14 species. A total of 14 species were recorded in the rainy season, 12 species in both the winter and summer seasons. The abundance and of fishes were significantly higher in rainy season (185±54.1 no. of fishes and 7462±28.87 fishes/day, respectively) as compared to other seasons. A high density of phytoplankton was observed in the summer season (385.3±15.4 no./L) while the density of zooplankton in the winter season (170.0±15.4 no./L). Fish abundance declined with decreasing dissolved oxygen, total nitrogen, and zooplankton density while, it rises with decreasing water depth, Secchi disk visibility, total ammonium nitrogen and nitrite nitrogen. Most of the measured water quality parameters were in the desirable range for fish, while, the number of fish species increased as compared to the previous studies. To sustain fish diversity in the dam, habitat improvement through the management of water quality parameters, the stocking of native species, and the avoidance of fishing may be helpful. The diversity of fishes showed that the water quality of Parasdoh dam is quite favourable for aquatic organisms. Changes in ichthyofaunal diversity can be used to know the changes in freshwater ecosystem as ichthyofaunal diversity is largely dependent on available food sources and predators present in given ecosystem.

Key Words: *Ichthyofauna, Diversity, Dynamics, Freshwater ecosystem.*

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I. Introduction:

Water is an important factor in the Earth and the all-life forms are originated and depended directly or indirectly on water. Wetlands are crucial for maintaining plant and animal diversity since they are home to many different species of flora and wildlife. They are crucial habitats for endemic, uncommon, and threatened plant and animal species. (Majupuria and Majupuria, 2006). There are more than 27,800 species of fish in the world of which about 10,000 are freshwater fish (Shrestha, 2008). Another study by Oli et al. (2013) reported a decline in species as compared to the previous study because they only recorded 22 species of fish belonging to 13 families and 5 orders. The water quality is the most important component that influence on the distribution of aquatic biota (De, 2000) as well as in the health of aquatic habitats, including habitats for fish, plankton, and other species (Bratram and Ballence, 1996). It has been noted that seasonal variations in temperature and precipitation are accompanied by variations in dam water quality (Zhang et al., 2015). The water quality of the dam is likely changing as it receives the loads of pollutants from the adjacent anthropogenic activities (Nyanti et al., 2015). Riverine fish fauna is subjected to a series of habitat changes such as water current, turbidity level, fishing pressure, loss of breeding grounds and the changes in fish food organisms due to environmental factors. India is one of the mega biodiversity countries and occupies ninth position in terms of freshwater mega biodiversity country. Freshwater biodiversity contains almost all conceivable aquatic habitats with. It influences human life in a number of ways. It is a rich source of food and fish plays a predominant role in overcoming the nutritional deficiencies of Proteins, fat and vitamins. It also provides several bye-products like fish meal, fish glue and fish oil etc. Fish not only provide food but boost up the economy of many countries of the world as well (Khan and Hasan, 2013). Fishes are very important from the biodiversity point of view and are the best bio-indicators of the

given ecosystem (Kumar, 2012). Over the last century, riverine ecosystems have suffered most due to intense human intervention resulting in habitat loss and degradation. As a consequence, many species of fishes have become highly endangered, particularly in rivers where heavy burden is placed on freshwater resources. The main causes of depletion fresh water diversity are habitat destruction and defragmentation (Szollosi., 2004), water abstraction, industrial pollution and private use (Szollosi, 2004; Dawson et al., 2004) exotic species introduction, pollution (Lima et al., 2004) and global climate change impacts (Leveque et al., 2005; Mas et al., 2005). Freshwater fish are one of the most threatened taxonomic groups (Darwall, 2005) because of their high sensitivity to the quantitative and qualitative alteration of aquatic habits. (Laffaille et al., 2005; Kang et al., 2009; Sarkar et al., 2008). Pawara et al., (2014) found 18 fish species belonging to 5 orders, 8 families and 14 genera in Godavari River at Dhangar Takli of Parbhani district in Maharashtra. Borana and Zafar (2014) studied Ichthyofauna of western region of Narmada River, Madhya Pradesh and recorded that fifty-eight fish species belonging to thirty-eight genera, sixteen families and six orders.

Tapti is a major river in central India. It is one of the major rivers of peninsular India, with the length of around 724 kilometres. The river arises from a place called Multai, situated in Betul district of eastern Satpuda range of southern Madhya Pradesh and flows Westward to Madhya Pradesh Nimar region, Maharastra's Khandeshi and East Vidarbha regions in North West corner of the Deccan plateau and South Gujrat, before emptying into the Gulf of Cambay of Arabian sea, in the Surat district of Gujrat. The Tapti basin lies in the states of Maharashtra (51504 sq/km), Madhya Pradesh (9804 sq/km) and Gujrat (3837 sq/km). the Parasdoh dam situated on Tapti River district Betul. Biodiversity means the variation in the genetics and lifeforms of populations, species, communities and ecosystem. Biological diversity is important to the fulfilment of human needs. Fishes from highest species diversity among all vertebrate groups a part from its economic importance.

To delineate the pollution in the dam the monitoring of water quality parameters is important. There was a gap in study since the dam was constructed. This study aims to close this knowledge gap by determining the current state of fish species, water quality indices, and seasonal fluctuations.

II. Materials And Methods

For present investigation water samples were collected from Parasdoh dam in July 2021 to June 2024. The water samples were collected from four different Station of Parasdoh dam. The samples were transferred to the bottle and brought to the laboratory without disturbances. For the analysis of physico-chemical parameters, monthly collection of water samples was done for the period of two years (July, 2021-June, 2024) from the selected study Station of water body. Estimation of selected physico-chemical parameters *viz;* temperature, depth, transparency and chemical parameters such as pH, dissolved oxygen, free carbon dioxide, carbonates, bicarbonates, chloride, calcium and magnesium was done on the spot while for rest of the chemical parameters such as nitrates, phosphates and sulphates, water samples were collected in the glass bottles and brought to the laboratory for further analysis.

Map. 1 Satellite map of Study area Parasdoh dam

Five sampling Station were selected including the water inlet, near the water outlet and the middle part of the dam for representative samples. Five sampling Stations were marked around one meter of the selected Station. Fish diversity Monthly fish sampling was done in day time from 10 am to 4 pm from the selected Station

with the help of cast net having mesh size of 6 mm x 6 mm. The circumference and diameter of the net were 7.3 m and 2.32 m, respectively. A local fisherman was hired for this purpose. The fish species were identified according to a key developed by Shrestha (2019) and preserved in 10% formalin solution. Total fish catch during each season was calculated by mean fish caught in three months. Shannon Wiener diversity indexes (H), species richness (S) and evenness index (E) were calculated to measure the fish diversity in four seasons during the study period.

Shannon wiener diversity index H = ∑s i=1 pi

ln pi Species richness

S = total number of observed species per area of defined ecosystem

Evenness index E = H / ln S

Where, H = diversity index, s = number of species,

Pi = (n/N) = relative abundance, n = number of individuals for each species,

N = the total number of individuals, E = the similarity or evenness index and ln = natural logarithm

Water quality analysis Water sampling was done early in the morning between 6 and 7 am monthly with column water sampler from the selected Station in the Fisheries Dam. The water quality parameters water temperature, Secchi disk visibility, DO, pH, total dissolved solids and electrical conductivity were measured in situ by digital multi-meter (Hanna, Model-HI 98194). The Secchi disk visibility was measured between 8 and 11 am. The depth of the dam was measured using a marked pole. A litter of water sample was collected in plastic bottle for the laboratory analysis of other water quality parameter as total alkalinity, total nitrogen, total phosphorus, total ammonium nitrogen, nitrite nitrogen, soluble reactive phosphorus and chlorophyll-a by standard methods (APHA, 2012). For the quantitative determination of plankton, five litters of surface water (up to 50 cm) were sampled between 8 and 10 am and filtered through plankton net (mesh size 5µm) and collected in a plankton tube. The samples were then preserved in formalin solution (4%) and density estimations (numbers/volume of water samples) was done with the help of Sedge wick-Rafter cell under microscope (Welch, 1984). Zooplankton is differentiated from phytoplankton based on large size and animal-like body shape having appendages.

Statistical analysis: The collected data were analysed by software package. Shannon diversity index was used to compare fish diversity in four seasons. Water quality parameters and fish abundance were analysed statistically by using ANOVA. Microsoft Excel 2010 was used to prepare diagrams, charts and graphs. All average values were given with ± S.E.

III. Results

Fish diversity A total of 27 fish species belonging to 13 genera, 9 families and 5 orders were caught in the dam. Among these species 7 were common, 3 were uncommon and 7 were rare (Table 1).

Based on total catch, the top five species were *Labeo rohita* (33.7%), *Catla catla* (16.3%), *Puntius ticto* (16.1%), Cyprinus carpio (10.2%) and *Mystus singhala* (6.1%). Cypriniformes was the most dominating order having 14 species with 72.9% total catch, followed by Siluriformes having 5 species with 19.8% total catch and Perciformes having 3 species with 7.5% total catch. The total species recorded is more in winter and rainy season (14 species), 12 species in summer seasons. Less number of species recorded is 10 in winter season. Based on the total catch, the highest numbers of individual fishes were recorded in spring season (180), followed by winter season (90), summer season (80) Table-1.

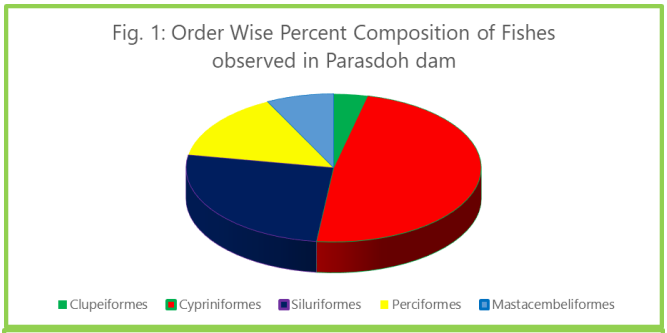
The present study showed 24 fish species,13 genera,7 families, 6 orders were recorded in the five Station respective viz. Station-S1 (near Overflow Outlet of dam), Station-S2 (Near main wall of dam), Station-S3 (Near Goula village), Station S4 (Near Pachdhar Village) and Station -5 near Borgaon village. Total twenty species of fishes were noticed in the Station-1 from the observed species *Labeo rohita, Catla catla, Cirrhinus mrigala, Labeo bata* are the main fishes of Parasdoh dam of Tapti River. The member of order Cypriniformes were found dominated. The most abundant family of fishes was Cyprinidae 80% then Ophicephalidae 5%, Siluridae 7%, Belonidae 2% and Notopteridae 2% while families like Mastacembelidae, Bagridae, Schiibeidae, Anguillidae together constituting nearly 1% each (Fig.2). during investigation we also reported some of the threatened fish species *Notopterus chitala*, *Tor tor*, *Labeo dussumieri*, *Mystus punctatus, Anguilla bangalensis*. Total eighteen species were recorded in the Station-2: the most abundant family of fishes was Cyprinidae 82%, Ophicephalidae 5%, Siluridae 5%, Notopteridae 4% each and other families Mastacembelidae, Bagridae, Belonidae, Schiibeidae, Anguillidae constituting 1% each (Fig.1). Total nineteen species were recorded in the Station-3: the most abundant family of fishes was Cyprinidae 83%, Ophicephalidae 6%, Siluridae 5%, Mastacembelidae 2% each and other families Belonidae, Notopteridae, Bagridae, Schiibeidae, Anguillidae constituting 1% each (Fig.2). Total twenty-one fish species were recorded in the Station-4: the most abundant family of fishes was Cyprinidae 85%, Ophicephalidae 4%, Siluridae 6%, Mastacembelidae 2%, each and other families Bagridae, Belonidae, Schiibeidae, Notopteridae, Anguillidae constituting 1% each (Fig.2). Total twenty-two fish species were recorded in the Station-5: the most abundant family of fishes was Cyprinidae 83%, Ophicephalidae 5%, Siluridae 7%,

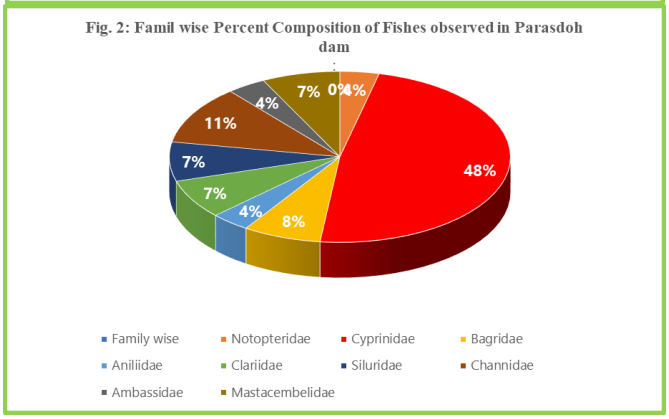
Mastacembelidae 2%, each and other families Bagridae, Belonidae, Schiibeidae, Notopteridae, Anguillidae constituting 1% each (Fig. 1).

The total twenty fish species recorded at Station-1, eighteen fish species recorded at Station-2, nineteen fish species recorded at Station-3 twenty-one fish species recorded at Station-4 and twenty fish species recorded at Station-5. As an outcome of the present research study, in all 27 fresh water fish species and 22 taxa were identified from Parasdoh Dam which belongs to 9 families and 5 orders. The family Cyprinidae was dominant with 14 fish species (51.85%) followed by Siluridae 07 (25.92%), Channidae 04 (14.81%), Mastacembelidae 02 (7.40%), Notopteridae 01 (3.7%), Clariidae 01 (3.7%), Gobiidae 01 (3.7%), Bagridae 01 (3.7%) (Table: 1 and Fig. 1 and 2).

Table 1: Fish Species reported in Parasdoh dam during the study period at different seasons

SN	Fish Species	Family	Order	Rainy season	Winter season	Summer season
1	*Notopterus notepterus*	Notopteridae	Clupeiformes	4	12	7
2	*Labeo bata*	Cyprinidae	Cypriniformes	4	5	2
3	*Labeo rohita*	Cyprinidae	Cypriniformes	15	22	11
4	*Labeo dyocheilus*	Cyprinidae	Cypriniformes	1	0	3
5	*Labeo boggut*	Cyprinidae	Cypriniformes	1	1	2
6	*Labeo fimbriatus*	Cyprinidae	Cypriniformes	1	1	3
7	*Labeo calbasu*	Cyprinidae	Cypriniformes	0	2	1
8	*Catla-Catla*	Cyprinidae	Cypriniformes	9	12	7
9	*Cirrhinus Cirrhosus*	Cyprinidae	Cypriniformes	2	3	1
10	*Cyprinus Carpio*	Cyprinidae	Cypriniformes	7	11	5
11	*Cirrhinus reba*	Cyprinidae	Cypriniformes	1	3	2
12	*Rasbora doniconius*	Cyprinidae	Cypriniformes	4	5	3
13	*Osteobroma cotio*	Cyprinidae	Cypriniformes	0	1	1
14	*Hypophthalmichthys Molitrix*	Cyprinidae	Cypriniformes	1	0	0
15	*Sperata seenghala*	Bagridae	Siluriformes	2	5	2
16	*Sperata aor*	Bagridae	Siluriformes	1	3	5
17	Clupisoma garua	Aniliidae	Siluriformes	1	0	0
18	Heteropneustes fossili	Clariidae	Siluriformes	5	8	2
19	Clarias batrachus	Clariidae	Siluriformes	1	1	3
20	Ompokbima culatus	Siluridae	Siluriformes	1	0	0
21	Wallago attu	Siluridae	Siluriformes	2	5	3
22	Channa gachua	Channidae	Perciformes	5	5	2
23	Channa punctata	Channidae	Perciformes	6	3	2
24	Channa marulius	Channidae	Perciformes	1	0	1
25	Parambassis range	Ambassidae	Perciformes	0	1	2
26	Mastecembelus armatus	Mastacembelidae	Mastacembeliformes	3	2	1
27	Mastecembelus puncatus	Mastacembelidae	Mastacembeliformes	2	1	0





Diversity index

Shannon diversity index, species richness and evenness index are given in Table 2. All the calculated indexes were statistically similar as compared to seasons. Shannon diversity index (H) ranges from 0 to 5 with value of 1.98 and below indicates very low according to Fernando (1998). In this study, Shannon diversity index is less than 1.98 throughout the seasons representing less diverse fish species in the dam. The species richness value represents the total number of fish species in a specific area of water body and it may vary from 9 to 13 species in different seasons. Evenness index may vary from 0 to 1, the value 1 represents all species are equally abundant and 0 represents one species dominant. According to this study, fish species are moderately to highly equally abundant throughout the seasons, with an average evenness index score of 0.76 to 0.87 (Table 2 and fig. 3 and 4).

Table 2. Shannon diversity index (H), Species richness (S) and evenness index (E) of Fisheries Dam in three seasons

SN	Parameters	Rainy season	Winter season	Summer season
1	**Shannon diversity index (H)**	1.75±0.04a	1.91±0.04a	1.78±0.02a
2	**Species richness (S)**	12a	111a	10a
3	**Evenness index (E)**	0.75±0.05a	0.85±0.05a	0.86±0.02a

Fig. 3. Showing diversity indices values of Fish Species reported from Parasdoh dam during the study period

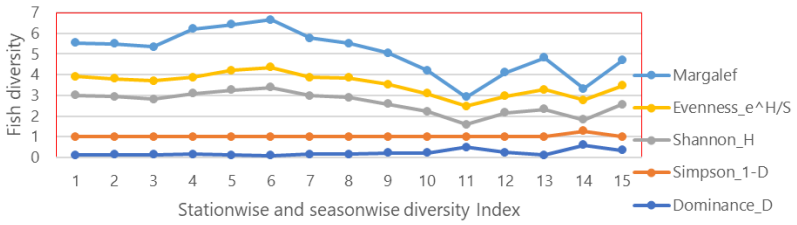
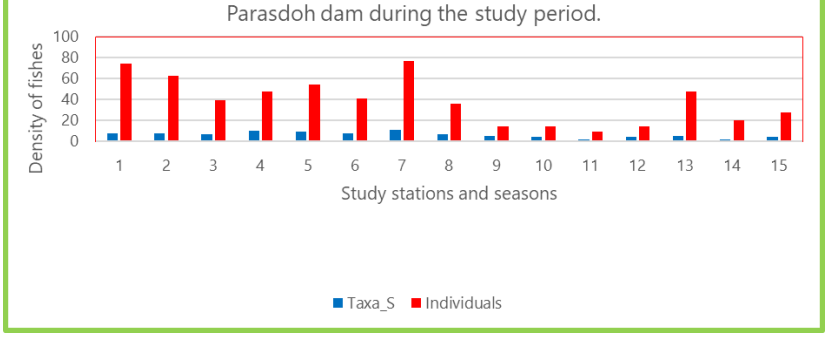


Fig. 4. Showing Overall density of Fish Species reported from Parasdoh dam during the study period.



Water quality parameters:

The water quality parameters of the Parasdoh dam were observed during the study and Mean value of water quality parameters of Parasdoh Dam in three seasons are presented in Table 3. The parameters except Secchi disk visibility, pH, total alkalinity, total phosphorus, nitrite nitrogen were statistically significant within three seasons. In physical water quality parameters, the water temperature was significantly lowest in the winter season (20.0±0.6°C) as compared to summer (31.2±0.8°C), rainy season (24.2±1.2°C) recorded. The water was more transparent in winter (59±20.3 cm) and summer season (55±22.7 cm) as compared to rainy season (32±2.1 cm). In chemical parameters, the dissolved oxygen (DO) is significantly higher in winter (4.4±0.2 mg/L) and rainy season (4.3±0.4 mg/L) than in summer season (1.9±0.6 mg/L). The overall mean value of pH was neutral and it ranged from 6.9 to 7.9. The total dissolved solids (TDS) and electricity conductivity (EC) values were highest in rainy season (135.7±0.3 mg/L and 272.6±0.5µS/cm) and lowest in summer season (110.3±2.3 mg/L and 203.5±10.4 µS/cm), respectively. The mean total alkalinity was statistically similar in all seasons and grand mean value was 122.6 mg/L as $CaCO_3$. The total nitrogen (TN) was significantly higher in the rainy season (1.87±0.2 mg/L) whereas TN values were statistically similar in winter, and summer seasons. The mean of total ammonia nitrogen (TAN) was significantly higher in the summer season (0.79±0.07 mg/L) as compared to winter (0.2±0.02 mg/L) and summer season (0.19±0.02 mg/L). The nitrite nitrogen value appropriate throughout the study period

and statistically similar, in all seasons with mean value of 0.046 mg/L. The total phosphorus was statistically similar in all seasons with 0.08 mg/L of mean value whereas the soluble reactive phosphorus (SRP) was significantly higher in summer season (0.045±0.002 mg/L) as compared to winter season (0.045±0.003 mg/L). The zooplankton was significantly higher in the summer season (175.0±8.5/L) while, the zooplankton were lower in the winter season (85.6±4.2/L).

Table 3. Average Water quality parameters of water of Parasdoh dam in three seasons during the study period

Water Parameter	Units	During Rainy season	During Winter season	During Summer season
		24.89	39.92	28.54
Temperature of surrounding Air	DC	22.64	29.90	25.68
Water Temperature	DC	7.59	7.47	7.78
pH	pH	188	208	210
TDS	ppm	302	325	342
Water Conductivity	µS/cm	158.56	164.44	188.31
Alkalinity of water	mg/l	7.13	7.49	7.40
DO (Dissolve Oxygen)	mg/l	1.77	2.43	0.55
BOD of water	mg/l	1.69	2.044	0.50
COD	mg/l	42.87	36.19	34.56
Secchi water Transparency	cm	2.41	3.12	2.73
Water Turbidity	NTU	11.12	10.64	11.12
Carbon di oxide (CO_2)	mg./l	33.87	36.81	14.83
Cl (Chloride)	mg./l	138	152	216
Total water Hardness	mg./l	27.7	31.4	33.6
Calcium Hardness	mg./l	3.8	4.2	4.6
Magnesium Hardness	mg./l	0.33	0.34	0.34
Water Nitrate content	mg./l	0.97	0.88	1.46
Nitrite	mg./l	32.77	27.34	27.06
SO_4 (Sulphate)	mg./l	0.86	0.59	0.93
N_2	mg./l	0.34	0.234	0.68
Urea	µg./l	0.284	0.234	0.76
PO_4 (Phosphate)	mg./l	24.89	39.92	28.54
Zooplankton density	No./L	97.5	118.3	192.5

Corelation of water parameters with fish diversity: Depth exhibited a strong negative correlation with fish abundance (r = -0.90), suggesting that fish tend to be more abundant in shallower waters. Similarly, Secchi Disk Visibility (SDV) and Total Alkalinity (TA) showed strong negative correlations (r = -0.81 and r = -0.80, respectively), indicating clearer and more alkaline waters were associated with lower fish abundance. Total Ammonia Nitrogen (TAN) and Nitrite Nitrogen displayed strong negative correlations (r = -0.74 and r = -0.72), suggesting toxic effects at higher concentrations that negatively impact fish abundance. Soluble Reactive Phosphorus (SRP) and the number of zooplankton also showed moderate negative correlations (r = -0.51 and r = -0.50, respectively), which may indicate limited food availability or unfavourable water conditions. In contrast, Total Nitrogen (TN) exhibited a strong positive correlation with fish abundance (r = 0.90), suggesting nutrient enrichment may support greater primary productivity, thereby enhancing fish populations. Chlorophyll-a and Total Phosphorus (TP) showed moderate positive correlations (r = 0.54 and r = 0.50, respectively), further supporting the link between nutrient availability and fish abundance. Dissolved Oxygen (DO) also had a moderate positive correlation (r = 0.69), indicating that higher oxygen levels support aquatic life. Other parameters, such as water temperature (r = -0.14), Total Dissolved Solids (TDS) (r = 0.22), Electrical Conductivity (EC) (r = 0.24), and pH (r = 0.01), showed weak correlations with fish abundance. Additionally, the number of phytoplankton displayed a very weak negative correlation (r = -0.04), suggesting limited influence on fish abundance.

IV. Discussion

Fish diversity and water quality parameters

All species collected during study period were reported by Soni et al., 2023 and from Parasdoh dam. However, the number of fish species reported in the study is higher as compared to the previous studies reported by Soni et al., (2023). In this study, sampling of fish was done only from dam area but in previous studies the sampling sites was entire river including reservoir area. The use of selective gear might not be effective for bottom living fishes and not being caught during sampling period. Similarly, flooding in dam during rainy season might be another reason for fish decline because rainy season is breeding time for most of the fish species found in reservoir. Another possible reason might be due to acute shortage of water in dam during dry season (Jha & Shrestha, 2004). Catch composition of Cypriniformes order was higher than other orders might be due to largest freshwater order. The exotic fish *Oreochromis niloticus* and indigenous fish *Cirrhinus mrigala* were caught during sampling might be due to escape from the experimental area. The mean depth of the dam was significantly higher

in rainy and winter season because of no rainfall in those seasons accumulating less water in dam. The water temperature of dam was higher in summer season might be due to higher air temperature in that season. As the water temperature is influenced by air temperature and intensity of solar radiation. In winter season, low air temperature and low light intensity significantly lowering water temperature of reservoir. Jha and Shrestha (2004) also reported higher temperature in summer season month (June) and lower in winter season month (February). Similar result reported by Adhikari et al. (2017) from the Kulekhani Reservoir. The Secchi disk visibility values were appropriate in spring and winter season. The turbidity might not be caused by the phytoplankton only because the chlorophyll-a concentration was very low during study. The Secchi disk visibility values were higher than desirable range in summer and winter season because in November and December month the dam water was transparent and clear. Because of the lower water temperature in the winter, a higher oxygen solubility may have contributed to the winter's highest dissolved oxygen concentration. In colder months, there is low microbial decomposition and low oxygen consumed. As the spring temperatures and light levels rise, the activity of plants, animals, and bacteria increases. More oxygen is produced and more oxygen is consumed resulting in dramatic fluctuations in daily dissolved oxygen levels and oxygen becoming less in the morning. Jha and Shrestha (2004) also reported higher water temperature in winter months in Rampur wetland. Similar trends were found by previous studies (Chaurasia and Tiwari, 2011; Niroula et al., 2010; Thapa and Pal, 2012) in different wetlands. The higher values of electrical conductivity and total dissolved solids were observed in the rainy season and lower value in summer season. The high EC and TDS value in the rainy season might be due to more accumulation of ions and their total concentration in the dam and the water was not discharging at that season. Nazeer et al. (2018) also reported higher values in the dry season as compared to wet seasons. The use of phosphorus-rich agricultural fertilizers in the watershed followed by agricultural runoffs into the reservoir may be the cause of the higher values of total phosphorus and soluble reactive phosphorus in the rainy and summer (Adhikari et al., 2017). Similar results reported by Thapa and Pal (2012) and Tuboi et al. (2017). Total nitrogen was significantly higher in rainy season might be due high-water temperature causes high metabolic rates of aquatic organism and high decomposition of organic matter resulting more nutrient in water. The result is accordance with the findings of Nazeer et al. (2018). Total ammonium nitrogen was significantly higher in summer season than in winter seasons might be due to surface runoff of ammonia rich fertilizers during rain. It can also be due to the high metabolic rate of fishes in reservoir causing more release of ammonia through gills and excreta. Oli et al. (2013) also reported similar results in Rampur ghol. The value of nitrite nitrogen was very low and suitable for fish and aquatic organisms. The high concentration of nutrients, particularly nitrogen and phosphorus, from agricultural land as surface runoff that was used in agricultural fields in the dam area may be the cause of the higher density of zooplankton in the summer. Pathak and Limaye (2012) and Dhanalakshmi et al. (2013) also reported the similar results and reported rain water carries lager amount of organic matter which caused excessive zooplankton growth. Increased zooplankton growth causes increased number of fishes in the following season. Similar results reported by Adhikari et al. (2017) in Kulekhani Reservoir, Nepal.

In addition, suitable water temperature, higher dissolved oxygen, phytoplankton and chlorophyll-a concentration also enhanced the activity of fishes in reservoir resulted more fish catch during netting. The mean abundance was lower in summer season might be due to more water depth in reservoir and fish may easily escape during netting. Overall, the findings highlight that nutrient availability, dissolved oxygen, and water clarity are significant factors influencing fish abundance, while deeper waters and elevated levels of ammonia and nitrite negatively impact fish populations.

V. Conclusion

In conclusion a total of 27 fish species belonging to 5 orders were recorded during study with higher catch composition of Cypriniformes order. The fish diversity changes with respect to seasons, higher number in Rainy season (14) followed summer season (11) and low in winter season (9). The abundance of fishes were higher in the summer season. All the measured physical, chemical and biological water quality parameters were changes as seasons changes with most of them are suitable for fish species. There is a need of proper management strategies for the sustainability of the Tapti river fish diversity and water quality management.

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