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Documentation of Cyprinid Minor Carps and Minnows in Bhadra Reservoir of Karnataka, India

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Abstract: Fishes are the cold blooded aquatic organisms. The main aim of this study was to know the minor carps and minnows of cyprinid fish community of the Bhadra reservoir in relation to physico-chemical parameters and monthly samples taken from June-2019 to May-2020. This water body is situated at 13°42 'N latitude and 75°38'E longitude located near Lakkavalli village of Chikmaglore district, Karnataka and the confluence of the Bhadra River. Fish collections were done with gillnets of standardized dimensions with several mesh sizes. 37 fish fauna identified in the Bhadra reservoir belongs to different genera with *Labeo* 8 species, *Puntius* 6 species, *Hypselobarbus* 3 species, *Rasbora* 3 species followed by *Cirrhinus, Pethia* and *Salmostoma* with 2 species each and rest of the genera having 1 species each, respectively. The species diversity is peak in winter, coinciding with favorable conditions such as enough water and sufficient food resources. The diversity was low in summer season probably due to the shrinkage of the water stretch of the reservoir. The maximum dissolved oxygen coupled with low biochemical oxygen demand and supplementary nutrient levels indicate that the reservoir is moderately oligotrophic in nature. The factors responsible for declining population of minor carps and minnow species is discussed in detail. To save this diversity and to develop a sustainable fishery practices and proper documentation leading to diversity information system is an urgent need.

Keywords: Abundance, Diversity indices, Minor carps, Minnows, Oligotrophic, Water quality, Physico-chemical parameters

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Introduction

The Cyprinidae family's minor carps are important fish for the market. *Cirrhinus reba, Labeo bata, Labeo finbriatus, Labeo calbasu, Cirrhinus cirrhosus*, and *Labeo kontius* are the carps used in

aquaculture. The Olive barb (*Systomus sarana*), which is important to the economy, is a member of the Cyprinidae family. The minor carp and barbs, aside from Cauvery carp, are typically appropriated all through India. Adults can be found in tanks, canals, ponds, and beels in addition to large rivers and streams. In addition to plankton and debris, they may also consume mud, vegetables, crustaceans, and insect larvae (https://vikaspedia.in/agriculture/fisheries/fish-production/culture-fisheries/culture-techniques-of-fishes/culture-of-minor-carps-and-barbs).

The family of minnows is extremely diverse, with numerous representatives found in most of the world. Numerous minnow species are comparable apparently and can accordingly be extremely challenging to distinguish. While carp and goldfishes have at least one strong spine at the front of their dorsal and anal fins, most minnows lack teeth or spines. They only have one dorsal fin, which usually has eight rays (carp and goldfish have more). Underneath the dorsal fin are the pelvic fins, which are abdominal fins. The tail is typically forked, but it can also be concave. The cheeks and opercles are devoid of scales. During spawning, many species of minnow acquire nuptial turbercles, or horny bumps, on their heads and become more colorful (http://www2.dnr.cornell.edu/cek7/nyfish/Cyprinidae/cyprinidae.html).

The majority of minnows can be kept at home in aquaria with ease and readily accept pellets and dried flakes. Minnows, with the exception of goldfish and carps, are typically smaller and more fragile than other types of fish. As a result, they do not fare as well when they are in the presence of large, aggressive fish. In general, the ones with looser and larger scales tend to be more delicate than others. Minnows typically stay high in the water column and are active. As schooling fish, they are "happier" when kept with other fish of their kind (https://portal.ct.gov/DEEP/Fishing/Freshwater/Freshwater-Fishes-of-Connecticut/Minnows-and-Carps).

As a result, the stability of environmental protection and the environmental value of all species on this planet depend on biodiversity. According to Moyle and Leidy (1992), fish are the most important species that can indicate the health of the environment and the pleasantness of the water. Fishes are important sources of high-quality protein and play a significant role in the social and financial realms by providing people with not only nutritious food but also income and employment opportunities. In addition, they are ecologically significant because they are the primary link in all aquatic animals' food chains (Mishra, 1962).

Kiran *et al.* (2007) and Thirumala and Kiran (2016 a,b, 2017 a,b,c,d,e,f, 2020) have done a lot of research on the diversity of freshwater fishes in Karnataka's various lentic water bodies. The current research aimed to investigate the minor carps and minnows found in Karnataka's Bhadra reservoir.

Materials and Methods

Study area:

Figure 1 depicts the location of Bhadra reservoir in the Chikmagalore district of the Tarikere taluk, close to the Lakkavalli village in Karnataka, India. The latitude and longitude of this body of water are 13^0 42' 00" N and 75^0 38' 20" E, respectively. It is at a height of 601 meters above mean sea level. Ganga Moola is the plave where Bhadra river begins to flow. This project can be used for both irrigation and power generation. The inflows into the Bhadra basin come from the North East monsoon (October-December) and the South-West monsoon (June-September). The site's catchment area is about 1968 square kilometers. That region receives an average rainfall of 513 cm to 117 cm. The profundity of the supply is around 186 feet and complete length is 1445 feet. The reservoir is intended to store 61.70 TMC of water and irrigate 1,05,570 ha of land in the districts of Chikmagalur, Shivamogga, Chitradurga, and Bellary. The reservoir's water is used for drinking, fishing, irrigation and electricity production. This region has a moderately cool climate.

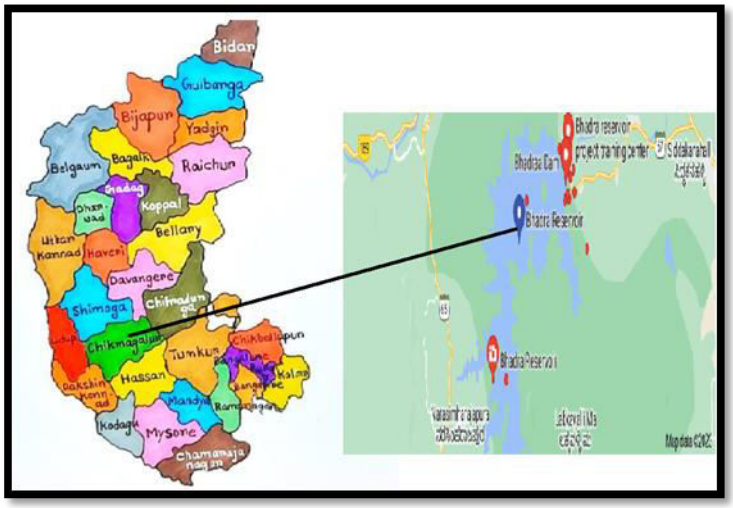

Fig. 1: Location of the Bhadra reservoir.

Identification of fish species:

Local fishermen assisted in the collection of the minor carps and minnow fishes from the back water of Bhadra reservoir and upstream of Bhadra river from June 2019 to May 2020. For the purpose of taxonomic research, the fish were preserved in 10% formaldehyde. Standard literature was used to identify fishes (Table 1) and determine their economic significance (Day, 1951; Jayaram, 1981; Datta Munshi and Srivastava, 1988; Talwar and Jhingran, 1991; http://fishbase.org).

Diversity indices:

Fish diversity was subjected to diversity analysis using the index like Shannon-Weiner index. Water samples were collected between 8 AM to 10 AM and further transported to the laboratory immediately for further analysis. Water temperature was measured at the time of sampling using mercury thermometer, pH was measured with standard pH meter, while other parameters were analyzed in the laboratory according to the methods recommended by Trivedy and Goel (1986) and APHA (1998).

Statistical analysis:

One-way ANOVA and post-hoc Tukey HSD test with Scheffe, Bonferroni and Holm multiple comparison tests was used for minor carps and minnows (Tables 2-7) in Bhadra reservoir by using astatsa.com software.

Results and Discussion

Due to their small size and vivid colors, *Puntius* and *Pethia* species are ornamental fish that can be kept in aquaria. *Gambusia* sp. is used as a fish that can survive. However, the present study discovered that *Labio calbasu* is a rare species. Beginning in July, the reservoir experiences a significant influx of freshwater, creating a freshwater isostatic habitat with the onset of the Southwest monsoon. As a result, the entire system is altered by the monsoon's high floodwater levels. Fish diversity rapidly declines as a result of human anthropogenic activities and overexploitation. Even though there are species that are important to the production, there are not enough of them to make fishing profitable and affordable. Plantation in the catchment and education about illegal fishing and the killing of juvenile and brood fish are required for conservation measures.

A total of 37 fish fauna identified during the study which belongs to different genera (Table 1; Figs. 2, 3) with *Labeo* 8 species, *Puntius* 6 species, *Hypselobarbus* 3 species, *Rasbora* 3 species followed by *Cirrhinus, Pethia* and *Salmostoma* with 2 species each and rest of the genera having 1 species each, respectively.

Table 1: Minor carps and minnows of Bhadra Reservoir

S. No.	Scientific Name	IUCN Biodiversity Status
1.	*Barilius bakeri*	LR-lc
2.	*Cirrhinus Cirrhosus*	VU
3.	*Cirrhinus reba*	LR-lc
4.	*Garra mullya*	LR-lc
5.	*Labeo ariza*	LR-lc
6.	*Labeo boga*	LR-lc
7.	*Labeo dussumieri*	LR-lc
8.	*Labeo Kawrus*	EN
9.	*Labeo potail*	EN
10.	*Labeo fimbriatus*	LR-lc
11.	*Systomus sarana*	LR-lc
12.	*Pethia ticto*	LR-lc
13.	*Puntius deccanensis*	Cr.EN
14.	*Dawkinsia filamentosa*	LR-lc
15.	*Rasbora caveri*	LR-lc
16.	*Puntius bimaculatus*	LR-lc
17.	*Puntius amphibius*	DD
18.	*Puntius jerdoni*	LR-lc
19.	*Puntius vittatus*	LR-lc
20.	*Hypselobarbus pulchellus*	CR
21.	*Salmostoma boopis*	LR-lc
22.	*Salmophasia untrahi*	LR-lc
23.	*Opsarius barna*	LR-lc
24.	*Rohtee agilbii*	LR-lc
25.	*Gymnostomus fulungee*	LR-lc
26.	*Rasbora rasbora*	LR-lc
27.	*Rasbora daniconius*	LR-lc
28.	*Puntius sophore*	LR-lc
29.	*Hypselobarbus kolus*	VU
30.	*Osteobrama cotio*	LR-lc
31.	*Hypselobarbus dobsoni*	DD
32.	*Labeo dero*	LR-lc
33.	*Labeo gonius*	LR-lc
34.	*Salmostoma bacaila*	LR-lc
35.	*Pethia shylynius*	VU
36.	*Danio rerio*	LR-lc
37.	*Cyprinus carpio*	VU

LR-lc-Lower risk least concern ; Cr.EN-Critically endangered ; VU-Vulnerable; DD-Data deficient; EN-Endangered

Figure 4 depicts the biodiversity status (IUCN) of Minor carps and minnows in Bhadra reservoir. As far as biodiversity status (IUCN-1994) is concerned, 27 species as Lower risk-least concern (72.97 %), Vulnerable 4 species (10.81%), Endangered and Data Deficient's are 2 species each (5.41%) and 1 species included under the category of Critical and Critically Endangered (2.7 %).

The *Cirrhinus fulungee, Salmostoma, Salmophasia, Rasbora*, and *Puntius* groups of fish were more prevalent. As a result, the current investigation reveals that Cyprinid fishes are the most common species, which is also supported by other studies (Thirumala *et al*., 2011).

Arya *et al.* (2001) have reported the existence of some species' breeding grounds, including,

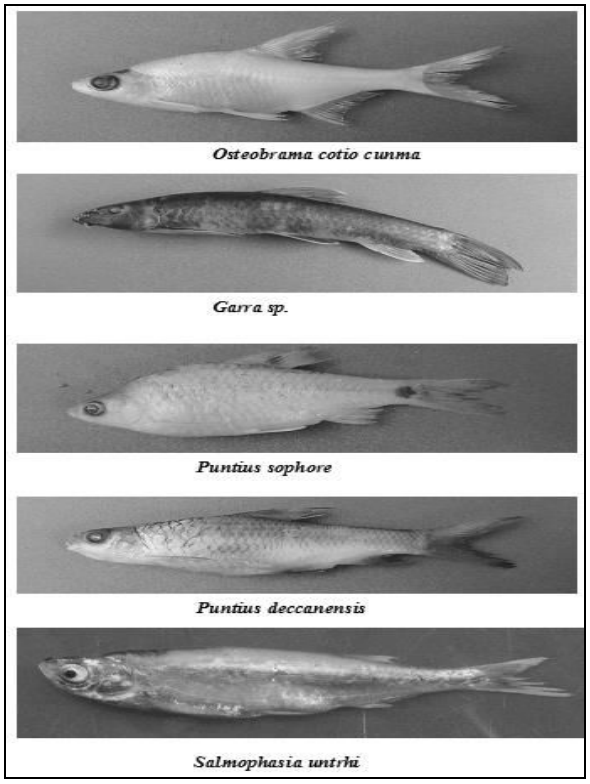

Fig. 2: Some Minor caps and Minnows from Bhadra reservoir.

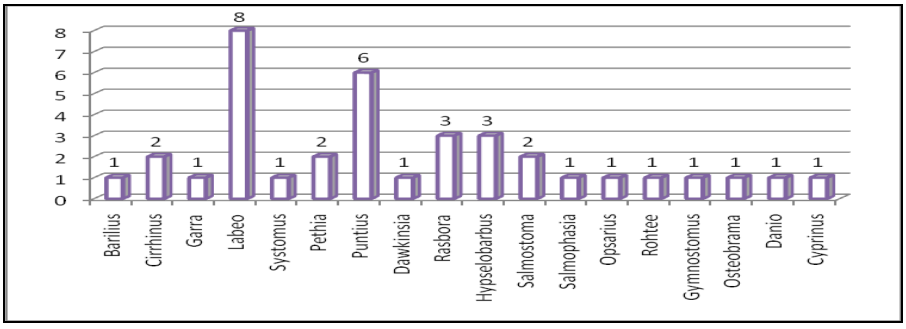

Fig. 3: Number of Minor carps and Minnows in each genera at Bhadra reservoir.

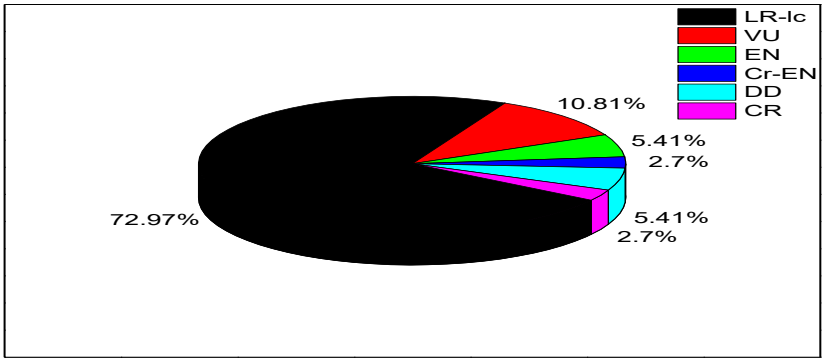

Fig. 4: Biodiversity status (IUCN,1990) of Minor carps and minnows in Bhadra reservoir.

Major carps, *Labeo calbasu*, and *Labeo fimbriatus* in the Indira sagar reservoir stretch. which are likely to vanish as a result of the construction of the dam. The population of these fishes in the reservoir area would suffer as a result of the loss of their breeding grounds.

According to Wilson (1988), the lotic fish fauna frequently confines itself to the upper reaches of the river that are not impounded due to habitat changes brought about by dam construction. This perspective suggested that the upstream river stretch and its tributaries might play a significant role in the native fish fauna's ability to survive. However, it is important to pay close attention to the presence of these species because they might take over the reservoir's native fish fauna and even eradicate it. Gobindsagar, where exotic carps have taken over as the dominant species, is an illustration of this kind of dominance.

According to the study's findings, the study area's fish diversity is decreasing as water quality rises. A decrease in fish diversity eventually results in a decrease in native species' fish production and the extinction of several species. As a result, the socioeconomic sector of the study area eventually becomes unstable, leading to an increase in the poverty of local fishermen. It demonstrates that delicate native species like *Puntius* sp. and *Labeo calbasu* etc., are in danger due to rising water pollution. Controlling water pollution in Bhadravathi town and preserving fish species in the Bhadra River would both benefit from this investigation.

The Shannon-Weiner index for minor carps and minnows in Bhadra reservoir is shown in Figure 5. Its values are between 2.0 and 4.2. The same index was used by Pereira (2000) to assess the diversity of Camaleao Lake, with scores ranging from 3.9 to 4.1. According to Barthem (1981), there was a range of 2.2 to 3.2 in the Shannon index in Central Amazonian lakes.

Water Quality:

Water temperature varied from 27°C to 29°C all through the period (Fig. 6). The water temperature was at its highest during the summer (29°C), while it was at its lowest during the winter (27 °C). The presence of suspended matter, silt, clay, colloidal particles, plankton, and other microorganisms is the cause of turbidity (Kataria *et al*., 1996) with an average of 8.5 NTU during the winter and 5.0 NTU during the summer. The pH was found to be between 7.2 and 7.8, indicating that the water was slightly alkaline in nature. The highest total alkalinity occurred during the rainy season, when it ranged from 38 to 44 mg/l.

According to Parashuram and Singh (2007), an aqueous solution's electrical conductivity (EC) is a measure of its capacity to conduct an electric current. EC ran between 65 to 79.4 µmhos/cm. During the rainy season, a high level of electrical conductivity was observed. This could be because the inlet flow has a higher concentration of ions (Jha and Barat, 2003). The amount of particles that are dissolved in water is measured using the total dissolved solids (TDS) test. 1000 mg/l is the WHO standard. TDS in high concentrations may not be suitable for crop irrigation or aquatic life. The TDS was between 40 and 47.6 mg/l. TDS values were low during the winter and high during the monsoon, according to seasonal analysis. Narain and Chauhan (2002) also reported results that were comparable.

The most crucial parameter that can be utilized as an indicator of water quality, primary production, and pollution is dissolved oxygen (DO). The DO concentrations ranged from 6.4 to 7.84 mg/l. DO values were found to be at their lowest during the summer and at their highest during the winter season. Due to organisms' high metabolic rates, months of low DO may be the case. Adebisi (1981) and Deshmukh and Ambore (2006) found similar patterns. According to Rajashekara *et al.* (2007) the reservoir water's DO level of 7.5 mg/l may be advantageous to aquatic organisms.

The amount of organic materials in aquatic solution that support the growth of micro-organisms has been measured using biochemical

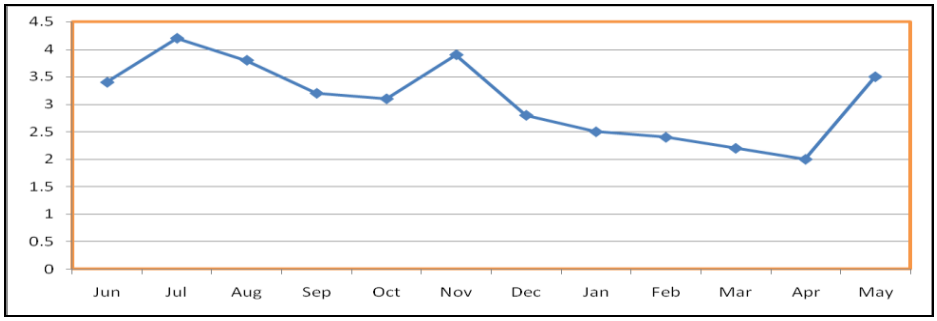

Fig. 5: Monthly variations in Shannon-Weiner index of Minor carp and Minnow fish species in Bhadra reservoir.

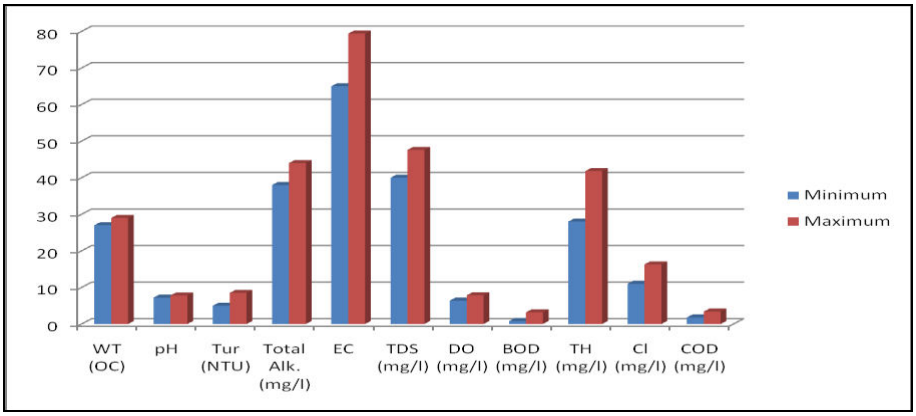

Fig. 6: Minimum and maximum values of water parameters in Bhadra reservoir.

Table 2: Descriptive statistics of independent treatments

Treatment →	A	B	C	D	Pooled Total
observations	10	10	10	10	40
sum	441.0000	259.0000	63.000	51.0000	814.000
mean	44.1000	25.9000	6.3000	5.1000	20.3500
sum of squares	28,173.000	9,771.000	497.000	315.000	38,756.00
sample variance	969.4333	340.3222	11.1222	6.1000	569.0026
sample std. dev.	31.1357	18.4478	3.3350	2.4698	23.8538
Std. Dev. of mean	9.8460	5.8337	1.0546	0.7810	3.7716

(A) *Salmostoma/Salmophasia/Puntius /Cyprinus sp*; (B) *Labeo/Cirrhinus/Rasbora/Garra sp.*; (C) *Osteobrama/Danio/Rohtee/Hypselobarbus sp.*; (D) *Pethia/Opsarius/Dawkinsia sp.*

Table 3: One-way ANOVA of independent treatments

Source	Sum of squares	DF	mean square	F statistic	p-value
Treatment	10,248.3000	3	3,416.1000	10.2974	4.9054e-05
Error	11,942.8000	36	331.7444		
Total	22,191.1000	39			

The p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, suggesting that the one or more treatments are significantly different.

Table 4: Tukey HSD data

Treatments Pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	3.1599	0.1332233	insignificant
A vs C	6.5628	0.0010053	** p<0.01
A vs D	6.7712	0.0010054	** p<0.01
B vs C	3.4029	0.0939394	insignificant
B vs D	3.6113	0.0685207	insignificant
C vs D	0.2083	0.8999947	insignificant

Table 5: Scheffe data

Treatments Pair	Scheffe T-statistic	Scheffe p-value	Scheffe inference
A vs B	2.2344	0.1919595	insignificant
A vs C	4.6406	0.0006733	** p<0.01
A vs D	4.7879	0.0004458	** p<0.01
B vs C	2.4062	0.1421636	insignificant
B vs D	2.5536	0.1080597	insignificant
C vs D	0.1473	0.9991381	insignificant

Table 6: Bonferroni and Holm results: all pairs simultaneously compared

Treatment Pair	Bonferroni and Holm T-statistic	Bonferroni p-value	Bonferroni inference	Holm p-value	Holm inference
A vs B	2.2344	0.1905537	insignificant	0.0635179	insignificant
A vs C	4.6406	0.0002689	** p<0.01	0.0002240	** p<0.01
A vs D	4.7879	0.0001720	** p<0.01	0.0001720	** p<0.01
B vs C	2.4062	0.1282575	insignificant	0.0641287	insignificant
B vs D	2.5536	0.0902550	insignificant	0.0601700	insignificant
C vs D	0.1473	5.3022043	insignificant	0.8837007	insignificant

Table 7: Bonferroni and Holm results: only pairs relative to A is compared

Treatments Pair	Bonferroni and Holm T-statistic	Bonferroni p-value	Bonferroni inference	Holm p-value	Holm inference
A vs B	2.2344	0.0952769	insignificant	0.0317590	* p<0.05
A vs C	4.6406	0.0001344	** p<0.01	8.9617e-05	** p<0.01
A vs D	4.7879	8.6017e-05	** p<0.01	8.6017e-05	** p<0.01

oxygen demand. The values of biochemical oxygen demand ranged from 0.8 to 3.2 mg/l. According to Rice (1938), the presence of a significant amount of organic matter brought in by the surface runoff of heavy rain during the winter probably contributed to maximum values. Biochemical oxygen demand values were low during the rainy season; this is because organisms' rates of reproduction are slowed down by temperature. From the Manar river district in Nanded, Manea Madlapure (2002) also made similar observations. A measure of the capacity to precipitate soap is total hardness. It is the sum of the water's polyvalent cations. The overall hardness was between 28 and 41.8 mg/l. Surface runoff caused the highest hardness to be recorded during the rainy season. The WHO's permissible limits were met by the total hardness values.

In order to determine the concentration of ground water in waste water, chlorides are crucial. The chloride concentration in this study ranged from 11.0 to 16.3 mg/l. Damodharan and Suresh (2005) observed results that were comparable. The presence of bio-chemically resistant substances and toxic conditions can be identified with the help of the chemical oxygen demand (COD) test. In the current investigation, COD was highest during the summer (3.4 mg/l) and lowest during the rainy season (1.8 mg/l), indicating lower microbiological activity and oxidisable matter in the water. The water body was moderately oligotrophic, as evidenced by the low

levels of phosphate, nitrate, calcium, magnesium, and ammonia.

Considering the pollution factor in the catchment area, agriculture is the primary activity, making significant use of fertilizers and pesticides. All other human activities, except for agriculture, are negligible. Due to runoff, these pollutants end up in the reservoir. Even though there is no possibility of a high pesticide concentration in the reservoir water, biomagnification makes it important for higher-order organisms like fish. As a result, it demonstrates the pressing need to measure the effects of pesticides on aquatic species.

Conclusion

This study is the first to record the presence of minor carps and minnows in Bhadra reservoir, Karnataka. Fishing should be prohibited for approximately three months during the breeding season to prevent overexploitation and ensure the proper growth of fish. Additionally, mesh regulation in fishing should be properly ensured as an essential factor. The low assortment and declining of the fish species were ascribed to the co operations of many variables in the water body which incorporates over double-dealing of the species, low cost of rearing, unfavorable environment, contamination, approaching of select species. Numerous conservation measures, such as, are in place to prevent a similar species decline in water bodies. To maintain the genetic diversity of the species, beautify the fisheries, increase aesthetic value, and control of invasive species, public recognition and education must be geared toward the species. stoking of the species, improving habitat, and controlling invasive species are also necessary. Therefore, in order to safeguard these resources, it is essential to produce fish in a sustainable manner by taking the appropriate measures to maintain variety.

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