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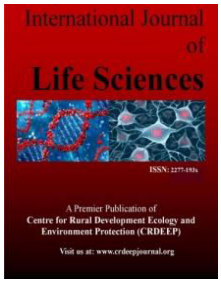

Full Length Research Paper

Diversity and Abundance of Fishes Inhabiting the Western region of Narmada River Madhya Pradesh India.

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ABSTRACT

The current study was carried out to find the diversity and abundance of fishes in the selected sites of river Narmada in Madhya Pradesh for a period of 2 years that is from Jan 2017 to Dec 2018. A total of 52 species belong to 10 orders containing 16 families were observed Family Cyprinidae contained highest number of species 25 followed by Bagridae, Siluridae and ophiocephalidae containing 4 each respectively. Highest number of species were observed on site 4 (47 species) followed by site 2 (45species) site 3 contains 42 species and site 1 (43 species). For the measurement of diversity a total of two diversity indexes were used Shannon and Simpson index. Shannon index showed the similar trend and ranged from 2.77 to 3.78 and Simpson index ranged from 0.01 to 0.03. The present data was compared to the previously published data it showed that the overall diversity is still conserved but there is massive decrease in the number of particular species. Therefore proper scientific management of the aquatic resource, implementation of laws for illegal fishing, further study regarding the activities effecting the diversity and implementation of new methods and protocols for their sustainable conservation is at crying need.

Introduction

Among different ecosystems, freshwater ecosystems are the richest and more diverse ecosystems on earth .6% of all species, and more than 10% of all animal species, occur in freshwater, including 25% of all vertebrates. Among vertebrates, fishes are the fifth largest agricultural resource and are the primary source of protein to over one billion people. It has been estimated that the global diversity of all fishes is 32,500 species. Considering that freshwater may constitute less than 0.3% of available global water, it is remarkable that there are almost 15,000 freshwater fish species. While marine communities contain more species in total, freshwaters are far richer per unit volume of habitat. Here, freshwater fish species occur at one per 15 km³ of water (compare to one per 100,000 km³ of sea water). This reflects the productivity, physiographic diversity and geographical isolation of freshwater habitats. Comprising approximately 25% of all vertebrates, freshwater fishes are an important component of global biodiversity. Approximately 7,956 of all fish species (30%) are contained within just 6 of the 515 taxonomic families. Remarkably, 6,100 (77%) of species in these representative families live in freshwater Out of 15000 freshwater fish species recorded in the world (Leveque *et al.* 2008), 868 were found in India accounting for 5.75 % global freshwater fish diversity. It includes 192 endemic species and 327 species listed as threatened in India by the IUCN (Lakra*et al.* 2010). Freshwater fishery resources in India include 45,000 Km. of rivers, 1, 26,334 Km. of canals, ponds and tanks 2.36 million hectares and 2.05 million hectares of reservoirs (Ayappan and Birdar, 2004).

Recent study estimations have suggested that Aquatic ecosystems are particularly concerned by the loss of biodiversity especially due to human activity (Abell, 2002; Pullin, 2000). Freshwater fishes are one of the most threatened taxonomic groups because of their high sensitivity to the quantitative and qualitative changes of aquatic habitats and limitations in the physiology, morphology, and life history of species associated with environmental constraints (Williams *et al.,* 2003; Skov and Svenning, 2004; Hilbert *et al.,* 2004; Thomas *et al.,* 2004). Fish communities, and specific species, are excellent indicators of biological and ecological integrity due to their continuous exposure to water conditions. Fishes display an array of biotic responses, such as changes in growth, distribution and abundance related to water pollution, critical habitat degradation, eutrophication, organic enrichment, chemical toxicity, thermal changes and food availability and thus enforced extinction, should be key elements of ecosystem monitoring programs. Due to the life history traits fishes are suitable as early-warning signals of anthropogenic stress on natural ecosystem dynamics,

or conversely, as indicators of ecosystem recovery and of resilience. (Chovanec*et al.,* 2003; Schneiders*et al.,* 1993; Schiemer, 2000). Today the fish diversity and associated habitats Conservation measures to mitigate the impact of the pressures have largely been slow and inadequate and as a result many of the species are declining rapidly (Dudgeon *et al.,* 2006). The main causes for the decline are habitat destruction and fragmentation, practices of land-use (including abandonment, and intensification of use ofnatural resources, exotic speciesintroduction, unplanned and illegal fishing, irrigation needs, industries and private use, pollution) and global climate changeimpacts (Kumar *et al.,* 2000; Dulvy*et al.,* 2003;Leveque *et al.,* 2005; Leptez*et al.,* 2009). Over the past 30 years, freshwater species have declined faster compared to terrestrial or marine species (Jenkins, 2003). Unfortunately, growing evidence indicate that this trend is likely to persist in the future. In order to promote the efficient management of freshwater biodiversity and eventually inverse its decline, there is an urgent need to provide solid estimations of fish species losses under plausible climate change, distribution patterns and water consumption scenarios.

Material and methods

Description of study Area

River Narmada (life line of Madhya Pradesh) is a west flowing river which flows over an area of 98,796 km² and lies between east longitudes 72 degrees 32' to 81 degrees 45' and north latitudes 21 degrees 20' to 23 degrees 45' lying on the northern extremity of the Deccan Plateau. The river flows through four states of India that is in Gujarat, Madhya Pradesh, Maharashtra and Chhattisgarh. Madhya Pradesh shares the largest portion (86.18%) while the remaining part lies in Gujarat (11.6%), Maharashtra (1.5%), and Chattisgarh (0.72%). During its course, the river originates from an elevation of 1051 m to sea level, and flows through narrow gorges in the head reaches. The basin is bounded on the north by the Vindhya ranges, on the east by the Maikal range, on the south by the Satpura ranges and on the west by the Arabian Sea. The river swallows 41 tributaries, of which 22 touches the left bank and 19 from the right bank.

Study stations

A total of 4 stations were selected for study which are as

Site1: Omkareshwar

Omkareshwar is a famous place of pilgrimages, situated 77 km from Indore in Khandwa District. Madhya Pradesh shaped like the holy Hindu Symbol. 'OM', this sacred island, on the conflux of the river Narmada and Kaveri is visited by pilgrims from all over the country to seek blessing at the temple of Shri OmkarMandhata. It's Latitude (D M S) – 22º15' 1" N and Longitude – (DMS) 76º8' 48" E

Site2. Mandleshwar:

Mandleshwar is a small town and a NagarPanchayatKhargon District in the Madhya Pradeshstate of India (Asia). It is a town of historical andreligious importance situated on the banks ofNarmada River at a distance of 8 km east from Maheshwar, which was the capital of Holkar States and 99 km from Indore.

It's Latitude– 22º18 Latitude (DMS) 22º10' 60" N and Longitude –75º67. Longitude (DMS) 75º0' 0" E.

Site3. Maheshwar:

Maheshwar is a small town in Khargone district of Madhya Pradesh state in central India. It is located 91 km. away from Indore (4 hour by bus), the commercial capital of the state. The town lies on the North bank of the Narmada River.

Its Latitude– 22º18 Latitude (DMS) 22º10' 60" and Longitude – 75º58, Longitude (DMS) 75º54' 60" E.

Site4: Khalghat

Khalghat is a small town and a Municipality in Dhar district in the state of Madhya Pradesh, India. It is located on the banks of Narmada River and national Highway 3 Agra- Indore – Dhule – Mumbai. It is 76 km away from Indore.

Its latitude is 22o 10' O"N and longitude is 75o 27'O" E

Sampling

The selected sites were surveyed by walking and some guidelines were also taken from the local fishermen. Fishes were collected with the help of local fishermen by using cast nets of various sizes (2.5 m x 7 mm and 2 m x 10 mm). Collection was done at 5 m intervals and at each site three attempts were made to minimize the error. For very small fishes, modified methods for collection, such as cloths and bottles were used. Cloth of sizes 1 m x 0.6 m and 1 m x 0.45 m were used as traps by placing it at the bottom of water near the periphery of the stream mimicking natural substratum. After preset time the cloth was gently lifted up above water surface by holding it at four corners and fishes were collected. Sometimes plastic bottles were also used for collection. After collection the number was counted and recorded. Local names was also noted after asking from the fishermen. For biometric studies (morphometric and meristic) and species identification. 2-3 specimens for each type were collected from each station. The collected specimens were preserved in 4% formalin solution and kept in air tight plastic bottles. The morphometric study included measurement of standard length, total length and body were done using measuring scales, Vernier calipers and pan balance. Fish identification was done using keys developed by (Talwar and Jhingran, 1991; Pethiyagoda, 1991; and Jayaram, 1999).

Data analysis

The Species distribution denoting the presence or absence of the species on monthly and yearly basis, total number of species, average yearly variations with SD and SE and average variations were performed using Microsoft excel, 2013.

Percentage of occurrence

$$\%age \text{ of occurrence} = \frac{\text{number of individuals belonging to ith family}}{\text{total number of individuals}} \times 100$$

Diversity indexes: following diversity indexes were used

Shanon -Weiner index

$H = \sum piInPi$

Simpson index:

$D = 1/\sum pi2$

Results

During the current study, a total of 52 species belong to 10 orders containing 16 families were observed Table 1.

Table 1: Species composition of fishes observed during year 2017 and 2017

Order	Family	Species
Cypriniformes	Cyprinidae	catlacatla
		Labeobata
		Labeocalbasu
		Labeorohita
		labeodara
		labeofambriates
		labiogonius
		puntiuschola
		puntiussarana
		puntiussophore
		puntiusticto
		puntiusvitatus
		Garragotylagotyla
		cirrhinusmrigilla
		Cyprinuscarpio
		Osteobramacotio
		ctenopherogodonidela
		devarioaeqipinnatus
		Hypophthalmichythysnobilis
		salmophasisbacaila
		clupisomaGarua
		tor tor
		tar pitora
		crossochillieslatius
		BeriliusBendilesis
		rasboradaniconius
		banganadero
	Saccobranchidae	*Heteropneustesfossillis*
	Bagridae	Mystusbleekari
		Mystuscavasius
		Mystusseenghala
		ritsrorgia
	Siluridae	Ompokbimaculatus
		ompokmalabaricus
		ompokpabda
		wallagoattu
	Cobitidae	Nemacheilusbotia
Perciformes	Nandidae	*Nandusnandus*
	Centropomidae	*chandaNama*
	Gobiidae	Glossogobiusgiuris
	Ambassidae	parambasialala
Mastacembeleformes	Mastacembelidae	*Mastacembalusarmatus*
		Mastacembeluspancalus
Ophiocephaliformes	Ophiocephalidae	chanaGachua
		channamarilius
		Channapunctata

		Channa straita
siluriformmes	Schilbeidae	clupisomaGarua
Clupeiformes	Notopteridae	Notopterus notopterus
Beloniformes	Belonidae	Xenentodoncancila
Mugiliformes	Mugilidae	rhinomogilcarsula
Anabantiformes	Osphronemidae	trichogasterfacitata
	Badidae	badisbadis

Family Cyprinidae contained highest number of species 25 followed by Bagridae, Siluridae and ophiocephalidae containing 4 each respectively. Highest number of species were observed on site 4 (47) followed by site 2 (45) site 3 contains 42 species and site 1 (43). Among all the species observed during the study period some species such as:

Catla catla , Labeo bata, Labeo calbasu Labeo rohita, Labeo dara, Labeo fambriates, Labeo gonius, Puntius chola Puntius sarena , Puntius sophore, Puntius ticto, Puntius vitatus Garra gotyla gotyla, Cirrhinus mrigilla, Cyprinus carpio, Ctenopherogodon idela, Salmophasia bacaila, Tor tor , Tar pitora, Heteropneustes fossillis, Mystus bleekari, Mystus seenghala, Ompok bimaculatus, Ompok malabaricus, Wallago attu, Chandanama, Glossogobius giuris, Channa marilius, Channa punctate, Channa straita, Cirrhinus mrigilla, Notopterus notopterus, and Badis badis were found on all the study sites that is on site 1,site 2 , site 3 and site 4 table , *Nandus nandus* was found on site 1 and site 2, *Trichogaster facitata and Ompok pabda* were found on site 1, site 2 and site 4, *Devario aqipinnatus* and *Hypophthalmichythys nobilis* on site2 and site 4, *Clupisoma garua* was found site 1 and 4 and *Crossochillies latius, Berilius bendilesis and Rasbora daniconius* were found site 3 and site 4.Table 2.

Table 2: Presence and absence of species on the sampling stations.

Order	Family	Species	Site 1	Site 2	Site 3	Site 4
		catlacatla	+	+	+	+
		Labeobata	+	+	+	+
		Labeocalbasu	+	+	+	+
		Labeorohita	+	+	+	+
		labeodara	+	+	+	+
		labeofambriates	+	+	+	+
		labiogonius	+	+	+	+
		puntiuschola	+	+	+	+
		puntiussarana	+	+	+	+
		puntiussophore	+	+	+	+
		puntiusticto	+	+	+	+
		puntiusvitatus	+	+	+	+
		Garragotylagotyla	+	+	+	-
		cirrhinusmrigilla	+	+	+	+
		Cyprinuscarpio	+	+	+	+
		Osteobramacotio	-	+	-	+
		ctenopherogodonidela	+	+	+	+
		devarioaeqipinnatus	-	-	-	+
		Hypophthalmichythysnobilis	-	+	+	-
		salmophasisbacaila	+	+	+	+
		clupisomaGarua	-	+	-	+
		tor tor	+	+	+	+
		tar pitora	+	+	+	+
		crossochillieslatius	-	-	+	+
		BeriliusBendilesis	-	-	+	+
		rasboradaniconius	-	-	+	+
	Cyprinidae	banganadero	+	-	+	+
Cypriniformes	Saccobranchidae	*Heteropneustesfossillis*	+	+	+	+

		Mystusbleekari	+	+	+	+
		Mystuscavasius	+	-	+	-
		Mystusseenghala	+	+	+	+
	Bagridae	ritsrorgia	+	+	+	+
		Ompokbimaculatus	+	+	+	+
		ompokmalabaricus	+	+	+	+
		ompokpabda	+	+	-	+
	Siluridae	wallagoattu	+	+	+	+
	Cobitidae	Nemacheilusbotia	+	-	+	+
	Nandidae	Nandusnandus	+	+	-	-
	Centropomidae	chandaNama	+	+	+	+
	Gobiidae	Glossogobiusgiuris	+	+	+	+
Perciformes	Ambassidae	parambasialala				
		Mastacembalusarmatus	+	+	+	+
Mastacembeleformes	Mastacembelidae	*Mastacembeluspancalus*	-	+	+	+
		chanaGachua	-	-	+	+
		channamarilius	+	+	+	+
		Channapunctata	+	+	+	+
Ophiocephaliformes	Ophiocephalidae	Channa straita	+	+	+	+
siluriformes	Schilbeidae	cirrhinusmrigilla	+	+	+	+
Clupeiformes	Notopteridae	Notopterus notopterus	+	+	+	+
Beloniformes	Belonidae	Xenentodoncancila	+	+	+	+
Mugiliformes	Mugilidae	rhinomogilcarsula	+	-	-	+
Anabantiformes	Osphronemidae	trichogasterfacitata	+	+	-	+
	Badidae	badisbadis	+	+	+	+

Note: Presence (+) Absence (-)

On site1 a total of 2762 individuals of fishes were found during the study period with highest number in the month of December 180 individuals followed by January 178 individuals. Lowest number was observed in the month of July 66 followed by June 68 individuals. Among observed species highest number was contributed by *Labeo rohita* 211 and the lowest number by *Puntius vitatus* 22 individuals.

On site 2, 2198 individuals of fishes were collected during the study period. Highest number of individuals were found in the month of January 145 and the lowest number was found in the month of July 41 individuals. *Labeo bata* was with highest number of individuals 141 and *Nandus nandus* was with lowest number of individuals 12.

During year 2017 and 2018, 2289 individuals belonging 43 species of fishes were collected on site 3. Individual species with highest number of individuals was *Labeobata*156 individuals and the species with lowest number of individuals was *Chana gachua* 24 individuals. The month of December was observed with highest number 154 individuals while the month of July was with lowest number of individuals 24.

On site 4, 2298 individuals of fishes were collected with highest number in the month of December 169 individuals and lowest number in July 39 individuals. *Labeo rohita* was with highest individuals 189 and *Osteobrama cotio* was with lowest individuals 14.

By percentage of occurrence family Cyprinidae dominated by contributing, 58% and followed by Ophiocephalidae 9%. The lowest contribution by family by Schilbeidae 1% for year 2107 and 2018.

For the measurement of diversity a total of two diversity indexes were used Shannon and Simpson index. Shannon index showed the similar trend and ranged from 2.77 to 3.78. on site 1 the value ranged from 3.72 to2.85. Highest value was observed in the month of October and the lowest value in the month of June. On site 2 the value varied from 2.77 to 3.68.on site 3 the values observed were in the range of 2.88 to 3.72 and on site 4 the values observed was in the range 2.85 to 3.73. Simpson index ranged from 0.01 to 0.03 and were almost similar throughout the study period. Value above 1 of Shannon index suggests that the river Narmada provides better habitat for fishes and can support the maximum number of fishes.

Discussion

Fisheries in India have great potential of contributing to the food security of the country. Reservoirs and lakes are the main resources exploited for inland fisheries and understanding of fish faunal diversity is a major aspect for its development and the sustainability management. . The change in the composition of

fish assemblage indicates variation in the water (Jhingran 1983; Kumar and Paul 1990). Fishes constitute nearly half of the number of vertebrate fauna found in the world. Fish diversity and its conservation are regarded as one of the major issues of enabling sustainable use of natural resources. The present study is its kind for the River Narmada in which I try to quantify the species and their occurrences. During the current study, a total of 52 species belong to 10 orders containing 16 families were observed. (Vyas *et al.,* 2009) studied on fish fauna of tributaries and recorded 52 species belonging to 28 genera, 13 families and 7 orders. (Bose *et al.,* 2013) have reported 57 species, belonging to 35genera, 13 families and six orders from Middle Stretchof River Tawa. (Pathak, et al., 2014) observed 58 species of fishes in the western segment of river Narmada. (Vyas *et al.,* 2007) reported, a total of 47 species of fishes belonging to 29 genera, 15 families, and six orders were recorded in the Hoshangabad stretch of Narmada. (Chouhan, et. al., 2013) recorded 59 fish species which belonging to 34 genera, 17 families and 7 orders at Maheshwar, Khalghat and Barwani sites of Narmada. Family Cyprinidae contained highest number of species 25 followed by Bagridae, Siluridae and Ophiocephalidae containing 4 each respectively. The highest number of species belonging to the cypenidae may be due their large fecundity and the tolerance towards the changes in the physical and biological characteristics of water body. (Sharma, et al., 2008) stated that Due to more fecundity of major carps and suitable environmental conditions are responsible for relatively higher population density of Cypriniformes.

Presence of various species of fishes showed the variation on different sites of the study area. Site 4 showed the highest number of species 50 species and site 2 showed lowest numbers of species. The difference in the number of species is due to the difference of habitat that is the depth and rate of flow and also due the presence of availability of food. Habitat heterogeneity (including depth and flow heterogeneity) increases downstream providing a wide range of niches (Guegan*et al.,* 1998) that may be used by a large set of species (Oberdorff*et al.,* 1993; Aarst and Nienhuis, 2003). (Sarkar and Bain, 2007) found that most numerous and diverse group of fish were associated with deep depositional habitats of Gerua River (Uttar Pradesh) and species and life stages found occupied a statistically distinct subset of the river habitats. . In rivers, water flow generally depends upon the amount of water available and on its depth water and can influence water chemistry, habitat, population dynamics and water temperature (Schindler *et al.,* 2007; Saksena*et al.,* 2008). The habitat structure determines the abundance and diversity of organism (Baretto and Uieda, 1998; Hubert and Rahel, 1989; Hynes, 1970; Pusey *et al.,* 1993; Schlosser, 1982).

The number of individuals present on different sites also showed considerable variations with highest number of individuals in the months of November and December and lowest number in the months of May and June. The pattern of difference in the number of individuals may be due following reasons. Low diversity in summer months is due to extreme reduction of depth which ultimately results in increase of salinity, free CO2 and hardness of water, decrease of dissolve oxygen, transparency and pH of water leading to the reduction in fish diversity whereas its vice versa in winters. Due to this, large scale degradation of physico – chemical parameters and very poor catchment of fishes is recorded in summers thus reflecting low diversity level. Some external factors also adds up to this situation such as introduction of exotic species, simple habitat destruction resulting from human withdrawals for human acts like agriculture, irrigation etc and direct exploitation such as impoundments, migration of species etc.

For the measurement of diversity a total of two diversity indexes were used Shannon and Simpson index. Shannon index showed the similar trend and ranged from 2.77 to 3.78 on site 1 the value ranged from 3.72 to 2.85. Highest value was observed in the month of October and the lowest value in the month of June. On site 2 the value varied from 2.77 to 3.68.on site 3 the values observed were in the range of 2.88 to 3.72 and on site 4 the values observed was in the range 2.85 to 3.73 Simpson index ranged from 0.01 to 0.03 and were almost similar throughout the study period. Value above 1 of Shannon index suggests that the river Narmada provides better habitat for fishes and can support the maximum number of fishes. The difference in the diversity index could be attributed to the different physico – chemical parameters such as temperature, dissolved oxygen and depth of the habitat. The summer season is generally observed with low depth of water, highest temperature low dissolved oxygen and increase in the organic and inorganic pollutants while the post monsoon is observed with high depth due to increase in water level by monsoon rains, mixing of water via rains increase in the dissolved oxygen and the dilution of organic and inorganic pollutants. All these factors have the direct impact on the diversity and assemblage of fishes.

The present results are also found to be in agreement with investigations carried out by (Kumar and Paul 1990; Chouhan, et al., 2013; Sharma, et al 2011; Chouhan, et al., 2010; Chouhan, et al,.2013.)

Conclusion

River Narmada is found to support considerably rich fish diversity and acts as potential economic source for the local people and government of India. A total of 52 species belong to 10 orders containing 16 families were observed. Family Cyprinidae contained highest number of species 25 followed by Bagridae, Siluridae and Ophiocephalidae containing 4 each respectively. Highest number of species were observed on site 4 (47) followed by site 2 (45) site 3 contains 42 species and site 1 (43). Site 4 provides all types of habitat that is riffle and pond type etc. also the site one possesses small pebbles, rock beds and plenty of vegetation which suits for most of the species for their survival and reproduction. By percentage of occurrence family Cyprinidae dominated by contributing 53%, 56%, 58% and 53% followed by Ophiocephalidae 9%, 6% 9% and 7% on site 1 2 3 and 4 respectively. Highest number of individuals were recorded on site 1 (2798) followed by site 3 (2289) both site are wide and pond type Ghats, sacred religious places and usual fishing is inhibited there, most importantly there is artificial feeding by the common people to the fishes. For the measurement of diversity a total of two diversity indexes were used Shannon and Simpson index. Shannon index ranged from 3.09 to 3.66 while as Simpson index ranged from 0.01 to 0.03. Value above 1 of Shannon index suggests that the river Narmada provides better habitat for fishes and can support the maximum number of fishes. The present data when compared to the previously published data it showed that

the overall diversity is still conserved but there is massive decrease in the number of particular species (Tor tor). The case was already noticed by the working body and a workshop for the management of Mahasheer conservation was also done in the Indore city of Madhya Pradesh. By all this is it is quite evident to recommend here that proper scientific management of the aquatic resource, implementation of laws for illegal fishing, further study regarding the activities effecting the diversity and implementation of new methods and protocols for their sustainable conservation is at crying need.

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