

RESEARCH ARTICLE

Biodiversity and conservation assessment of freshwater fishes of Harsi Reservoir, Madhya Pradesh, India

Shrotriy Ved Prakash

Government Kamla Raja Girls (Autonomous) Postgraduate College, Gwalior-474001, Madhya Pradesh, India

Address for correspondence Email: veds.11@rediffmail.com

Manuscript details:	ABSTRACT
<p>Received: 19 October, 2014 Revised : 05 December, 2014 Accepted: 02 February, 2015 Published : 30 March, 2015</p> <p>Editor: Dr. Arvind Chavhan</p> <p>Cite this article as: Shrotriy Ved Prakash (2015) Biodiversity and conservation assessment of freshwater fishes of Harsi Reservoir, Madhya Pradesh, India, <i>Int. J. of Life Sciences</i>, 3(1): 27-35.</p> <p>Acknowledgement: The author thankfully acknowledges the University Grants Commission, New Delhi, for financial assistance (SAP-II, No. F-03.07.2002). I am also thankful to the Head School of Studies in Zoology, Jiwaji University, Gwalior and the Coordinator, UGC-SAP (DRS Phase-I) for providing necessary laboratory facilities. The authors are also thankful to Mr. Bharosi Lal, Contractor, Fisheries Society of Gwalior division, for helping us in collection of fish samples and providing boating facility during research work.</p> <p>Copyright: © 2015 Author(s), This is an open access article under the terms of the Creative Commons Attribution- Non-Commercial - No Derivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non- commercial and no modifications or adaptations are made.</p>	<p>This contribution focuses on the diversity, population and conservation aspects of fishes in one of the large freshwater body of Madhya Pradesh, 'Harsi reservoir'. The extensive survey was conducted from April, 2005 to March, 2007. A total of 51 species were recorded belonging to 33 genera, 16 families and 7 orders. As far as the fishes under different orders are concerned, order Cypriniformes consists of 15 genera belonging to 3 families, Siluriformes of 10 genera to 6 families, Perciformes of 3 genera to 3 families, Osteoglossiformes and Synbranchiformes of 2 genera each to singular family and Clupeiformes and Beloniformes of 1 genus each, to single family. The analysis showed that 07 and 04 fish species, as endangered by two different mode of classification. Apart from the Indian Major Carps, certain threatened species viz., <i>Chitala chitala</i>, <i>Tor tor</i>, <i>Ompok bimaculatus</i> and <i>Eutropiichthys vacha</i> were recorded from the reservoir. A sisorid, <i>Gagata sexualis</i> has been reported for the first time from this region. The study confirms that this freshwater body may prove congenial for conservation of regional fish diversity, especially for local and endangered fish species.</p> <p>Keywords: Conservation Status, Ichthyo-fauna, IUCN categorization, Threats to fish diversity.</p> <p>INTRODUCTION</p> <p>Throughout the world, freshwater environments are facing threats as regard to both ecosystem stability, biodiversity and many strategies have been proposed to solve this crisis (Cowx 2002 Suski and Cooke 2006). Stress caused by anthropogenic environment, degradation due to urbanization, construction of dams, abstraction of water bodies for irrigation and power generation and pollution are major constraints towards loss of habitat and thus biodiversity (Lyubov et al., 2011). The biodiversity crisis that we are currently facing requires priority setting at global, regional, and local scales in order to concentrate limited</p>

resources on the most important conservation needs (Darwall and Vie, 2005; Knight et al., 2008;). Myers et al. (2000) identified 18 mega-biodiversity 'hotspot' regions of the world, based on the criterion of exceptional concentration of species and endemism as well as exceptional degree of threats arising out of increased pressures of human intervention, with the possibility of potential extinction of constituent species caused by the latter and they have predicted the possibility of a major extinction spasm impeding in these areas. However, it has been pointed out that if key localities of biotic richness can be identified, conservation priorities could be determined in a more informed and methodological manner (Mittermeier et al., 1999; Myers et al., 2000). The principal drawback, however, remains the lack of basic data, especially of fish species.

India is blessed with a very rich and diverse natural water resource in the form of rivers, streams, estuaries, backwaters, impoundments, mangroves, floodplain wetlands, man-made reservoirs, lakes and ponds. The country is also endowed with a rich fish genetic biodiversity with approximately 2, 200 fish species and ranks 9th in term of freshwater mega biodiversity (Qureshi, 2007). A significant portion of the freshwater fish production in India is still based on the harvest from wild population (Sugunan, 1997). Attempts have been made to assess the freshwater fishes of Madhya Pradesh for their biodiversity and conservation have been done by many scientists including Garg et al. (2007 2010), Saksena (2007), Rao et al. (2007) and Dhakad et al. (2008).

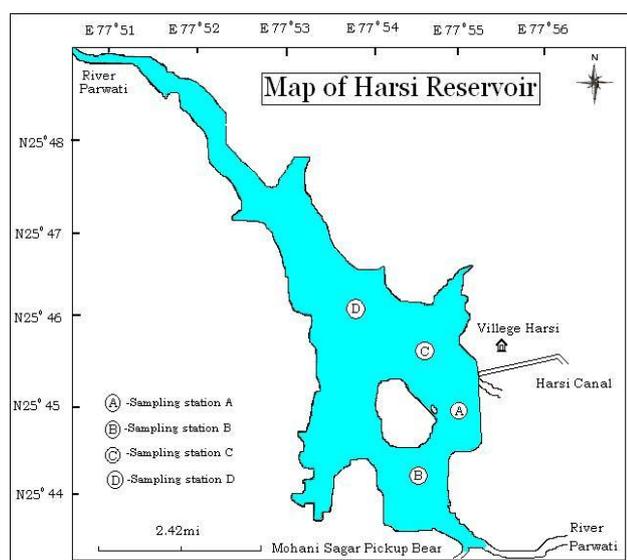


Figure 1: Location map of Harsi reservoir with sampling sites

The first assessment (Anon, 1992-1993) categorized 46 freshwater fish species as threatened in India. In the second assessment, 320 freshwater fishes were included and 43 freshwater fish species were categorized as critically endangered, 90 as endangered and 81 as vulnerable (CAMP,1998) while, a recent assessment for central India (Madhya Pradesh, Chattisgarh and Rajasthan) reported 168 fish species, of which, 41 species (24.40%) were placed as threatened (Sarkar and Lakra 2007). Therefore, In the present study, a detailed survey was conducted in the Harsi reservoir, Gwalior, Madhya Pradesh to ascertain the present scenario of fish diversity within the reservoir.

MATERIALS AND METHODS

Study Area: Harsi is an earthen dyke reservoir constructed on Parwati River which is situated near Harsi village in Bhitwar Tehsil, District Gwalior, Madhya Pradesh. Geographically, the ordinal points of the reservoir lie at N 25' 47^o to N 25' 48^o latitude and E 79'52^o to E 77' 55^o longitude (Figure 1). The water spread area of reservoir is 1960 km² (at full reservoir level), which is sometimes attained during the peak of the rainy season. Maximum depth of the reservoir was found to be 20.51m , whereas average depth was 10.86±1.08 m during the period of study. The reservoir is being heavily used for fisheries and irrigation of various crops such as wheat, Bengal gram, peas etc. through a canal named Harsi canal.

Samples were collected seasonally from five permanent sites in the Harsi reservoir using a different types of nets including gill net, cast net (Ghagaria jal), dip net and gamchhas. Total water body was divided into five sampling zones covering all representative habitats of the reservoir. Samplings was done after dawn (from 8:00 am to 12:00 noon) and to supplement the above efforts, regular sampling was also done before the dusk (03:00 to 5:00 pm) in order to assess the species diversity found at the study sites. Colour, spots (if any), maximum size and other characters of the fishes caught were recorded and the samples were preserved in 10% formalin solution, while large fishes were gutted for visceral preservation. Systematic identification of the fishes was done with the help of standard keys provided by Talwar and Jhingran (1991), Jayaram (1999) and Srivastava (1968). References to conservation status within this paper are based on IUCN classification as

per CAMP (1998), CAFF (2006) and Sarkar and Lakra (2007).

RESULTS AND DISCUSSION

Madhya Pradesh is the second largest geographic state of the country with an area of 3,08,245 km². This state has 4,60,384 ha of inland waters (Sugunan 1997) and about 138 freshwater fish species recorded, of which nearly 41 species are considered as threatened and 01 species *Hilsa ilisha* as critically endangered (Sarkar and Lakra 2007). Therefore, in order to prioritize freshwater fish species and their conservation action, an urgent need was felt to assess the present status of freshwater fishes of Harsi reservoir.

The ichthyo-faunal diversity of the Harsi reservoir is restricted to 51 species belonging to 33 genera, spread over 16 families. The composition of species and their percent under various orders has shown that 27 species are available under Cypriniformes with 52.94%, 12 species under Siluriformes with 23.53%, 6 species under Perciformes with 11.76%, 2 species each under Synbranchiformes and Osteoglossiformes with 3.92% and 1 species each under Clupeiformes and Beloniformes with 1.96% contribution each (Table 2).

An analysis of the taxonomic composition of fish fauna suggests, that Cyprinidae was the most abundant family with 25 representative species (49.02%) occurring in the study site. Bagridae, second dominant family, has 6 species (9.80%), followed by Channidae with 4 representative species (7.84%), 2 species each to Notopteridae (3.92%), Siluridae (3.92%), Sisoridae (3.92%) and Mastacembelidae (3.92%), whereas, Clupeidae, Cobitidae, Balitoridae, Schilbeidae, Clariidae, Heteropneustidae, Belonidae, Ambassidae and Gobiidae are the families having single species each (1.96%) representation (Table 3).

The IUCN categorization of fish species in the Harsi reservoir has been depicted in (Table 4). An important observation was that 7 species such as *Chitala chitala*, *Notopterus notopterus*, *Acanthocobitis botia*, *Tor tor*, *Rita rita*, *Ompok bimaculatus* and *Eutropiichthys vacha*, those were placed under the category of endangered species as per IUCN (CAFF, 2006), were found as stable population and having high conservation

significance and enjoying good population in Harsi reservoir. It is worth mentioning here that *Gagata sexualis* belonging to family Sisoridae is a new report from this reservoir and this region. Varied ecological status of the 7 endangered species and *Gagata sexualis* endows uniqueness at Harsi reservoir and therefore, there is an urgent need for conservation of these species by protecting the fauna from over exploitation and habitat destruction etc. Garg et al. (2007-2010) have studied fish fauna of Ramsagar reservoir, Datia, Madhya Pradesh and recorded 42 species of which family Cyprinidae was dominant with 21 (50%) species of the family. In the present investigation, 51 species of fishes were identified in which family Cyprinidae was most abundant with 25 species with 49.02% share which supported the previous fish fauna studies carried out in this region.

In the CAMP (1998), information regarding a total of 166 fishes was compiled for Central region, while in CAFF (2006), a total of 138 fishes were recorded. In these eight years, fish fauna of Madhya Pradesh has declined at a faster rate than the other states and this is a very serious issue for fish scientist towards fish conservation efforts. In the present investigation, we have classified fishes of Harsi reservoir on the basis of CAMP and CAFF as endangered (EN), vulnerable (VU), lower risk near threatened (LRnt), lower risk least concern (LRlc), not evaluated (NE) and Data deficient (DD) with their respective representative fish species were 04, 09, 24, 05, 09, 00 and 07, 10, 23, 06, 01, 04 respectively (Table 4). On the basis of IUCN categorization, we have found the similarity coefficient and distances between the categories and made a cluster diagram using the un-weighted pair group method with arithmetic mean (UPGMA) algorithm using Past software (1.91) which clearly shows that, the LRlc, EN, DD, VU and NE categories are directly correlated with each other while the LRnt (lower risk and near threatened) are not related to the other five categories (Figure 2). Similarly, It has also indicated endangered species (EN) are highly correlated with lower risk least concern (LRlc). It may be assumed that fishes under LRlc go towards the endangered category and therefore, the conservation of fishes categorized as LRlc is extremely desired.

Three species *Notopterus notopterus*, *Acanthocobitis botia* and *Rita rita* are declared as endangered species in CAFF but were categorized as lower risk near



Fig. 1 *Chitala chitala*

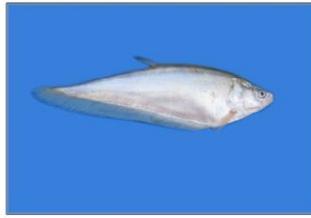


Fig. 2 *Notopterus notopterus*

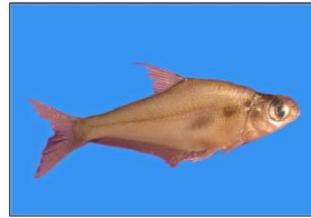


Fig. 15 *Osteobrama cotio cotio*



Fig. 16 *Puntius amphibiis*



Fig. 3 *Gudusia chapra*

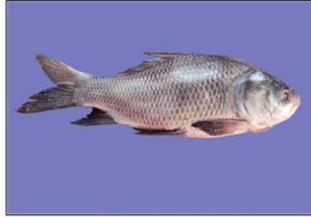


Fig. 4 *Catla catla*



Fig. 17 *Puntius conchonius*



Fig. 18 *Puntius sarana sarana*

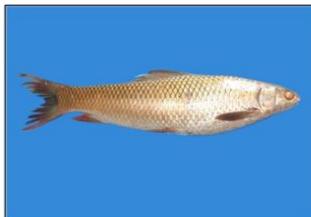


Fig. 5 *Cirrhinus mrigala*

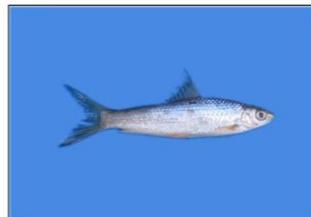


Fig. 6 *Cirrhinus reba*



Fig. 19 *Puntius sophore*



Fig. 20 *Puntius ticto*



Fig. 7 *Ctenopharyngodon idella*

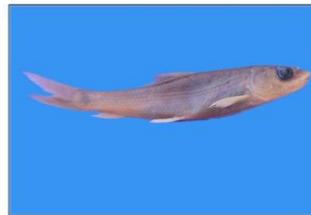


Fig. 8 *Labeo boggut*



Fig. 21 *Tor tor*

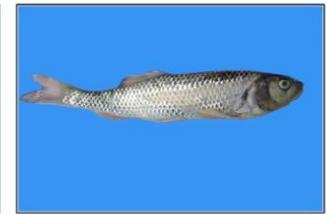


Fig. 22 *Barilius bendelisis*

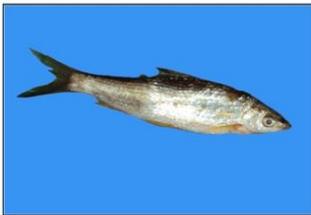


Fig. 9 *Labeo bata*

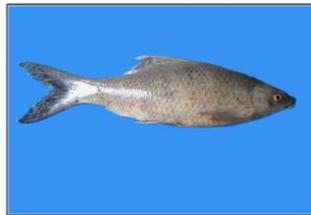


Fig. 10 *Labeo calbasu*



Fig. 23 *Danio devario*



Fig. 24 *Esomus danricus*



Fig. 11 *Labeo dyocheilus*



Fig. 12 *Labeo fimbriatus*



Fig. 25 *Rasbora daniconius*



Fig. 26 *Salmophasia laubuca*

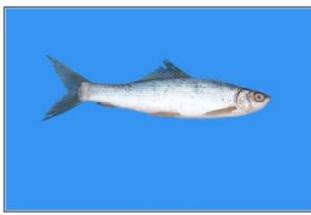


Fig. 13 *Labeo gonius*

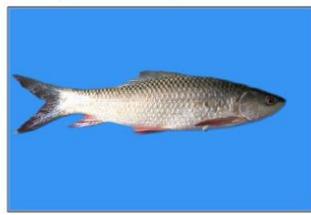


Fig. 14 *Labeo rohita*

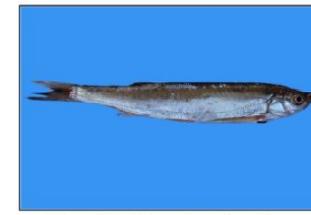


Fig. 27 *Salmostoma bacaila*

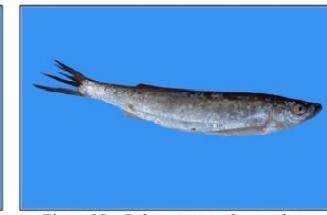


Fig. 28 *Salmostoma clupeioides*

Fig 1 to 28 Showing the various fish species identified in Harsi Reservoir



Fig. 29 *Lepidocephalichthys guntea*



Fig. 30 *Acanthocobitis botia*



Fig. 41 *Clarias batrachus*



Fig. 42 *Heteropneustes fossilis*



Fig. 31 *Mystus cavasius*



Fig. 32 *Mystus bleekeri*



Fig. 43 *Xenentodon cancila*



Fig. 9.44 *Mastacembelus armatus*



Fig. 33 *Rita rita*



Fig. 34 *Sperata oar*



Fig. 45 *Mastacembelus pancalus*



Fig. 46 *Parambassis (Chanda) ranga*

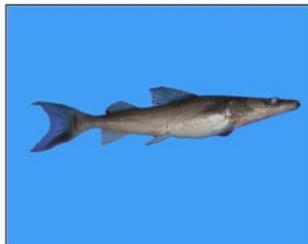


Fig. 35 *Sperata seenghala*



Fig. 36 *Bagarius bagarius*



Fig. 47 *Glossogobius giurus giurus*



Fig. 48 *Channa (Ophiocephalus) orientalis*



Fig. 37 *Gagata sexualis*



Fig. 38 *Ompok bimaculatus*



Fig. 49 *Channa (Ophiocephalus) marulius*



Fig. 50 *Channa (Ophiocephalus) punctatus*

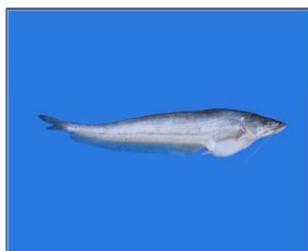


Fig. 39 *Wallago attu*



Fig. 40 *Eutropiichthys vacha*



Fig. 51 *Channa (Ophiocephalus) striatus*

Fig 29 to 51 Showing the various fish species identified in Harsi Reservoir

Table 1: Systematic list of fishes of Harsi reservoir along with IUCN categories

Class	Order	Family	S.N.	Name of Fish	Local name	CAMP (1998)	CAFF (2006)		
Actinopterygii	Osteoglossiformes	Notopteridae	1.	<i>Chitala chitala</i> (Hamilton-Buchanan)	Chital	EN	EN		
			2.	<i>Notopterus notopterus</i> (Pallas)	Patola	LR-nt	EN		
	Clupeiformes	Clupeidae	3.	<i>Gudusia chapra</i> (Hamilton-Buchanan)	Phulua	LR-lc	LR-lc		
	Cypriniformes	Cyprinidae	4.	<i>Catla catla</i> (Hamilton-Buchanan)	Catla	VU	LRnt		
			5.	<i>Cirrhinus mrigala</i> (Hamilton-Buchanan)	Mrigal	LRnt	LRnt		
			6.	<i>Cirrhinus reba</i> (Hamilton-Buchanan)	Naren	VU	VU		
			7.	* <i>Ctenopharyngodon idella</i> (Valenciennes)	Grass carp	NE	LRnt		
			8.	<i>Labeo boggut</i> (Sykes)	Boga	NE	LRnt		
			9.	<i>Labeo bata</i> (Hamilton-Buchanan)	Bata	LRnt	LRnt		
			10.	<i>Labeo calbasu</i> (Hamilton-Buchanan)	Kariya	LRnt	LRnt		
			11.	<i>Labeo dyocheilus dyocheilus</i> (Mc Clelland)	Kharont	VU	VU		
			12.	<i>Labeo fimbriatus</i> (Bloch)	Cut rohu	LRnt	LRnt		
			13.	<i>Labeo gonius</i> (Hamilton-Buchanan)	Kursa	LRnt	LRnt		
			14.	<i>Labeo rohita</i> (Hamilton-Buchanan)	Rohu	LRnt	LR-lc		
			15.	<i>Osteobrama cotio cotio</i> (Hamilton-Buchanan)	Gudgudi	LRnt	LRnt		
			16.	<i>Puntius amphibius</i> (Hamilton-Buchanan)	Khadia	NE	DD		
			17.	<i>Puntius conchoni</i> (Hamilton-Buchanan)	Khadia	LRnt	LRnt		
			18.	<i>Puntius sarana sarana</i> (Hamilton-Buchanan)	Puthia	VU	VU		
			19.	<i>Puntius sophore</i> (Hamilton-Buchanan)	Khadia	LRnt	LRnt		
			20.	<i>Puntius ticto</i> (Hamilton-Buchanan)	Khadia	LRnt	LRnt		
			21.	<i>Tor tor</i> (Hamilton-Buchanan)	Mahaseer	EN	EN		
			22.	<i>Barilius bendelisis</i> (Hamilton-Buchanan)	Phulua	LRnt	LRnt		
			23.	<i>Danio devario</i> (Hamilton-Buchanan)	Patukari	LRnt	LRnt		
			24.	<i>Esomus danricus</i> (Hamilton-Buchanan)	Dendua	LRlc	LRlc		
			25.	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	Zhazara	NE	LRlc		
			26.	<i>Salmophasia laubuca</i> (Hamilton-Buchanan)	Chal	LRlc	LR-IC		
			27.	<i>Salmotomabacaila</i> (Hamilton-Buchanan)	Chilua	LRlc	DD		
			28.	<i>Salmotoma clupeoides</i> (Bloch)	Silhani	LRlc	DD		
				Cobitidae	29.	<i>Lepidocephalichthys guntea</i> (Hamilton-Buchanan)	Bamni	NE	LR-lc
				Balitori	30.	<i>Acanthocobitis botia</i> (Hamilton-Buchanan)	Carri,Natwa	LR-nt	EN

Table 1: Continued...

Class	Order	Family	S.N.	Name of Fish	Local name	CAMP (1998)	CAFF (2006)
Actinopterygii	Siluriformes	Bagridae	31.	<i>Mystus cavasius</i> (Hamilton-Buchanan)	Kitua	LRnt	LRnt
			32.	<i>Mystus bleekeri</i> (Day)	Kirua	VU	VU
			33.	<i>Rita rita</i> (Hamilton-Buchanan)	Gegra	LRnt	EN
			34.	<i>Sperata oar</i> (Hamilton-Buchanan)	Tengra	NE	LRnt
			35.	<i>Sperata seenghala</i> (Sykes)	Singhara	NE	LRnt
		Sisoridae	36.	<i>Bagarius bagarius</i> (Hamilton-Buchanan)	Lamra	VU	VU
			37.	<i>Gagata sexualis</i> (Tilak)	Buhani/Unknown	NE	NE
		Siluridae	38.	<i>Ompok bimaculatus</i> (Bloch)	Pauda	EN	EN
			39.	<i>Wallago attu</i> (Block & Schneider)	Lonch	LRnt	LRnt
		Schilbeidae	40.	<i>Eutropiichthys vacha</i> (Hamilton-Buchanan)	Bachua	EN	EN
		Clariidae	41.	<i>Clarias batrachus</i> (Linnaeus)	Mangur	VU	VU
		Heteropneustidae	42.	<i>Heteropneustes fossilis</i> (Bloch)	Singhi	VU	VU
	Beloniformes	Belanidae	43.	<i>Xenentodon cancila</i> (Hamilton-Buchanan)	Suja	LR-nt	LRnt
	Synbranchiformes	Mastacembelidae	44.	<i>Macrogathus armatus</i> (Lacepede)	Baam	NE	VU
			45.	<i>Mastacembelus pancalus</i> (Ham-Buch)	Baam	LRnt	LRnt
	Perciformes	Ambassidae	46.	<i>Pseudoambassis (Chanda) ranga</i> (Ham-Buch)	Chanda	NE	VU
		Gobiidae	47.	<i>Glossogobius giuris giuris</i> (Ham-Buch)	Patharchita	LRnt	LRnt
		Channidae	48.	<i>Channa (Ophiocephalus) orientalis</i> (Ham-Buch)	Sola	VU	DD
			49.	<i>Channa (Ophiocephalus) marulius</i> (Ham-Buch)	Sol	LRnt	VU
			50.	<i>Channa (Ophiocephalus) punctatus</i> (Bloch)	Gilgonch	LRnt	LRnt
	51.	<i>Channa(Ophiocephalus) striatus</i> (Bloch)	Durkasol	LRnt	LRnt		

* Exotic fish ; En = Endangered species; VU = Vulnerable; LRnt =Lower risk near threatened;
LRlc = Lower risk least concern; NE = Not evaluated; DD =Data deficient

Table 2: Composition of genera and species under different in orders

S.No.	Order	Genera	% of Genera in order	Species	% of Species in order
1	Osteoglossiformes	02	6.06	02	3.92
2	Clupeiformes	01	3.03	01	1.96
3	Cypriniformes	15	45.45	27	52.94
4	Siluriformes	10	30.30	12	23.53
5	Beloniformes	01	3.03	01	1.96
6	Synbranchiformes	01	3.03	02	3.92
7	Perciformes	03	9.09	06	11.76

Table 3: Composition of genera and species under different in families

S. No.	Families	Genera	% Contribution of Genera to Families	Species	% Contribution of Species to Families
1.	Notopteridae	2	6.06	2	3.92
2.	Clupeidae	1	3.03	1	1.96
3.	Cyprinidae	13	39.39	25	49.02
4.	Cobitidae	1	3.03	1	1.96
5.	Balitoridae	1	3.03	1	1.96
6.	Bagridae	3	9.09	5	9.80
7.	Sisoridae	2	6.06	2	3.92
8.	Siluridae	2	6.06	2	3.92
9.	Schilbeidae	1	3.03	1	1.96
10.	Clariidae	1	3.03	1	1.96
11.	Heteropneustidae	1	3.03	1	1.96
12.	Belanidae	1	3.03	1	1.96
13.	Mastacembelidae	1	3.03	2	3.92
14.	Ambassidae	1	3.03	1	1.96
15.	Gobiidae	1	3.03	1	1.96
16.	Channidae	1	3.03	4	7.84

Table 4: Status of fishes of Harsi Reservoir according to IUCN categorization

S. No.	IUCN categories	Abbreviations	CAMP 1998	CAFF 2006
1.	Endangered	EN	04	07
2.	Vulnerable	VU	09	10
3.	Lower risk near threatened	LRnt	24	23
4.	Lower risk least concern	LRlc	05	06
5.	Not evaluated	NE	09	01
6.	Data deficient	DD	00	04

CAMP, 1998; CAFF, 2006

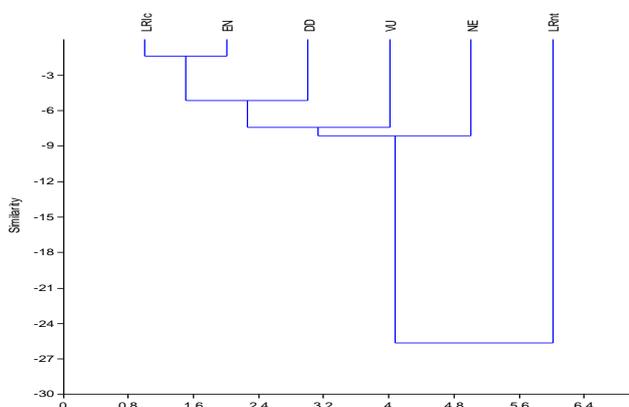


Figure 2: UPGMA clustering (Euclidean) of various IUCN categories using similarity matrix

The overall assessment indicates that a number of species recorded in Harsi reservoir were not observed by Garg et al. (2007, 2010) and Rao *et al.* (2007) in Ramsagar and Tighra reservoirs in this region. It suggested that Harsi reservoir is having a congenial habitat for freshwater fishes of this region. Therefore, it is very much essential to make a conservation management plan for Harsi reservoir, in which it may be possible to replenish the stock of threatened taxa with the help of Fisheries and Irrigation Departments, Government of Madhya Pradesh. The contributions of local peoples, fishermen and fisheries societies will also go a long way in the conservation of reservoir and its fish fauna, because no conservation strategy and

safeguarding biodiversity can be successful without the cooperation and involvement of the local communities (Koh and Sodhi 2010; Antons, 2010).

CONCLUSION

Analysis of fish species composition, distribution and ecological status with reference to their conservation status revealed that fish species diversity level in the Harsi reservoir appears to be constant. It is because of the fact that reservoir harbors only one exotic species i.e., grass carp, *Ctenopharyngodon idella*.

REFERENCES

- Anon (1992-1993) Annual report National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh, India.
- Antons C (2010) The role of traditional knowledge and access to genetic resources in biodiversity conservation in Southeast Asia. *Biodiver. Conserv. doi.* 10, 1007/s10531-010-9816-y.
- CAFF: (2006) Conservation Assessment of Freshwater Fish Diversity for Central India held at Central Institute of Agricultural Engineering (ICAR), Bhopal on November, 25,
- CAMP (1998) Report of the workshop on Conservation Assessment and Management Plan. Zoos Outreach Organization and National Bureau of Fish Genetic Resources, (NBFGR), p. 156.
- Cowx IG (2002) Analysis of threats to freshwater fish conservation past and present challenges. *In: Conservation of freshwater fishes, Options for the future.* (Eds M.J. Collares Pereira, I.G. Cowx, & M.M. Coelho). Blackwell Scientific Press, UK, p. 201-220.
- Darwall WRT and Vie JC (2005) Identifying important sites for conservation of freshwater biodiversity: extending the species-based approach. *Fish Manag. and Ecol.*, 12, p 287-293.
- Dhakad NK, D Shinde and P Choudhary (2008) Fish-fauna of Mod Sagar reservoir of Jhabua District Madhya Pradesh. *Nat. Environ. Poll. Tech.*, 7, 159-161.
- Dubey PK LP Maheshwari AK Jain (1980) Ichthyo-Geographical Survey of Chambal Division, Madhya Pradesh. *J. Jiwaji Univ.*, 8, 113-122 .
- Garg RK, RJ Rao and DN Saksena (2007) Checklist of fishes of Ramsagar reservoir, Datia district, Madhya Pradesh, India. *Zoo's Print*, 22, 2801-2803.
- Garg RK, RJ Rao and DN Saksena (2010) Fish diversity, production potential and commercial fisheries of Ramsagar reservoir, Datia, Madhya Pradesh, India. *J. Bombay Nat. Hist. Soc.*, 107, 24-29.
- Jayaram KC (1999) The freshwater Fishes of Indian region. Narendra Publishing House, New Delhi.
- Knight AT, RM Cowling, M Rouget, A Balmford, AT Lombard and BM Campbell (2008) Knowing but not doing: selecting priority conservation areas and the research-implementation gap. *Conserve Biol.* doi, 10.1111/j.1523-1739.2008.00914.x.
- Koh, LP and NS Sodhi (2010) Conserving Southeast Asia's imperiled biodiversity: Scientific management and policy challenges. *Biodiver. Conserv. doi.*, 10, 1007/s10531-010-9818-9.
- Lyubov E B, Alexander Y K, Vadim A K, Marsha E M, Daniel L B, Michael JC (2011) Endemic Species: Contribution to community uniqueness, effect of habitat alteration, and conservation priorities. *Conserv. Biodivers. doi.*, 10.1016/j.biocon.2010.08.010.
- Mittermeier RA, N Myers, RP Gil and CG Mittermeier (1999) Hotspots: Earth's biologically richest and most endangered terrestrial eco-regions. Cemex, S.A. and Conservation International, Mexico City, p 432.
- Myers N, RA Mittermeier, CG Mittermeier, GA Da Fonseca and J Kent (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403, 853-858.
- Qureshi TA (2007) Status of Finfish Diversity of Madhya Pradesh. *In: Proceeding of the Workshop on Conservation Assessment of Freshwater Fish Diversity for Central India.* (Eds.: W.S. Lakra and U.K. Sarkar). National Bureau of Fish Genetic Resources (NBFGR), Lucknow (U.P.), India, p. 07-18.
- Rao RJ, RK Garg, DN Saksena and BD Singh (2007) Fish germplasm resources of Gwalior and Datia District, Madhya Pradesh *In: Proceeding of the Workshop on Conservation Assessment of Freshwater Fish Diversity for Central India.* (Eds.: W.S. Lakra and U.K. Sarkar). National Bureau of Fish Genetic Resources (NBFGR), Lucknow (U.P.), India, p. 46-49.
- Saksena DN (2007) Fish Diversity of northern Madhya Pradesh (Gwalior and Chambal divisions *In: Proceeding of the Workshop on Conservation Assessment of Freshwater Fish Diversity for Central India.* (Eds W.S. Lakra and U.K. Sarkar). National Bureau of Fish Genetic Resources (NBFGR), Lucknow (U.P.), India, p. 50-57.
- Sarkar, UK and Lakra WS (2007) An overview of the diversity and conservation status of freshwater fishes of central India. *In: Proceeding of the Workshop on Conservation Assessment of Freshwater Fish Diversity for Central India.* (Eds W.S. Lakra and U.K. Sarkar). National Bureau of Fish Genetic Resources (NBFGR), Lucknow (U.P.), India,
- Srivastava Gopal Ji (1968) Fishes of Uttar Pradesh and Bihar, Vishwavidyalaya Prakashan, Varanasi, India. .
- Sugunan, VV (1997) Reservoir fisheries of India. *FAO Fisheries Technical paper.*,
- Suski, CD and SJ Cooke (2006) Conservation of aquatic resources through the use of freshwater protected areas: opportunities and challenges. *Biodivers. Conserv.* 17, 2495-2511.
- Talwar PK and Jhingran AG (1991) Inland fishes of India and Adjacent countries. Vol I, II. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi, India.