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Biodiversity of the Freshwater Fishes in the Protected Forest Areas of Uttar Pradesh and its Significance in Management of Riverine Fish Diversity

U. K. Sarkar*, A.K. Singh and J. K. Jena

National Bureau of Fish Genetic Resources
Canal Ring Road, Dilkusha, Lucknow- 226002, India

*Email : usarkar1@rediffmail.com

Introduction

India has developed a network of 605 protected areas covering approximately 4.74% of the total geographical area of the country in the form of 509 wildlife sanctuaries, 96 National parks, and 3 conservation reserves. The total protected areas have been earmarked for extensive *in situ* conservation of habitats and ecosystems. Fisheries play promising role in socioeconomic development by providing nutritional security for the burgeoning Indian population and contribute to economic upliftment of farmers and fisher folks.

The Uttar Pradesh has vast potential of aquatic bioresources and offers considerable scope of inland fisheries development and aquaculture. Fishery resources are available in the form of rivers and their tributaries, reservoirs, wetlands, lakes, ponds and tanks exhibiting a rich genetic diversity. However, owing to ever increasing demand of water in this region, these bioresources are experiencing serious threats to both biodiversity and ecosystem stability and a number of fishes are disappearing due to several anthropogenic factors. During the last few decades, the fish biodiversity of the country are declining rapidly due to anthropogenic environmental degradation like urbanization, damming, abstraction of waters for irrigation and power

generation and pollution, which have subjected our natural water bodies in general and rivers, in particular to severe stress with devastating effects on fresh water fish diversity.

In view of the significance to improve the socio-economic condition of fisherman community and to achieve sustainable utilization of resources for fisheries development, optimum production of fish from water bodies, employment generation, availability of protein rich food, appropriate planning and strategies are of utmost importance. To respond to new challenges and developments, Govt. of India has legislated the Biological Diversity Act (2002) and the Biological Diversity Rules (2004), which aims at conservation of our natural heritage and ensures the sharing of benefits of the utilization of biological resources in an equitable manner.

Though Indian Fisheries Act of 1879 (modified in 1956) is a landmark with regard to fisheries but has had no remarkable impact on the conservation of fish biodiversity. Review of literature shows that very few studies have so far been made on fish diversity of the forest protected waters and their conservation potential with reference to freshwater ecosystem. The present communication evaluated pattern of fish diversity, composition, abundance and habitat within the Katarniaghat Wildlife Sanctuary,



an wildlife protected area and outside the protected area during 2002-2005 to determine whether this forest protected area provides benefits to freshwater fishes.

Study area

The Katraniaghat Wildlife Sanctuary (listed as the Kateraniaghat Pashu Vihar Sanctuary by the United Nations Environment Programme, 2005) covers an area of 40 009 ha with 12 000 ha of rivers, streams, small channels, beels, perennial and seasonal pools, and wetlands. Land cover is largely composed of grasslands, mature forests, marshy lowlands, a good network of small channels, perennial ponds, wetlands and tanks and ten small villages with nearly 3000 inhabitants. This study was conducted in the Gerua River spanning the Katraniaghat Wildlife Sanctuary. This river is large (mean annual discharge near 1 500 m³ s⁻¹, up to 900 m wide), surrounded by protected lands of India and Nepal, and upstream of major diversions and river alterations in the study reach. The width of the river channel varies considerably with location, discharge and the number of channels on a cross section, but channel widths in the study reach typically ranged from approximately 150 m to 900 m. Most of the sampling sites in the forest protected area were shaded by dense riparian vegetation.

Fish diversity in the wildlife protected area

A total of 87 species representing 22 families and 52 genera are recorded within the wildlife protected area. The Cyprinidae was the most dominant family accounted for 49.43% (40 species) of the total number of fish species collected followed by the family Bagridae 8.04% (7 species) and Schilbeidae 5.74 % (5 species). The most dominant species was a cyprinid *Salmostoma bacaila* (Relative abundance (RA), 11.32%) and the subdominant species were a Schilbeid *Eutropichthys vacha* (RA, 7.79), Notopterid *Notopterus notopterus* (RA, 5.63%), Schilbeid *Clupisoma garua* (RA, 5.34%) and Sisorid *Bagarius bagarius* (RA, 4.87%). This also indicated that

25-28% of total fish species showed higher occurrence and 54 and 20 % species with medium and low occurrence respectively. While the relative abundance of two Indian major Carps like *Catla catla* and *Labeo rohita* was relatively poor (1.27 – 1.49), however, considerable abundance(1.98) was recorded for carp *Cirrhinus mrigala*. Considerable relative abundance of some of the species was also observed for conservation and management viz. feateher back *Chitala chitala*, *Notopterus notopterus*, Pabda *Ompok bimaculatus*, goonch *Bagarius bagarius*, mahseer *Tor putitora*, *Tor tor*, *gerua vacha* *Eutropichthys vacha*, *Pangasius pangassius* etc . Carps like, *Labeo bata*, *Cirrhinus reba* showed higher abundance and among exotics Chinese carp *Cyprinus carpio* was recorded from gerua river inside sanctuary.

Among 87 species recorded from the sanctuary, 12 species (13.79%) that is distributed in cold-water habitat, 46 species (52.87%) are warm water and recognized as food fish, 13 species (14.94%) are good potential aquarium fishes and 4 (4.59 %) are considered as potential game fishes (*Tor tor*, *Tor putitora*, *Aorichthys aor* and *Bagarius bagarius*) in India. The study also showed new record in maximum length of six freshwater fish species viz. *Notopterus notopterus* (35.0 cm.), *Gudusia chapra* (20.0 cm.), *Barilius barila* (13.0 cm.), *Ompok pabo* (28.0 cm.), *Xenentodon cancila* (31.5 cm.) and *Salmostoma bacaila* (20.5 cm.). It was also observed that the 31% of fish species, which are reported as threatened under different categories as per IUCN patteredn, were recorded with moderate to higher density in the protected area. Overall, fish species diversity ranged from 17-55 species outside the protected area as compared to 87 species within the protected areas. Shanon-Weiner diversity index of the different sites indicated values of 3.9 within the protected area, and values ranging from 12-2.1 outside the protected area.

Fish diversity of the protected areas of river Ganga

Considerable fish diversity has been reported in



View of river Gerua flowing through Katarniaghat Wildlife Sanctuary



Important fish species of Gerua river : Clock wise (from top left) *Labeo rohita*, *Catla catla*, *Labeo gonius*, *Cirrhinus mrigala*, (bottom) *Chitla chitla*



Murrels : (left) *Channa punctatus*, (right) *Channa straita*, (bottom) *Channa marulius*.



Botia lohachata



Danio devario



Chanda nama



Rasbora daniconius



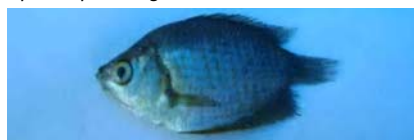
Puntius sophore



Botia lohachata



Lepidocephalus guntea



Colisa fasciatus

Ornamental fish species



Ompok bimaculatus



Ompok pabda



Ompok pabo



Bagarius bagarius



Clupisoma garua



Eutropiichthys vacha



Sperata seenghala



Mystus cavasius

Other Important fish species of Gerua river



the Ganges passing through protected area of river Ganga basin. A total of 59 species were recorded from the Turtle Sanctuary located in the middle stretch of river Ganges. Similarly, the Rajaji National Park and Jhilmil Conservation Reserve located in the upper stretch recorded with 40 and 41 fish species respectively. Many cold water fishes especially *Barilius* spp. was observed breeding in large numbers in these protected areas. The percentage contribution of the fishes of the protected areas to the total diversity were 72%, 65% and 44% for upper, middle and lower stretches, respectively showing that protected areas are important for fish conservation in the basin (Sarkar *et al.* 2011).

Discussion

The Gerua River in the Katraniaghat Wildlife Sanctuary provides large river habitats in an intact setting upstream of major diversions and river alterations. Habitat use pattern across assemblages of fish in flowing waters have been reported several times but almost always for streams and small rivers. The pattern of results suggests that conservation efforts aimed at habitat protection are most important when water quality supports priority species. The findings suggested that conservation of large river fishes should strive to maintain both erosional and depositional channel habitats with depths, substrates, and current speeds inclusive of the ranges reported.

In India, efforts have been made recently in bringing together the studies of fish diversity in various rivers with regard to fresh water habitat. However, fish diversity of many water bodies within protected area network and their importance in conservation of biodiversity is not studied well. Based on the pattern of species diversity and distribution it may be proved that a protected riverine ecosystem can benefit unprotected areas of the river in terms of maintaining of diversity upto certain longitudinal range. However, many factors are involved and methods need to be established for

evaluation and assessment and real benefit of the protection in the unprotected riverine areas. The difference observed here between fish densities, diversity and sizes inside and outside the protected area is most probably largely a consequence of several anthropogenic and ecological factors. Researchers have shown higher fish population densities in forest protected areas compared to unprotected areas (Bell, 1983) and greater sizes of individuals in protected areas (Bell, 1983; Bayle-Sempere and Ramose-Espla, 1993; Dufour *et al.* 1995), both of which in turn result in greater biomass (Francour, 1991). Baird (2006) reported that fish sanctuaries and conservation zones can benefit fish stocks, especially relatively sedentary species, but also highly migratory species. The present study revealed higher taxa richness of some of the food fishes within protected area viz; *Salmostoma bacaila* (11.32%), *Eutropichthys vacha* (7.79%), *Notopterus notopterus* (5.63), *Clupisoma garua* (5.34%), *Bagarius bagarius* (4.87%), etc. However, among Indian major carp (IMC), the population of *Catla catla* was poorly represented by 1.2 % as compared to *Labeo rohita* (1.4 %) and *Cirrhinus mrigala* (1.9%). More species diversity and abundance within protected area as compared to unprotected area might be due to several reasons. One of the important observation in the study was that good occurrence of species of high conservation importance in India like prized game fish *Tor tor*, *T. putitora*, *Chitala chitala* and *Bagarius bagarius* was much higher inside sanctuary as compared out side sanctuary indicating the significance of protected habitat. In the protected area a specialized behavior was observed by endangered *Chitala chitala* showing frequent sights like river dolphins. New record length (TL) of six fresh water fish that exceeds the earlier records (Talwar and Jhingran, 1991) shows that protection can influence on sizes of the fishes. Our research showed similar patterns, with more species, greater population densities and larger individuals, and additionally showed higher number and densities of endangered fishes within the protected area compared to unprotected area.



Interesting to note that average size of the fishes was larger in sanctuary than fishes of out side sanctuary. The present author described record size (22.5 cm. TL) of a clupeid (*Gudusia chapra*) from Samaspur Bird Sanctuary, Uttar Pradesh, India (Sarkar *et al.*, 2002).

It has been observed that inspite of absence of specific conservation measures adopted to protect the freshwater fishes as compared to terrestrial wildlives, the waterbodies within protected area can benefit fish conservation in many ways. For the protection of aquatic resources, flora and fauna of the rivers and tributaries in the protected and unprotected area, there is a need to scientifically manage the aquatic resources. Some of the needed additional management measures for fish biodiversity are;

Habitat restoration and rehabilitation

This involves integration of hydrological, hydraulic and water quality principles with concepts of ecological integrity. Adequate protection and management of riparian zone, based on sound ecological principles, is another effective strategy for addressing many existing problems of river ecosystem degradation. The protection and care of breeding grounds and prevention of environmental degradation are essential.

Ranching, stock enhancement and total harvestable catch

The stocking of indigenous fish yearlings (from wild population) for ranching year after year in outside protected area of the river will be helpful for restoration of threatened fish species. Ranching with hatchery bred individual should not be carried which may cause inbreeding and genetic erosion. Strong management strategies fixing total harvestable catch (THC), through the use of quotas are needed to reduce overall collection pressure and maintaining status quo with regard to the collection and of local species from the unprotected areas of the river.

Community based conservation areas

For the conservation of biodiversity of the aquatic resources it is essential to identify some suitable segments of the rivers for declaring as conservation areas, so that the population of native fish fauna may be conserved. Beside these, *in situ* conservation and management measures should be taken through community involvement to protect them. Clearly a method is required for prioritizing inland water sites for conservation at local scale. New approaches of conservation for freshwater fishes have been suggested by many authors (Boon, 2000).

Improvement of human resource and capacity in fish biology and conservation

If conservation of the fishes are to be successful there is an urgent need to carry out research on the basic ecology, fish systematics, life history traits , habitat preferences, climate changes and fish conservation, stock characteristics and establish proper facilities. Awareness programme have to be intensified for the increased perception in conservation actions.

Identification of threat criteria

For proper planning of aquatic biota conservation, it is necessary to identify the different factors and the extent up to which they are diminishing.

Conservation priority of the endangered species

Priority of conservation should be given to species of river Gerua listed under endangered category and accordingly conservation priority should be given to species of vulnerable category. Long term strategies are also required to enhance the natural stock of low resilient species (long population doubling time) for conservation.

Conclusion

The present study indicates benefit of protection in the adjacent unprotected areas (more



fish density and diversity, presence of endangered fish). Evidently, the waterbodies in the protected area could play a significant role in conserving the freshwater aquatic species of high conservation importance in India and other developing countries. The study also advocates a need to revise the approach and management of the protected area to mitigate, maintain ecological integrity and restore the loss of aquatic diversity.

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