

# Development of tools for assessing conservation categories of siluroid fishes of fresh water and brackish water wetlands of South West Bengal, India

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**Abstract** Twenty-five species of fishes belonging to 18 genera, 7 families under the order siluriformes have been recorded from different freshwater and brackish water wetlands of South West Bengal, India. Fishery potential of 17 commercially important siluroid fishes were noted especially from market surveys as well as from information collected from local fishermen communities. Following the IUCN guidelines, and also through Participatory Rural Appraisal (P.R.A.) methods, an attempt has been made to assess the conservation status of such fishes, many of which are thought to be threatened. Trend analysis, Fish Magnitude Value and Rank based Quotient revealed the threatened status of 17 siluroid fishes.

**Keywords** Siluroid fishes · PRA · Trend analysis · Rank based quotient · Fish magnitude value · Village magnitude value

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## Introduction

India is endowed with rich inland water resources in the form of ponds, bills, streams, lakes, reservoirs, natural wetlands and rivers. Fishes of the inland water bodies of the Indian sub-continent have been a subject of study since last century (Hamilton-Buchanan 1822; Day 1978; Jayaram 1999; Talwar and Jhingran 1991; Menon 1999). A number of man made changes in the riverine habitats due to large scale water abstraction for irrigation, construction of dams and barrages, siltation, soil erosion due to deforestation in the catchment areas, and water pollution through industrial, agricultural and municipal wastes have all had devastating effects on the fish stocks of Indian rivers (Jhingran 1988, Mishra et al. 2002). In view of constant anthropogenic stresses with advancement of modernization and ever-growing demand for fish for food, the rich diversity is being eroded and the population of some species have been declined significantly. Most fish species belonging to the order Siluriformes are prone to the harmful effects of environmental degradation resulting in their population decline (Jhingran 1988; Kumar 1998).

The lack of information on the occurrence, distribution and status of ichthyofauna of South West Bengal is a big handicap in popularizing and propagating the less known fish varieties in a particular ecosystem for their conservation. Thus, there is a need to survey fish fauna inhabiting the

different freshwater habitats of South West Bengal. Such assessment would help planning methods for their effective exploitation as well as to ensure higher production. There exists scanty information on freshwater resources of various parts of India which are gradually becoming non-productive due to different natural and anthropogenic factors.

A Conservation Assessment and Management Plan (C.A.M.P.) workshop was conducted for 329 taxa out of 650 species and sub-species of freshwater fishes of India, to assess their status in the wild. This information was used to assess the status of every taxon and assign a category of threat according to the Revised-IUCN Red List categories, 1994.

Local fisher folks very much aware of the environmental status of different fish habitats, their mode of distribution and occurrence of different flora and fauna in different habitats. They have their own names for the different biotic elements, which may embrace one or more habitat type. It goes by the name of *People's Biodiversity Register*, (*P.B.R.*) and seeks to document the knowledge of occurrence, practices of propagation, sustainable harvests and conservation, as well as economic uses of biodiversity resources that reside with India's local communities. According to Gibson and Koontz (1998), community-based natural resource management (CBNRM) is increasingly viewed as the most appropriate arrangement for promoting sustainable development of natural resources. The local communities are more cognizant of the intricacies of local ecological processes and practices; and that they are more able to effectively manage those resources through local or 'traditional' forms of access (Tsing et al. 1999). It is often easier and more appropriate to work with existing groups of stakeholders rather than trying to create new interest groups. A mechanism should be sought for bringing together representatives of the various categories of stakeholders for *Participatory Rural Appraisal* (PRA) in order to identify constraints and differences, resolve conflicts, review progress, make collaborative management decisions, etc (Cernea 1991; Bhaumik and Saha 1998).

With this background, the present study was carried out with two objectives: 1-To assess the present status of freshwater Siluroid fishes of South West Bengal, and 2-To delineate strategic intervention for their conservation through the identification of some causal factors relating to fish declining with the

help of participatory approach of local fishermen community through Participatory Rural Appraisal (PRA) which includes intensive and systematic learning experiences carried out in a community by a multidisciplinary team including the members of that community (Mukherjee 1997). Crawford and Morito (1997) also in Canada emphasized on stakeholders' perception in fish conservation. PRA, a way of learning from and with the community members to investigate, analyze and evaluate the constraints and the opportunities, needs assessment and priorities in the area of fishery management. The causal factors identified through using PRA techniques shall be helpful delineating conservation strategy with a pro-people approach.

## Materials and methods

### The study areas

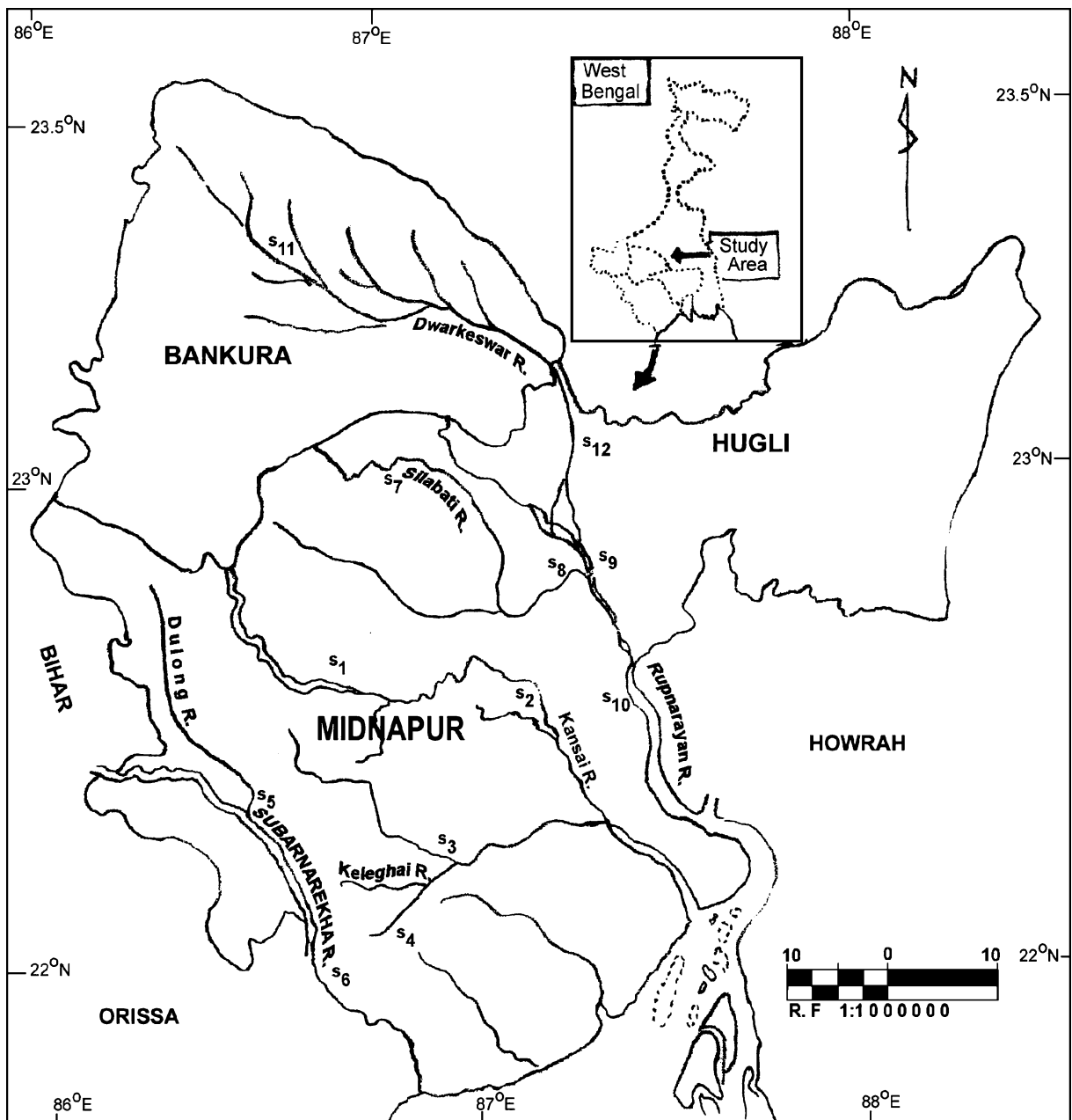
South West Bengal with a geographical area of 24,111 Km<sup>2</sup> (22–23.3° N; 86–88.3° E) is bounded in the north by Birbhum, northeast by Bardhaman, east by 24 Pargana (North), southeast by 24 Pargana (South), south by Bay of Bengal, southwest by Orissa, west by Bihar and northwest by Purulia. This region enjoys extreme macroclimatic conditions. Some areas are draught prone while others are flood affected. Some areas are under marine influence while others are with hilly tracts. The whole area is a mix of diverse landscapes.

Studies were conducted in six rivers all of which ultimately open into estuarine networks of South West Bengal viz Kansai, Keleghai, Subarnarekha, Khirai, Dwarakeswar and Shilabati (Fig. 1) for two consecutive years (July 2000–June 2002).

All total twelve (12) study sites were selected for documenting the occurrence, abundance, seasonal variations and distribution of ichthyofauna of South West Bengal (Fig. 1).

### Methods for collection and identification of fishes

Token samples of fishes were collected at monthly intervals from different study sites directly from the fishermen as well as from the local markets retailers and auctioneers. The number of collected fishes varied from 5 to 20 depending upon the body size



**Fig. 1** Map showing the extent of fresh water bodies vis-à-vis the river networks of South West Bengal along with the location of different study sites (S1 to S12)

and weight of different fishes. Different fishing gears like cast net, drag net, bag net, gill net and some other traditional traps were operated in different water bodies (Mishra et al. 2001a). Fishes brought in the local markets from outside places were not taken into consideration. The collected specimens were preserved in 4% buffered formalin. Local name of

different fishes were determined through discussion with focus groups. The specimens were identified subsequently following standard published keys and description (Day 1978; Talwar and Jhingran 1991; Menon 1999; Jayaram 1999) and in consultation with the scientists of the Zoological Survey of India, Kolkata. So far 103 different fish species belonging

to 76 genera under 33 families and 11 orders of fishes were recorded from freshwater and brackish water bodies of South West Bengal (Mishra et al. 2003). Identified specimens were kept in the Department of Zoology, Vidyasagar University.

### Participatory techniques

Selected Participatory Rural Appraisal Techniques were carefully designed and applied to extract primary information relating to the population status of fishes. The techniques like (a) Trend Analysis (b) Fish Magnitude Value (c) Matrix Ranking and (d) Rank Based Quotient are being elaborated below. The tools used is an improvisation of the PRA method for problem prioritization matrix as applied by Mukherjee (1997) and Patra et al. (2005).

### Participatory Rural Appraisal

(a) Trend Analysis: The trend analysis is for depicting the nature of decline of a species over decades through applying Participatory Rural Appraisal (PRA) techniques. It was done to analyze the nature of increasing or declining numbers of the target fish population over decades. In this analysis, the experience profiles of the stakeholders were also taken into consideration. For trend analysis, 75 respondents were put to interactions in order to identify and assess the decadal decline of different fish species (17) in terms of time and visibility of the target species in the near and around surroundings which indicate the biosocial niche having 5 km<sup>2</sup> area.

(b) Fish Magnitude Value (F.M.V.): It was calculated from a participatory approach where both the geographical as well as temporal dimensions were considered. Fish Magnitude Value (FMV) has been designed and calculated from vertical and horizontal logic. Matrix ranking tool has got vertical logic i.e. item of problems and horizontal logic i.e. rank position, In this case, both the geographical distributions as well as temporal dimensions were taken into consideration while calculating the fish magnitude value. The contention was that fish species had declined not over a geographical space but also over the time as well. This is an innovative technique relying basically on the perceptual assessment by the fishermen of different age groups (40 to 75 years old) about the decline of different fish species not only

over time but also over distribution e.g. the fishermen assessed what have been the availability vis-à-vis biomass (kg) of a fish species in a given decade (60 s) in terms of scores designed by themselves and these score values were multiplied by the visibility range vis-à-vis the extent of their occurrence (km<sup>2</sup>), to help determine the status of that species in that decade. This type of calculation over decades would delineate by what percentage the decline has been occurring since the benchmark decade. To avoid the biases in the perceptual assessment made by an individual farmer, the total score value of a group was divided by the number of members of that very group to have an interpolated value in the form of a mean (Mukherjee 1997; Patra et al. 2005).

$$\text{Mean of FMV} = \frac{\text{Biomass} \times \text{Area of Occupancy}}{\text{Number of respondent}}$$

(c) Matrix Ranking: A number of causal factors were found to be instrumental for the declining of fish population from their natural wetland habitats (irrigation canals, creeks, tributaries, floodplain and rivers) of South West Bengal. Group meetings at 2 months intervals with local fishermen community of Khakurda, Bankura, Arambag, Sonakonia, Norghat, Midnapore Sadar and Khirai were organized to collect information relating to factors responsible for declining of fishery resources. Mostly the male members of the community (Nos 30) assembled in the meeting place at a time. The set of criteria was discussed by the fishermen community who were also requested to add to the list and to score on the set of criteria generated. Habitat destruction, non restricted nylon thread fishing gears, ichthyotoxic materials derived from local plants and also chemicals used for agriculture, fishing during breeding seasons, water pollution by wastes from human settlements and industries, fish diseases (Epizootic Ulcerative Syndrome and others), excessive and non judicious use of water, human population explosion, occurrence of flood, introduction of exotic fish species, siltation and fishes without being endowed with scales were found to be the major problems for the declining of fishery resources. To initiate the process of scoring by individuals, the criteria were written on piece of paper in vernacular (such criteria were read out loudly and understood by the participants, although many of them could not read or write) and arranged in a

column on the ground. Each person was given a handful of stone chips (10 stone chips) and asked to score each criterion as much or as little as he wished to. It was free scoring as explained to the participants, where relative importance of a criterion would get indicated by putting more stone chips to more important ones and less stone chips to those which were relating less important.

(d) R.B.Q.: It was made to re rank the identified causes in terms of their vertical and horizontal dimensions. Ranking were done with the help of Rank Based Quotient (RBQ). A focus group was formed. They were put to a discussion in identifying ten (10) causal factors. It was made to rank the identified causes in terms of their vertical and horizontal dimensions. In the calculation of RBQ value the following formula was used to isolate the perceived causes and their relative values in causing the fish population decline (Mukherjee 1997).

$$\left[ \text{RBQ} = \sum \frac{fi(n+1-i)}{Nn} \times 100 \right],$$

N = Total number of fishermen; n = Number of Ranks; i = rank position; fi = frequency of i.

(e) Village Magnitude Value (V.M.V.): Village Magnitude Value is a product and derived through applying R.B.Q. technique.

#### I.U.C.N. categorization

I.U.C.N. categorizes the taxa in given scheme depending upon the different criteria (IUCN 2001, Red List Categories and Criteria, Version 3.1). In accordance to IUCN Red listing process, different conservation categories of fishes under study have been determined.

**Critically Endangered (CR):** A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria (IUCN 2001) for Critically Endangered and it is therefore considered to be facing an extremely high risk of extinction in the wild.

**Endangered (EN):** A taxon is Endangered when the best available evidence indicates that it meets any one of the criteria (IUCN 2001) for Endangered and it is therefore considered to be facing a very high risk of extinction in the wild.

**Vulnerable (VU):** A taxon is Vulnerable when the best available evidence indicates that it meets any one of the criteria for Vulnerable (IUCN 2001) and it is therefore considered to be facing an extremely high risk of extinction in the wild.

In the present work, the species was categorized specifically following percentage of population size reduction and mean decline on market landing. The percentage of population size reduction was calculated on the basis of F.M.V. and was compared with the percentage given in list.

For Critically Endangered (CR) decline on FMV was  $\geq 80\%$  and mean decline on market landing was  $\geq 60\%$ .

For Endangered (EN) decline on FMV was  $\geq 70\%$  and mean decline on market landing was  $\geq 40\%$ .

For Vulnerable (VU) decline on FMV was  $\geq 50\%$  and mean decline on market landing was  $\geq 30\%$ .

For Near Threatened (NT) decline on FMV was  $< 50\%$  and mean decline on market landing was  $\geq 15\%$ .

IUCN standardises the percentage of population reduction over decades which have been taken into consideration with the value of FMV (Patra et al. 2005).

#### Results and discussion

The siluroid fish fauna in this freshwater and brackish water networks is represented by 25 species belonging to 18 genera and 7 families in South West Bengal (Mishra et al. 2003). They also enjoy a wide range of distribution in different water bodies (rivers, canals, creeks, ponds, irrigation canal). Occurrence and distribution of these fish species in different habitats are presented in Table 1. Out of the total fishes, 17 are of commercial significance for their good taste, fast growth rate or medicinal values. Out of 17 siluroid fishes documented from different water bodies (lentic and lotic) of South West Bengal, *Batasio batasio*, *Mystus cavasius*, *Mystus vittatus*, *Rita rita*, *Aorichthys aor*, *Ompok pabda*, *Ompok bimaculatus*, *Ompok pabo*, *Ailia coila*, *Clarias batrachus* were found to inhabit in freshwater whereas *Wallago attu*, *Clupisoma garua*, *Eutropiichthys vacha*, *Pangasius pangasius*, *Bagarius bagarius* are found to inhabit in both freshwater and brackish water bodies and *Mystus gulio*, *Arius gogora* inhabited exclusively in brackish water bodies. A Conservation Assessment and Management Plan (C.A.M.P.) workshop assessed 329

**Table 1** Occurrence and distribution of Siluroid fishes in different freshwater and brackishwater habitats of South West Bengal, India

Species	Kansai	Keleghai	Subarnarekha	Silabati	Rupnarayan	Dwarkanagar
	FW	FW	FW	FW	BW	FW
Order: Siluriformes Family-1: Bagridae						
1. <i>Rita rita</i> (Ha-Bu).	+	–	+	+	+	–
2. <i>Batasio batasio</i> (Ha-Bu).	+	+	–	+	–	–
3. <i>Mystus bleekeri</i> (Dey).	+	+	+	+	–	+
4. <i>Mystus cavasius</i> (Ha-Bu).	+	+	+	+	–	+
5. <i>Mystus gulio</i> (Ha-Bu).	–	–	+	+	+	–
6. <i>Mystus vittatus</i> (Bloch).	+	+	+	+	+	–
Genus-4: <i>Aorichthys</i> (Wu)						
7. <i>Aorichthys seenghala</i> (Sy).	+	–	+	+	+	–
8. <i>Aorichthys aor</i> (Ha-Bu).	+	+	+	+	+	+
Family-2: Siluridae						
9. <i>Ompok bimaculatus</i> (Bl).	+	+	+	+	–	–
10. <i>Ompok pabda</i> (Ha-Bu).	+	+	–	+	–	–
11. <i>Ompok pabo</i> (Ha-Bu).	+	–	–	–	–	–
12. <i>Wallago attu</i> (Sch)	+	+	+	+	+	+
13. <i>Ailia coila</i> (Ha-Bu).	+	–	+	+	–	+
14. <i>Pseudeutropius atherinoides</i> (Bl).	+	+	+	+	–	+
15. <i>Chupisoma garua</i> (Ha-Bu).	+	–	+	+	+	+
16. <i>Eutropiichthys vacha</i> (Ha-Bu).	+	–	+	+	+	–
Family-3: Pangasiidae						
17. <i>Pangasius pangasius</i> (Ha-Bu).	+	–	+	+	+	+
Family-4: Sisoridae						
18. <i>Gagata cenia</i> (Ha-Bu).	+	–	+	+	+	+
19. <i>Bagarius bagarius</i> (Ha-Bu).	–	–	+	+	+	+
20. <i>Nangra viridescens</i> (Ha-Bu).	–	–	+	+	+	–
21. <i>Erethistes puszilus</i> (Mul-Tro).	+	–	+	+	+	+
22. <i>Clarias batrachus</i> (Lin).	+	+	+	+	–	+
23. <i>Heteropneustes fossilis</i> (Bloch).	+	+	+	+	–	+
24. <i>Arius gagora</i> (Ha-Bu).	+	–	+	+	+	–
25. <i>Arius platystomus</i> (Day)	–	–	–	–	+	–

FW fresh water, BW brackish water

species of freshwater fishes of India, to evaluate their population status in the wild. Out of 17 different species, which have been taken into consideration in the present study, only 12 species were considered in the CAMP workshop and they were assigned different threat categories (Table 4). However, the said workshop did not make any comment of any fishes of South West Bengal, India.

The high-value catfishes like *O. pabo*, *O. bimaculatus* and *P. pangasius* have become conspicuously less abundant in recent times (Das 1988; Mukherjee et al. 2002). Other economically important catfishes have also declined due to over exploitation (Dudgeon 2002). *Bagarius bagarius* locally known as ‘Baghar’, the largest Indian freshwater fish is known to inhabit

mainly the upper reaches of major rivers with a gradual decrease in numbers in down stream. It was used to offer a good fishery from the upper portions of river Gandak and Kosi in Bihar even two decades ago. Since then, there has been a steady decline in ‘Baghar’ fish catch (Prasad 1994). Menon (1989) listed this species in the group of threatened fishes. *P. pangasius*, which was used to be fairly common in the Ganges and the Brahmaputra rivers, has also declined steadily in recent past (Prasad 1994; Mukherjee et al. 2002). Among other commercial catfishes, the abundance of *C. garua*, *P. pangasius*, *O. pabda*, *M. vittatus* and *M. tengara* have decreased considerably during last couple of decades (Yadava and Chandra 1994; Mukherjee et al. 2002). The



density of *M. cavasius* in South West Bengal has been declining steadily during the last three decades (Mishra et al. 2001a, b, c). Some of the following species may be grouped under either critically endangered or endangered or vulnerable or near threatened fishes of this region.

The earlier method of grouping of fishes into different categories viz. Threatened, Extinct, Endangered, Vulnerable, Rare and Indeterminate have been criticized due to their perceived subjective nature and abstractive dimension. The IUCN Council adopted the latest version in this regard (IUCN-2001. Red list Categories and Criteria. Version 3.1) as a result of comments from IUCN (IUCN 1994) and Species Survival Commission (SSC) memberships (IUCN 1994) and from a final meeting of the Criteria Review Working Group in February, 2000 and the version incorporated changes of the earlier categories into nine categories viz. Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE).

With the help of PRA method (Participatory Rural Appraisal method), decade wise trend analysis (From 1960–2000) and Fish Magnitude Value (FMV), it was confirmed that, there has been severe decline in the freshwater fish fauna in South West Bengal in general and other food and game fishes in particular. The trend analysis on decadal distribution starting from 1960 to 2000 depicts the availability of 17 siluroids in terms of Fish Magnitude Value (FMV) and percentage in fish population depletion. In conforming with the IUCN guidelines the information was elicited through a focus group consisting of 75 stakeholders, the experience of whom ranged from 20 to 50 years and their age varied from 40–75 years. They were asked to assess and delineate the decadal distribution of fishes in terms of time and quantification of catches in nearby areas and around surroundings (Mukherjee 1997). This had enabled the eldest persons to provide information of both earliest and present decades; while middle aged groups generated information of last three decades and ultimately a collected wisdom helped having a participatory and standardized information on this issue. The assessment of fish population over a period of 50 years indicated a chronological status of the respondents capable of perceiving the change or trend precisely. According to

surveys, total Fish Magnitude Values (FMV) have declined for all species under study between the decades of 1980 to 1990. In determining the conservation status, the declines in FMV from the beginning of the period covered (1950) through different decades ending in 2000 were calculated and the declines after the decade ending 2000 as observed were as follows: *R. rita* (79.45%), *B. batasio* (60.7%), *M. gulio* (46.56%), *M. cavasius* (56.87%), *M. vittatus* (70.48%), *A. aor* (61.72%), *O. bimaculatus* (59.64%), *O. pabda* (78%), *O. pabo* (83%), *W. attu* (62.8%), *A. coila* (60.7%), *C. garua* (63.28%), *E. vacha* (63.7%), *P. pangasius* (62.8%), *B. bagarius* (62.58%), *C. batrachus* (66.98%) and *A. gagora* (61.28%). The average decadal declines for the different species as observed were as follows: *R. rita* 33.45; *B. batasio* 27.56; *M. gulio* 25.6; *M. cavasius* 29.9; *M. vittatus* 34.3; *A. aor* 28.05; *O. bimaculatus* 29.32; *O. pabda* 35.3; *O. pabo* 36.82; *W. attu* 26.7; *A. coila* 28.6; *C. garua* 27.7; *E. vacha* 29.24; *P. pangasius*; *B. bagarius* 29.2; *C. batrachus* 26.14 and *A. gagora* 28.4 (Table 2). Market landing of fishes in local markets near rivers was one indication of the availability, abundance or rarity of a harvested species. While the retailer of fishes in fish markets were asked to provide data on fish landing, the responses elicited that the volume of landing has been dwindling since 1997 (Table 3). This indicated the similar pattern as that of the FMV data derived from the fishermen. Data representing the mean decadal decline of selected seventeen (17) species starting from 1960 to 2000 have been presented in Table 2. In order of FMV, the following species can be arranged as follows. It has been found that had the decadal mean of FMV been the highest for the species *O. bimaculatus* (177.72) which suffered an abrupt decline between 1980 and 1990 from 225.3 to 81.02, decadal mean of FMV of different other species would have been as follows: *A. aor* 177.69; *C. batrachus* 171.69; *M. vittatus* 170.58; *E. vacha* 168.67; *R. rita* 164.16; *C. garua* 161.26; *A. gagora* 159.66; *B. bagarius* 156.59; *O. pabo* 152.80; *M. gulio* 151.13; *A. coila* 149.72; *W. attu* 149.69; *P. pangasius* 148.66; *B. batasio* 133.67; *M. cavasius* 132.93 and *O. pabda* 104.85 (Table 4). The coefficient of variation (CV) of all the species so far as rate of decline is concerned had been more or less consistent (Table 4). It was envisaged from the present context that out of 17 siluroid fishes in South West Bengal, 4 should be classified as Endangered, 12 as Vulnerable i.e. 16 as Threatened and 1 as Near Threatened category (Table 4).

**Table 2** Decade wise trend analysis of Siluroid fishes of South West Bengal

Sl. No.	Local Name	Scientific Name	1960	1970	Decline %	1980	Decline %	1990	Decline %	2000	Decline %	Mean Decline
1	Ritha	<i>Rita rita</i>	266.8	253.5	-4.9	220.7	-12.9	66.2	-70	13.6	-79.45	33.45
2	Batasi	<i>Batasio batasio</i>	217.13	182	-16.18	151.4	-16.8	84.6	-44.12	33.21	-60.7	27.56
3	Nona tengra	<i>Mystus gulio.</i>	232.13	200.7	-13.54	175.6	-12.5	107.6	-38.72	57.5	-46.56	27.83
4	Sataphuli tengra	<i>Mystus cavasius</i>	224.2	196.16	-12.51	152.5	-22.26	64.13	-57.9	27.66	-56.87	29.9
5	Nona tengra	<i>Mystus vittatus</i>	296.2	262.33	-11.43	214.5	-18.23	61.66	-71.25	18.2	-70.48	34.3
6	Aar tengra	<i>Aorichthys aor</i>	279.6	252.3	-9.76	227.6	-9.79	93.26	-59.02	35.7	-61.72	28.05
7	Pabda	<i>Ompok bimaculatus</i>	287.8	261.8	-9.03	225.3	-13.9	81.02	-64.03	32.7	-59.64	29.32
8	Pabda	<i>Ompok pabda</i>	185.7	157.8	-15.02	122.5	-22.37	47.76	-61.01	10.5	-78	35.3
9	Pabda	<i>Ompok pabo</i>	265	239.4	-9.66	203.4	-15.03	48.02	-76.4	8.16	-83	36.82
10	Boal	<i>Wallago attu</i>	236.5	203.7	-13.87	169.06	-17	101.46	-39.9	37.72	-62.8	26.7
11	Banspata	<i>Ailia coila</i>	241.7	211.9	-12.33	183.8	-13.26	79.8	-56.6	31.38	-60.7	28.6
12	Fultasi	<i>Clupisoma garua.</i>	255.1	225.14	-11.74	190.86	-15.23	98.9	-48.18	36.32	-63.28	27.7
13	Bacha	<i>Eutropichthys vacha</i>	270.1	246.7	-8.66	207.9	-15.73	87.05	-58.13	31.6	-63.7	29.24
14	Pangas	<i>Pangasius pangasius</i>	183.8	229.6	+ 19.9	201.6	-12.2	93.5	-53.62	34.8	-62.8	21.74
15	Baghar	<i>Bagarius bagarius</i>	254.3	224.5	-11.72	190	-15.37	83.06	-56.3	31.08	-62.58	29.2
16	Magur	<i>Clarias batrachus</i>	259.8	231.7	-10.82	208.4	-10.1	119.2	-42.8	39.36	-66.98	26.14
17	Gora aar	<i>Arius gogora</i>	257.5	226.13	-12.2	188.7	-16.55	90.8	-51.88	35.16	-61.28	28.4

The decline trend has been calculated through people's participation and quantified based on the intensity of perception. This is a good indicator to delineate the overall trend of decline. The '-' value indicates increase in decline and the '+' value points out decrease in decline. However the overall decline (Mean decline) has been figured up at the last column

Table 5 represents the problem of identification and scores relating to the problems pertaining to the causes of population decline of different fish species of the study areas over the decades. These were 10 in numbers [habitat destruction, non restricted nylon thread fishing gears, ichthyotoxic materials derived from local (plants and chemicals) used for agriculture, fishing during breeding seasons, water pollution by wastes from human settlements and industries, siltation, excessive and non judicious use of water, human population explosion, occurrence of flood and fishes bodies without being endowed with scales]. These problems were identified through participatory interactions and also had undergone categorisations, sortings and screenings. The number of participants in these interactions was 10 for each focus group. Interviews with five such groups were conducted to generate adequate data. Following Rank Based Quotient (RBQ), it was found that habitat destruction occupied the first rank followed by non restricted gears (2), fishing during breeding seasons (3), water pollution (4), occurrence of flood (5), multifarious water use (6), human population pressure (7), use of ichthyotoxic materials (8), siltation (9) and catfish skin sensitivity because of the absence of scales (10).

It was also observed that for the problem no-1, the Village Magnitude Value (VMV) was so high that it had left considerable gap for the other causes to follow.

Threats to both freshwater and brackishwater fishes of India are physical in nature, such as habitat destruction, fragmentation, poisoning, pollution, pesticides, destructive fishing, and other kinds of human interference. Trade is an important contributing factor in threatening fish taxa in India. This is mainly because of unsustainable harvest, poor scientific practices in fishing and an ever-growing demand. Depth and width of water bodies, velocity of water and thereby water discharges are very important abiotic factors of the fish environment. Interference with the river discharges has greatly affected the migration, growth and breeding of fishes (Menon 1988).

The increasing and indiscriminate use of pesticides and other agrochemicals in agricultural fields in India have rendered the ichthyofaunal ecosystem ecologically stressed with toxic heavy metals. The participatory interaction and studies have got ample of evidences of such contamination and stresses (Konar 1975; Saunders 1969; Jhingran 1988; Tarzwell and Henderson 1957; Moore and Ramamoorthy 1984;



**Table 3** Monthly average landing of different commercially important Siluroid fish species of South West Bengal in different markets

Sl. No	Scientific name	Monthly landing (Kg) in 1997		Monthly landing (Kg) in 1998		Decline over previous year		Monthly landing (Kg) in 1999		Decline over previous year		Monthly landing (Kg) in 2000		Decline over previous year		Mean Decline over year
		Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range		
1.	<i>Rita rita</i>	62–225	125.5	73–185.2	102.47	18.35	57–105	71.48	30.24	64.41	19–68	25.44	0.2–1.95	1.2	95.28	52.07
2.	<i>Batasio batasio</i>	15–20.75	8.95	12.8–18.2	7.75	13.4	9.5–11.6	8.125	4.6154	53.53	5.7–9.4	3.775	1.5–2.5	1	73.5	36.25
3.	<i>Mystus gito.</i>	19–34	23.5	20–24	22.08	6.04	16–20	18.5	16.21	18.5	11.8–18	15.075	11.25–17	10.075	33.16	18.47
4.	<i>Mystus cavasius</i>	15–20.75	8.95	12.8–18.2	7.75	13.4	9.5–11.6	8.125	4.6154	53.53	5.7–9.4	3.775	1.5–2.5	1	73.5	36.25
5.	<i>Mystus vittatus</i>	90–175	132.5	80–125	103.45	21.9	45.5–85	67.625	34.63	63.84	20–30	24.45	5.5–11	6.5	73.41	48.44
6.	<i>Aorichthys aor</i>	49–55	52	39–45	41.5	20.2	29–37	33.25	19.8	48.1	15–20	17.25	7.5–10	8.625	50	34.53
7.	<i>Ompok bimaculatus</i>	42–50	46	32–40	36	21.7	25–30	27.5	23.6	30.9	18–20	19	9–12	10.5	44.7	30.23
8.	<i>Ompok pabda</i>	82–150	116	75–120	97.5	15.9	53–90	71.5	26.6	47.55	25–50	37.5	7.2–15	11.1	70.4	40.11
9.	<i>Ompok pabo</i>	5–19.3	8.95	4.9–24	7.49	16.31	3.3–9.4	5.17	30.97	50.29	1.5–4.3	2.57	0.5–1.72	0.68	73.54	42.78
10.	<i>Wallago attu</i>	159.25–239.5	186.25	95.5–235	135.05	27.49	64–164.75	95.21	29.5	28.25	48.5–104	68.31	29–78.7	36.81	46.11	32.84
11.	<i>Alita coila</i>	7.75–24.3	15.5	7.25–29	12.75	17.74	3.55–24.5	7.5	41.18	26.93	2.15–10.4	5.48	0.5–7.5	2.11	61.5	36.84
12.	<i>Clupisoma garua.</i>	25–32	28	19–25	22	21.4	12.7–25	17.25	21.6	39.13	8.4–15	10.5	3.3–7	4.75	54.76	34.22
13.	<i>Eutropichthys vacha</i>	49–55	52	39–45	41.5	20.2	29–37	33.25	19.8	48.1	15–20	17.25	7.5–10	6.625	50	34.53
14.	<i>Pangasius pangasius</i>	42–50	46	32–40	36	21.7	25–30	27.5	23.6	30.9	18–20	19	9–12	10.5	44.7	30.23
15.	<i>Bogarius bogarius</i>	15–50	15.5	2.1–32	12.75	17.74	8.1–22	7.5	41.17	20	6.4–18	6	2.1–8	2.5	58.33	34.31
16.	<i>Clarias batrachus</i>	22–30	26	17–20	18.5	28.8	13–19	16	13.5	37.14	9–13	11	4.2–8	6.1	44.54	30.92
17.	<i>Arius gagora</i>	51.5–143	73.3	39–74.25	58.67	19.96	24.5–67.25	39.42	32.81	35.21	13–47	25.54	10.25–27	14.47	43.34	32.83

**Table 4** Determination of conservation categories of siluroid fishes in South West Bengal

Sl. No.	Scientific Name	Local Name	Decadal mean of FMV	SD	CV	Percent decline of FMV after 2000	Mean decline of minthly market landing	●	■
1.	<i>Rita rita</i>	Ritha	164.2	116.2	70.8	79.45	52.07	L Rnt	EN (A1c)
2.	<i>Batasio batasio</i>	Batasi	133.7	74.4	55.6	60.7	36.25	-	VU (A1c)
3.	<i>Mystus gulio</i> .	Nona tengra	154.7	71.1	45.9	46.56	18.47	-	NT
4.	<i>Mystus cavasius</i>	Sataphuli tengra	132.9	84.4	63.5	56.87	36.25	L Rnt	VU (A1ac)
5.	<i>Mystus vittatus</i>	Nona tengra	170.6	123.7	72.5	70.48	48.44	VU	EN (A1c)
6.	<i>Aorichthys aor</i>	Aar tengra	177.7	106.9	60.2	61.72	34.53	-	VU (A1c)
7.	<i>Ompok bimaculatus</i>	Pabda	177.7	113.8	64.1	59.64	30.23	EN	VU (A1c)
8.	<i>Ompok pabda</i>	Pabda	104.9	73.8	70.4	78	40.11	EN	EN (A1c)
9.	<i>Ompok pabo</i>	Pabda	152.8	116.8	76.4	83	42.78	-	EN (A1c)
10.	<i>Wallago attu</i>	Boal	149.69	80.14	53.54	62.8	32.84	L Rnt	VU {B2b(i,ii,iii)}
11.	<i>Ailia coila</i>	Banspata	149.72	89.97	60.10	60.7	36.84	VU	VU (A1c)
12.	<i>Clupisoma garua</i> .	Fultusi	161.26	91.19	56.55	63.28	34.22	VU	VU (A1c)
13.	<i>Eutropichthys vacha</i>	Bacha	168.67	104.12	61.73	63.7	34.53	EN	VU (A1c)
14.	<i>Pangasius pangasius</i>	Pangas	148.66	81.54	54.85	62.8	30.23	CR	VU {A1ac;B1b(iii)}
15.	<i>Bagarius bagarius</i>	Baghar	156.59	95.44	60.95	62.58	34.31	VU	VU (A1c)
16.	<i>Clarias batrachus</i>	Magur	171.69	90.80	52.89	66.98	30.92	VU	VU (A1c)
17.	<i>Arius gogora</i>	Gora aar	159.66	93.64	58.65	61.28	32.83	-	VU (A1c)

● = Status of freshwater fishes as per IUCN Red list criteria (IUCN 1994) as recommended at Biodiversity Conservation Prioritization Project (BCPP) Conservation Assessment Management Plan (CAMP) Workshop, 1998 at NBFGR, India

■ = Present assessment of status of siluroid fishes of South West Bengal, India, IUCN (2001) categories criteria version 3.1 have been mentioned within parenthesis

‘-’ = Not assessed in the CAMP Workshop, 1998

FMV fish magnitude value, SD standard deviation, CV coefficient of variation, CR critically endangered, EN endangered, VU vulnerable, NT near threatened

Walker et al. 1996; Bhattacharya and Chakraborty 2001; Kumar 1998).

The mesh size of nets as used by fisher folks have also been responsible to kill some of important local fish species in a nonselective manner (Mishra et al. 2001a).

## Conservation

Conservation strategy is a holistic approach. Long term and short term strategy for conservation should be taken with the active participation of local community. In order to conserve identified threatened species of order Siluriformes from extinction, the strategies envisaged are: (a) Eco-restoration (b) Protective and Preventive measures (c) *in situ* and *ex situ* conservation and (d) environmental awareness raising.

(a) Eco-restoration: Suitable aquatic bodies should be marked and maintained for culture of species fingerlings with active participation of the local population. Brood stocks and juveniles, exploited accidentally, should be released back.

(b) Protective and Preventive measure: There are various Fedal Acts / enactments to control river abuses in India. We have water (Prevention and control of pollution) Act (1977), Wildlife Protection Act (1972), Environmental Protection Act, Insecticide Act, etc. The Indian Fisheries Act was the earliest and enacted at the turn of the last century and was framed to protect fish stocks from destructive fishing methods; to regulate size and mesh of fishing gears; to enforce closed season etc. For major carps, mahseers and other catfishes, which are threatened, fish sanctuaries or reserves should be established. The question of protection of fish life through establishment of fish sanctuaries has not received any attention so far.

**Table 5** Causative factors for the population decline of different fish species as identified by the different fishermen group

Sl No	Problems	Ranking by fishermen										<sup>a</sup> RBQ Values (%)	Average Loss (%)	Area (Km)	Village magnitude value	Rank
		I	II	III	IV	V	VI	VII	VIII	IX	X					
1	Multifarious water use		5								1	16	25	22	8,800	VI
2	Habitat destruction	16		3								61.33	45	50	1,37,992.5	I
3	Non restricted nylon thread fishing gear	10									1	34.63	40	45	62,334	II
4	Body without scales			5								13.63	10	25	3,407.5	X
5	Water pollution		9									27	25	40	27,000	IV
6	Siltation				2			1		1		6.65	15	35	3,491.25	IX
7	Fishing during breeding season	4		6	4							38.6	35	42	56,742	III
8	Flood		7				2					24.3	18	30	13,122	V
9	Human population pressure		6									18	21	20	7,560	VII
10	Use of ichthyotoxic materials (Plants/Chemicals)		1		4							12.3	16	30	5,904	VIII

$$^a \text{RBQ} = \sum^n fi(n + 1 - i) / Nn \times 100$$

*N* Total no. of fishermen, *n* No. of Ranks, *i* rank position, *fi* frequency of *i*

Nutrient rich deep-pools (depth not more than 2 m) locally known as ‘Garh’, found in the course of rivers serve as dry season refuges for brood fish during the period of low discharge or summer months where catching of fish is prohibited (Menon 1988). Habitat destruction, wanton destruction, construction of dams and weirs across rivers without provision for free movement of fishes, pollution, introduction of exotic fish species, and over exploitation are the major threats to different indigenous fish species.

(c) *In situ* and *ex situ* conservation: The study evinces that an *in-situ* conservation of aquatic fish species having a biological and social synergy with the ecodynamics could have been more appropriate in the conservation strategy. Cryopreservation of sperms, eggs or embryos and storage of cell cultures represent alternative methods of maintaining genetic variants (Kapoor et al. 1998). Regarding *ex situ* conservation, rehabilitation of declining fish species by spawning enhancement is necessary. For conservation and rehabilitation of declining fish species viz. *M. cavasius* (Mishra et al. 2001b), *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Labeo calbasu* (Mishra et al. 2001b, c), *M. cavasius* and *Mystus seenghala* and in some endangered fish species (Mukherjee et al. 2002) induced spawning appeared to be very much effective. Artificial breeding of rare and endangered fish species is being practiced to make available these species in their natural habitats and thereby restoring the gene bank of threatened species. It has

been possible to achieve success through hypophy-sation technique of some threatened fish species to produce pure seeds (Sehgal 1991; Mishra et al. 2001b).

(d) Environmental awareness raising: For sustainable development of common property resource, it is essential to involve local communities and other stakeholders. A mechanism should be sought for bringing together representatives of the various categories of stakeholders for participatory rural appraisal (PRA) to identify constraints and differences, resolve conflicts, review progress, make collaborative management decisions, etc. The salient aspect of the approach is the local communities and their members are the experts. Community-based natural resource management (CBNRM) allows each community to develop a management strategy, which may include conducting several workshops and training programs highlighting different problems and prospects of fishery activities so that developing a sustainable fishery management alongside delineating proper conservation strategies are possible in South West Bengal.

**Conclusion**

The erosion of local garmplasms in the ichthyofaunal scores had its both immediate and long-term impact. The modernization of agriculture and increasing

urbanization have led to pollution as well as ecological stress on the very existence of the fish species selected under the study. The present study not only developed an inventory but also created and applied some participatory tools to determine the conservation status of fish species based on local knowledge. The need of the moment is to quantify and standardize the information so that quantification can be formalized according to international standards. A pro-people approach was innovatively followed in this study to quantify the people's perception on the decline of different local species of fishes. This is a journey towards deriving and standardizing techniques and tools for measuring decline or degeneration of different fish species. This approach could go complementary in providing necessary inputs for the conventional IUCN approach. This type of study can also be replicated to peruse the experience and learning of the local peoples to standardize the observation of the conventional researches.

The heuristic importance of this study had been immense while we found that with the given level of ecological stress, the same niche and the same set of folk observers, some species like *M. gulis* (18.47%) had experienced lowest decline i.e highest survivability and the species *R. rita* (52.07%) had undergone highest decline i. e lowest survivability. This would reveal if studied meticulously the biosocial missing link for the most desired survivability even amidst the same level and intensity of degeneration factors causing mortality.

The retailer and fisherman, the two key fish handlers in fishmarkets in India, have themselves become the strategic points for generating fresh validated data on the nature and quanta of fish landings in the local markets, While fishermen could provide the fresh-farm-water data on fish catches, the retailers could provide an account of how much they are in receipts of the fish quanta, sustaining fish diversity as well. In this study, the differential perception by retailers and fishermen on the decline of different fish species has been centered to present the heterodoxy and the perceptions undergone ultimately to an interpolation process to generate a near realistic data.

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## References

- Bhaumik U, Saha SK (1998) Role of extension in arousing mass awareness and public participation in fish conservation movement. In: Ponniah AG Das P, Verma SR (eds) Fish genetic and biodiversity conservation. vol. 5. Natcon Pub, Muzaffarnagar, pp 157–163
- Bhattacharya N, Chakraborty SK (2001) Distributional Pattern of Some Heavy Metals in the Structural Components of Two Contrasting Wetlands in the Vicinity of a Iron Extraction Factory of Midnapore District, West Bengal, India, Chapter 25, Ecology of Polluted Waters
- Cernea MM (1991) Putting People First, sociological variables in rural development. The World Bank, Washington D.C.
- Crawford SS, Morito B (1997) Comment: toward a definition of conservation principles for fisheries management. *Can J Fish Aquat Sci* 54(11):2720–2723 doi:10.1139/cjfas-54-11-2720
- Das P (1988) Conservation and management of fish genetic resources of India. In: Jhingran AG, Sugunan VV (eds) Conservation and management of inland capture fishery resources. vol. 57. C.I.C.F.R.I, Barrackpore, West Bengal, India, pp 20–24
- Day F (1978) The fishes of India, being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Cylon. Text and atlas in 4 parts. London: XX + 778 pp., 195 pls
- Dudgeon D (2002) An inventory of riverine biodiversity in monsoonal Asia: present status and conservation challenges. *Water Sci Technol* 45(11):11–19
- Gibson CC, Koontz T (1998) When 'community' is not enough: institutions and values in community-based forest management in southern Indiana. *Hum Ecol* 26(4):621–647 doi:10.1023/A:1018701525978
- Hamilton-Buchanan F (1822) A account of the fishes found in the river Ganges and its branches. Edinburgh and London. Vii + 405 pp + 39 pls
- I.U.C.N. (1994) IUCN Red list categories. Prepared by the IUCN species survival commission. IUCN, Gland, Switzerland
- I.U.C.N. (2001) The IUCN Red List Categories and Criteria. Version 3.1. IUCN Species Survival Commission, IUCN, Gland, Switzerland and Cambridge. UK, pp 1–30
- Jayaram KC (1999) Freshwater fishes of the Indian Region. Narendra Publishing House, Delhi XXVII 551:18. Plates
- Jhingran AG (1988) Aquatic pollution with special reference to the Ganga river system. National symposium on environmental impacts on animals and aquaculture. Dept. of Zoology, Kalyani Univ., Kalyani, India, pp 6–19
- Kapoor D, Mahanta PC, Pandey AK (1998) Ichthy diversity of India: Status and conservation. In: Ponniah AG, Das P, Verma SR (eds) Fish gen. biodiversity conserv. vol. 5. Natcon Pub, Muzaffarnagar, pp 47–53
- Kumar A (1998) Conservation of fish genetic resources of North Bihar. In: Ponniah AG, Das P, Verma SR (eds) Fish gen. biodiversity conserv. vol. 5. Natcon Pub, Muzaffarnagar, pp 63–68

- Konar SK (1975) Pesticides and aquatic ecosystems. *Indian J Fish* 22:80–85
- Menon AGK (1988) Conservation of the Ichthofauna of India. In: Jhingran AG, Sugunan VV (eds) Conservation and management of Inland capture fishery resources. vol. 57. C.I.C.F.R.I, Barrackpore, West Bengal, India, pp 25–33
- Menon AGK (1989) Conservation of the Ichthyofauna of India. In: Jhingran AG, Sugunan VV (eds) Conservation and management of inland capture fisheries resources of India pub. Inland fish., Soc. India. CICFRI, Barrackpur, West Bengal, pp 25–33
- Menon, AGK (1999) Check list-Freshwater fishes of india. *Rec. Zool. Surv. India, Occ. Paper No. 175:i-xxix*, 1–366
- Mishra SS, Pradhan P, Chakraborty SK (2001a) Status of fishing technologies for inland water bodies of South West Bengal, India. *Vidyasagar Univ J Biol Sci* 7:45–59
- Mishra SS, Pradhan P, Chakraborty SK (2001b) Induced spawning of a Siluroid fish, *Mystus cavasius* (Hamilton-buchanan) for its propagation. *Aquacult* 2(2):169–176
- Mishra SS, Pradhan P, Dutta NC, Chakraborty SK (2001c) Studies on the performance of ‘Ovatide’-on breeding of Indian major carps. *J Indian Fish Assoc* 28:125–129
- Mishra SS, Pradhan P, Giri S, Chakraborty SK (2002) Environmental Perturbation with regard to water quality and fishery resources of river Rupnarayan: A potential threat from a thermal power plant, West Bengal, India. In: Verma SR (ed) Sustainable development and cold water fish genetic resources. vol. 7. Nature Conservators, Muzaffarnagar, pp 155–172
- Mishra SS, Pradhan P, Kar S, Chakraborty SK (2003) Ichthyofaunal diversity of South West Bengal. *Rec Zoological Surv India* 220:1–65
- Moore JW, Ramamoorthy S (1984) Heavy metals in natural waters, applied monitoring and impact assessment. Springer Verlag, New York
- Mukherjee N (1997) Participatory appraisal of natural resources. Concept Publishing Company, New Delhi
- Mukherjee M, Praharaj A, Das S (2002) Conservation of Endangered fish stock through artificial propagation and larval rearing technique in West Bengal, India. *Aquaculture Asia* VII (2):8–11
- Patra MK, Acharjee SK, Chakraborty SK (2005) Conservation categories of siluroid fishes in North-East Sundarbans, India. *Biodivers Conserv* 14:1863–1876 doi:10.1007/s10531-004-1041-0
- Prasad PS (1994) Status paper on endangered, vulnerable and rare fish species of Bihar. In: Dehadrai PV, Das P, Verma SR (eds) Threatened fishes of India. vol. 4. Natcon Pub, Muzaffarnagar, pp 25–29
- Saunders JW (1969) Mass mortalities and behavior of brook trout and juvenile Atlantic salmon in a stream polluted by agricultural pesticides. *J Fish Res Bd Can* 26:695–699
- Sehgal KL (1991) Artificial propagation of the golden mahseer, *Tor putitora* (Ha.) in the Himalayas. Special Pub. No. 2. 12 pp. National Research Center on Coldwater Fisheries, Haldwani
- Talwar Pk, Jhingran AG (1991) Inland fishes of India and adjacent countries. New Delhi, Bombay, Calcutta, Oxford and IBH Publishing Co. PVT. LTD. I & II, pp 1–1062
- Tarzwel CM, Henderson C (1957) Toxicity of dieldrin to fish. *Trans Am Fish Soc* 86:245–257 doi:10.1577/1548-8659(1956)86[245:TODTF]2.0.CO;2
- Tsing AL, Brosius JP, Zerner C (1999) Assessing community-based natural resource management: a conference report. *Ambio* 28(2):197–198
- Walker CH, Hopkin SP, Sibly RM, Peakall DB (1996) The fate of metals and radioactive isotopes in contaminated ecosystem. Principles of Ecotoxicology, Taylor and Francis Ltd, pp 51–72
- Yadava YS, Chandra R (1994) Some threatened carps and catfishes of brahmaputra river system. In: Dehadrai PV, Das P, Verma SR (eds) Threatened fishes of India. vol. 4. Natcon Pub, Muzaffarnagar, pp 45–55