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Availability and Conservation Status of Freshwater Fish in the Contai Sub-divisions of Purba Medinipur District, West Bengal, India

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Abstract

The present study was conducted to generate a primary database on threatened categories of freshwater fish availability in the selected fish market at Contai subdivision, Purba Medinipur district, West Bengal, India with special reference to their conservation status. Two markets, namely Contai supermarket, Majna market of Contai-1 block, and other two markets Kalinagar fish market and Nachinda Bazar of Contai-3 block were surveyed for ten months from October-2020 to July-2021. A total of 67 fin and shellfish species were recorded during the survey period. In the present study as per IUCN (2018) out of 67 species found in Contai-1 and Contai-3 block, 48 species are in the Least Concern (LC) with a contribution of 71.64%, five species are vulnerable (VU) with a contribution of 7.46%, five species are Not Evaluated (NE) with the contribution of 7.46%, one species are Endangered (EN), and contribution of 1.49%, six species are Near Threatened (NT) with a contribution of 8.96% and two species are Data Deficient (DD) with a 2.99% contribution. The main aim of this study is to raise awareness of consumers and certain conservation measures of this threatened category of fishes and may regenerate the species in the natural resources.

Key words: Fish availability, Threatened, Conservation, Awareness, Natural resources

Freshwater fishes are important as they indicate the ecological processes and assessment at all levels of biological organization and interrelation between producer and consumer at the level of the ecosystem where fish species exhibit diverse morphological and behavioral adaptation in the natural habitat. Billions of people depend on fish as their primary source of protein all over the world and are well known for their economic, medicinal, and their rich amount of high-quality protein, vitamins, minerals, and salts. Fish can be easy for husbandry, harvested, and can be grown quickly and cheaply. Freshwater fish species constitute an important element of the food chain for many other species including species of potential conservation concern and a subsidiary food at a reasonable price for over 70 to 75% of people, who are suffering from malnutrition. Fishes also form a subsidiary food for over one billion people of low-income groups from rural areas of developing nations.

Fishes are a rich source of proteins with high nutritive value and excellent food for poor people and provide proteins, fats, minerals, and vitamin A and D, that is essential for the good health of the human population for thousands of years. They have good taste and are easily digestible and hence faith a good market value. Fishes are also a medicinal source and for decoration in homes as well as in offices. The fishery is an important economic activity in developing countries like India and has large export potential. The UN Food and Agriculture Organization estimate that approximately 35 million people are directly engaged, either full or part-time, in fishing practices. Over 95% of them live in developing countries, and most are small-scale fishers [1].

Over 10, 000 fish species live in freshwater which are approximately 40% of global fish diversity and one-quarter of global vertebrate diversity [2]. Worldwide freshwater fishes are the most diverse of all vertebrate groups but are also the most highly threatened. In the Indian region out of 2500 species, 930 are freshwater inhabitants & 1570 are marine [3]. ZSI recorded 2641 Pisces in the year 2012. A lot of work has been done in the Northern region followed by the southern region of India. The paper [4] enlisted 422 fish species from northeast India, belonging to 133 genera and 38 families. 667 species under 149 Genera of 35 families in the southern region have reported [5]. 950 species of freshwater fishes found in India [6].

In West Bengal, 171 freshwater fish species were reported by Sen [7]. After a few years, there was a wide change in the number of fish species reported. The freshwater fishes of the Midnapur, Bankura, and Hooghly districts studied by Mishra *et al*. [8]. 239 freshwater species belonging to 147 genera, 49 families, and 15 orders were recorded by barman [9].

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70 indigenous ornamental fish species belonging to 45 genera, 30 families, and 9 orders were reported by Basu *et al*. [10]. There were a few works on freshwater fishes that have been recorded in West Bengal. Diversity of freshwater fishes in the eastern part of Purba Medinipur district of West Bengal was studied by Bablu and Basudev [11]. The record of the freshwater fish fauna of Paschim Medinipur is mostly done by works of [12-14]. Ichthyofaunal diversity in the Negua Diversion canal of Purba Medinipur District has been studied by Payra *et al*. [15]. They [16] also studied the seasonal variation of plankton in the brackish water-fed canal of Purba Medinipur district and their role in fish production. Mandal et al. in 2015 studied the seasonal availability of crabs and their distribution in the Digha coast of Purba Medinipur district [17]. The present study was undertaken by surveying the availability of freshwater threatened fish species in selected markets of Contai subdivision, Purba Medinipur district, West Bengal, and finding the conservation measure of this threatened species.
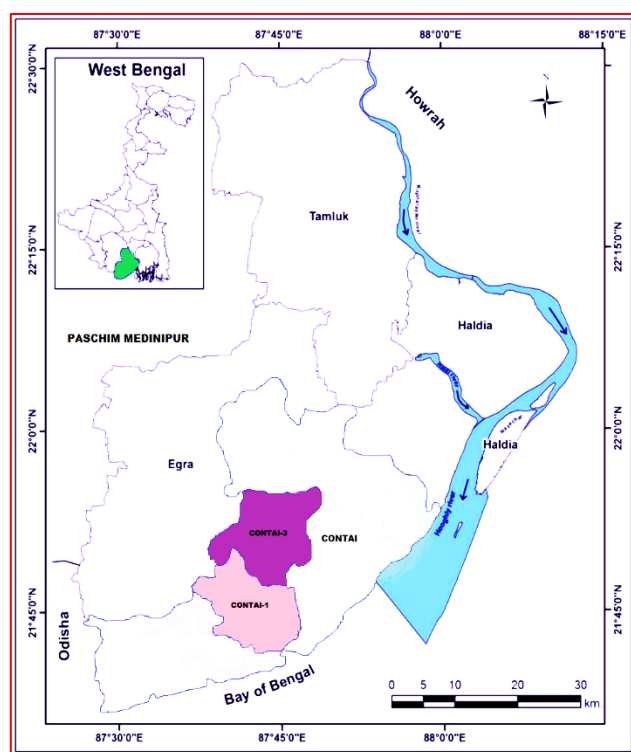

Fig 1 Location map of the study area

MATERIALS AND METHODS

About the study area

The study was conducted for ten months from October-2020 to July-2021 in the different fish markets of Contai supermarket, Majna market of Contai-1 block, Kalinagar fish market, and Nachinda Bazar of Contai-3 block. The selected fish market of the two-block under the Contai subdivision was taken for the survey. Geographically, Contai-1 block situated at 21°77'57" N (Latitude) 87°75'02" E (Longitude), Contai-3 block situated at 21°49'24" N (Latitude) 87°43'42" E (Longitude) in Purba Medinipur district (Fig 1).

Collection of fish samples

The present study was conducted by a personal survey of Contai supermarket, Majna market of Contai-1 block and Kalinagar fish market and Nachinda Bazar of Contai-3 block of district Purba Medinipur for 10 months from October-2020 to July-2021. Fish species were observed at the survey area and noted their abundance in each fish market on an alternative day basis (Fig 3). The threatened fish species were photographed (Fig 4).

Identification of fishes

Identification and subsequent taxonomic classification of fishes have been done based on literature like Talwar-Jhingran [18], Jayaram [19], http://www.fishbase.org. International Union for Conservation of Nature Red List of Threatened Species (IUCN, 2018) was followed to evaluate the present conservation status of the species [20].

Statistical analysis of the availability of fishes across different market
Concept of ANOVA test

ANOVA is short for Analysis **o**f Variance. The main purpose of an ANOVA is to test if three or more groups differ from each other significantly in one or more characteristics. One-Way ANOVA is used to determine whether there are any statistically significant differences between the means of the status of availability of fishes across different markets.

Hypotheses of ANOVA

Let μi means the status of availability of fishes in the markets (i = 1, 2, 3 and 4). The null and alternative hypotheses of one-way ANOVA can be expressed as: $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$, H_1: At least one μi different.

Test statistic

The test statistic for a One-Way ANOVA is denoted as F. The F statistic evaluates whether the group means are significantly different.

F statistic components to be depicted in a table like the following:

Table 1 F statistic

	Sum of squares (SS)	df	Mean square (MS)	F
Treatment	SSR	4-1	MSR = SSR / 4 – 1	MSR/MSE
Error	SSE	n-(4-1)	MSE = SSE / n - (4 – 1)	
Total	SST	n-1		

Where;
SSR = the regression sum of squares
SSE = the error sum of squares,
SST = the total sum of squares (SST = SSR + SSE)
n = the total number of valid observations
MSR = SSR/4-1 = the regression mean square
MSE = SSE/n-4-1= the mean square error

Then the F statistic itself is computed as F=MSR/MSE

RESULTS AND DISCUSSION

A total of 67 fin and shellfish species recorded from four markets was provided in (Table 2) with the dominance of availability. In the present study as per IUCN (2018) out of 67 species found in Contai-1 and Contai-3 block, 48 Species are the least concerned (LC) with 71.64% contribution, 5 species are vulnerable (VU) with contribution 7.46%, 5 species not evaluated (NE) with the contribution of 7.46%, one species are

Endangered (EN) and contribution of 1.49%, six species are Near Threatened (NT) with a contribution of 8.96% and two species is Data Deficient (DD) with 2.99% contribution (Table 3, Fig 2).

Table 2 Status of availability of freshwater fish species from fish markets of Contai subdivision, Purba Medinipur, West Bengal, and their diversity status

S. No	Name of the species	Contai supermarket	Majna market	Kalinagar fish market	Nachinda Bazar	IUCN Status
1	*Labeo bata* (Hamilton 1822)	4	2	4	3	LC
2	*Labeo rohita* (Hamilton 1822)	4	2	4	2	LC
3	*Cirrhinus reba* (Hamilton 1822)	3	1	2	2	LC
4	*Wallago attu* (Bloch and Schneider 1801)	3	2	3	2	VU
5	*Nandus nandus* (Hamilton 1822)	1	0	1	0	LC
6	*Pangasius pangasius* (Hamilton 1822)	4	3	4	4	LC
7	*Labeo boga* (Hamilton 1822)	2	1	2	1	LC
8	*Notopterus notopterus* (Pallas 1769)	3	2	3	3	LC
9	*Puntius sarana* (Hamilton 1822)	3	3	4	2	LC
10	*Mystus tengara* (Hamilton 1822)	4	3	4	3	LC
11	*Clarias batrachus* (Linnaeus 1758)	2	1	2	2	LC
12	*Catla catla* (Hamilton 1822)	4	3	4	4	LC
13	*Cirrhinus mrigala* (Hamilton 1822)	4	3	4	4	LC
14	*Puntius ticto* (Hamilton 1822)	3	2	2	2	LC
15	*Chagunius chagunio* (Hamilton 1822)	2	1	2	1	LC
16	*Chanda nama* (Hamilton 1822)	3	2	3	2	LC
17	*Channa marulius* (Hamilton 1822)	3	2	2	2	LC
18	*Hypophthalmichthys molitrix* (Valenciennes 1844)	4	3	3	3	NT
19	*Ctenopharyngodon idella* (Valenciennes 1844)	4	3	3	3	NE
20	*Puntius sophore* (Hamilton 1822)	3	2	3	2	LC
21	*Macrognathus pancalus* (Hamilton 1822)	3	1	2	1	LC
22	*Chitala chitala* (Hamilton 1822)	3	2	2	2	NT
23	*Macrobrachium rosenbergii* (De Man 1879)	4	3	4	3	LC
24	*Macrognathus aculeatus* (Bloch 1786)	2	1	2	1	LC
25	*Rhinomugil corsula* (Hamilton 1822)	2	2	3	2	VU
26	*Labeo calbasu* (Hamilton 1822)	3	2	2	2	LC
27	*Hypophthalmichthys nobilis* (Richardson 1845)	4	3	4	4	DD
28	*Cyprinus carpio* (Linnaeus 1758)	2	2	3	2	VU
29	*Carassius auratus* (Linnaeus 1758)	3	2	3	3	LC
30	*Rita rita* (Hamilton 1822)	3	2	2	2	LC
31	*Macrobrachium villosimanus* (Tiwari 1947)	4	3	4	3	LC
32	*Anabas testudineus* (Bloch 1792)	4	3	3	4	LC
33	*Clarias dussumieri* (Valenciennes 1840)	3	2	3	2	NT
34	*Oreochromis niloticus* (Linnaeus 1758)	4	2	3	3	LC
35	*Esomus danricus* (Hamilton 1822)	2	1	1	1	LC
36	*Pangasianodon hypophthalmus* (Sauvage 1878)	4	3	2	3	EN
37	*Amblypharyngodon mola* (Hamilton 1822)	3	2	2	1	LC
38	*Channa punctata* (Bloch 1793)	3	2	2	2	LC
39	*Oreochromis mossambica* (Peters 1852)	4	3	4	3	VU
40	*Mystus vittatus* (Bloch 1794)	4	3	4	3	LC
41	*Parambassis ranga* (Hamilton 1822)	2	1	1	1	LC
42	*Trichogaster fasciata* (Bloch and Schneider 1801)	3	2	3	2	LC
43	*Ompok bimaculatus* (Bloch 1794)	4	2	2	2	NT
44	*Channa orientalis* (Bloch and Schneider 1801)	3	2	3	2	VU
45	*Mystus aor* (Hamilton 1822)	3	2	3	2	LC
46	*Heteropneustes fossilis* (Bloch 1794)	3	2	2	2	LC
47	*Ompok pabda* (Hamilton 1822)	4	3	4	2	NT
48	*Clarias gariepinus* (Burchell 1822)	3	2	3	2	LC
49	*Channa striata* (Bloch 1793)	3	2	2	2	LC
50	*Macrognathus aral* (Bloch and Schneider 1801)	3	2	3	2	LC
51	*Colossoma macropomum* (Cuvier 1816)	4	3	4	3	NE
52	*Macrobrachium malcolmsonii* (Milne Edward 1882)	3	3	4	3	LC
53	*Puntius javanicus* (Bleeker 1855)	4	2	2	3	LC
54	*Mystus cavasius* (Hamilton 1822)	3	2	2	2	NE
55	*Puntius chola* (Hamilton 1822)	3	2	2	3	LC
56	*Xenentodon cancila* (Hamilton 1822)	1	0	1	0	LC
57	*Piaractus brachypomus* (Cuvier 1818)	4	3	4	3	NE
58	*Glossogobius giuris* (Hamilton 1822)	1	0	1	0	LC
59	*Monopterus cuchia* (Hamilton 1822)	0	0	0	1	LC

60	*Johnius gangeticus* (Talwar 1991)	0	0	1	0	DD
61	*Mugil cephalus* (Linnaeus 1758)	3	2	3	3	LC
62	*Planiliza parsia* (Hamilton 1822)	4	2	3	3	NE
63	*Lates calcarifer* (Bloch 1970)	3	2	3	3	LC
64	*Pseudapocryptes elongatus* (Cuvier 1816)	3	2	2	2	LC
65	*Apocryptes bato* (Hamilton 1822)	2	1	1	1	LC
66	*Glossogobius aureus* (Akihito and Meguro1975)	1	0	0	1	LC
67	*Ailia coila* (Hamilton 1822)	2	0	1	0	NT
	Average	2.9701	1.9254	2.5970	2.1493	

1: Number used: '4'= highly dominant, '3'=dominant, '2'= moderately dominant, '1'= less dominant, '0'= not available.
2: IUCN (International Union for Conservation of Nature and Natural Resources) Red list: LC: Least Concern, VU: Vulnerable, NE: Not Evaluated, EN: Endangered, NT: Near Threatened, DD: Data Deficient

Table 3 Number of species and percentage of fish fauna as per IUCN red list category

IUCN Status	Number of species	Percentage (%)
Least Concern (LC)	48	71.64
Vulnerable (VU)	05	7.46
Not Evaluated (NE)	05	7.46
Endangered (EN)	01	1.49
Near Threatened (NT)	06	8.96
Data Deficient (DD)	02	2.99

Table 4 Descriptive statistics of availability of fish across different markets

Different markets	N	Mean	Std. Deviation	Minimum	Maximum
Contai supermarket	67	2.9701	.99955	.00	4.00
Majna market	67	1.9254	.90977	.00	3.00
Kalinagar fish market	67	2.5970	1.07393	.00	4.00
Nachinda Bazar	67	2.1493	1.01882	.00	4.00
Total	268	2.4104	1.07552	.00	4.00

Table 5 ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between groups	43.657	3	14.552	14.487	.000
Within groups	265.194	264	1.005		
Total	308.851	267			

The table that shows the output of the ANOVA analysis and whether there is a statistically significant difference between our group means.

The significance value is 0.001 (i.e., $p = .001$), which is below 0.05. And, therefore, there is a statistically significant difference in the availability of fishes to types of markets.
[Here H_o (null hypothesis) is rejected (equal means), H1 (Alternative hypothesis) is accepted (differential means)]

Table 6 Multiple comparisons

				Tukey HSD
(I)	mkt (J) mkt	Mean Difference(I-J)	Std. Error	Sig.
Contai supermarket	Majna market	1.04478*	.17316	.000
	Kalinagar fish market	.37313	.17316	.139
	Nachinda Bazar	.82090*	.17316	.000
Majna market	Majna market	-1.04478*	.17316	.000
	Kalinagar fish market	-.67164*	.17316	.001
	Nachinda Bazar	-.22388	.17316	.568
Kalinagar fish market	Contai supermarket	-.37313	.17316	.139
	Majna market	.67164*	.17316	.001
	Nachinda Bazar	.44776*	.17316	.050
Nachinda Bazar	Contai supermarket	-.82090*	.17316	.000
	Majna market	.22388	.17316	.568
	Nachinda Bazar	-.44776*	.17316	.050

*The mean difference is significant at the 0.05 level.
The table, Multiple Comparisons, shows which groups differed from each other. The Tukey post hoc test is generally the preferred test for conducting post hoc tests on a one-way ANOVA, but there are many others. From the table, there is a statistically significant difference of availability of fishes across different markets.
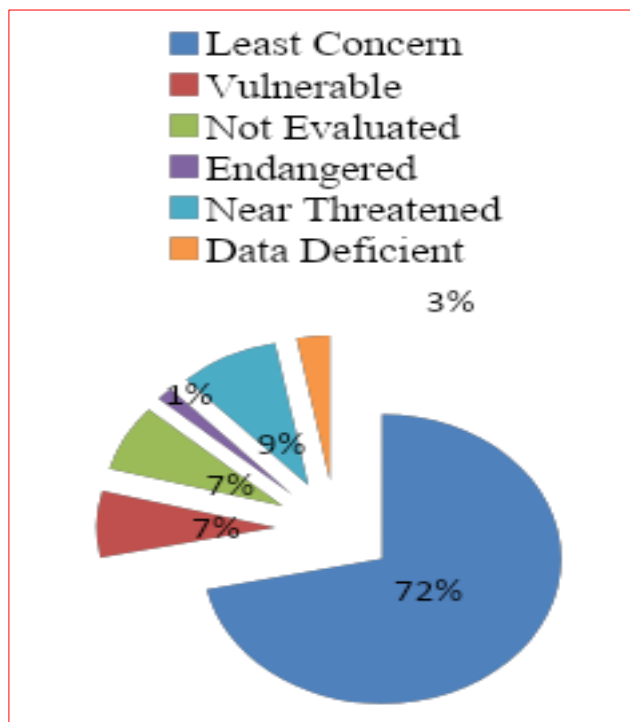
Fig 2 Percentage of species under different threat categories as per IUCN (2018)

Fig 3 Survey area (a) Contai supermarket (b) Majna market (c) Kalinagar fish market (d) Nachinda Bazar
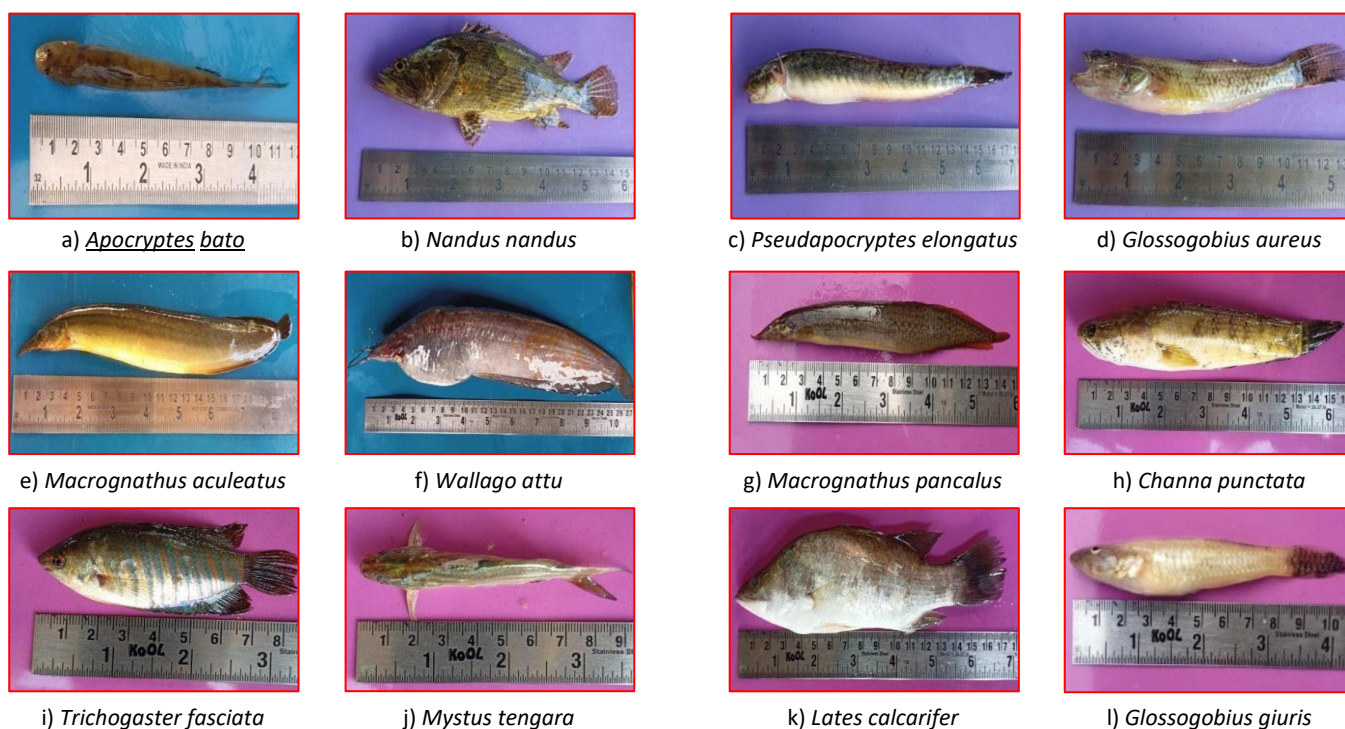

a) *Apocryptes bato*

b) *Nandus nandus*

c) *Pseudapocryptes elongatus*

d) *Glossogobius aureus*

e) *Macrognathus aculeatus*

f) *Wallago attu*

g) *Macrognathus pancalus*

h) *Channa punctata*

i) *Trichogaster fasciata*

j) *Mystus tengara*

k) *Lates calcarifer*

l) *Glossogobius giuris*

Fig 4 Threatened category of fishes

The diversity of freshwater fish is unevenly distributed on Earth. It is not only the strength of India, but also the strength of the world. Fish are one of the most endangered groups of animals and have the highest spread rates. Fish diversity correlates with biological and various physicochemical parameters that regulate the productivity and distribution of different fish species. Freshwater fishes are the most diverse group of India's vertebrates with a minimum of 600 species [21]. The freshwater fishes have distributed amongst approximately 20 orders 100 families and 300 genera [22].

Several authors have reported on the diversity of fish from the water resources of West Bengal. Bhakta and Bandyopadhyay [23] documented 46 fish species from freshwater water bodies in the Purba Midnapore District. Das *et al*. [24] recorded a total of 52 fin and shellfish species from the three markets in Kolkata. Mogalekar *et al*. [25] recognized 267 species of freshwater fishes [25]. Bhattacharya [26] identified 102 freshwater fish species belonging into total 10 orders and 27 families in Bankura district.

The diversity of freshwater in West Bengal is gradually diminishing due to the rapid deterioration of inland waters. The district of Purba Medinipur have many vast bodies of water commonly known as beels, ponds, and the bunds, which are the main sources of fish for the poor in the surrounding villages.

However, most are unproductive due to excessive burial and weed growth, with a fishing potential of only 33%. The aquatic ecosystem and its biodiversity are decreasing in the scale of global concern [27], especially for the river landscapes [28]. Freshwater fishes are most threatened after the amphibians among vertebrates and the fish extinction rate is very high than other higher vertebrates in the global scenario [29]. Conservation measures to reduce adverse impacts are slow and inadequate. As a result, many valuable aquatic species are being reduced at an alarming rate. The main causes of freshwater biodiversity loss are habitat degradation and fragmentation, invasive species, water diversion, pollution and the effects of global climate change [30].

Extensive studies have been conducted on freshwater fish in India. However, most are related to taxonomy, biology, and aquaculture. To date, fish diversity and conservation of fish in stagnant water has not been carried out, although this has been very important for fish productivity and diversity. Fish diversity has been declining in recent years due to irrational fishing practices, reduced water volumes, increased sedimentation, unwanted contamination and withdrawals. We have already released some freshwater species from India and some are endangered. Freshwater in India has been considered in terms of economic production. They serve as irrigation water sources, municipal industrial water sources and hydroelectric power plants, receiving waste from sewage and industrial plants and producing edible fish [31].

The biodiversity of fish has gradually declined due to various factors. Some of the factors recorded during the study were urbanization, domestic and industrial pollution, agricultural use of pesticides, inadvertent exploitation of fish, catching small fish, no restrictions on the mesh size used, catching fish during breeding seasons. In order to improve fish availability and diversity and promote sustainable development,

it is necessary to adhere to restrictions on mesh sizes of various nets, breeder catches and yields in protected areas. The permissible mesh size of gill net is 30 mm or more. Large carp larger than 15 cm can be caught in rivers, ponds and reservoirs [32]. Fish diversity can be maintained and enhanced through appropriate policymaking by the government's fisheries sector. West Bengal and its implementation and surveillance are carried out regularly with locals and through awareness campaigns between locals and the new generation.

CONCLUSION

The availability of fish in contai supermarket is significantly higher than the availability of fish majna and nachinda fish market. Again, the availability of fish in kalinagar fish market is significantly higher than the availability of fish in majna and nachinda fish market. But there is no significant difference in the availability of fish between contai supermarket and the kalinagar fish market. The water bodies of district Purba Medinipur have undergone several major changes during the past few years by anthropogenic activities like deforestation, flood, overfishing, sand mining, recreational activities, organic and inorganic pollution, and other activities. These changes were due to changes in the composition of the fauna of the fish. Some species may be extinct in this area. There is a need of re-evaluation of threatened category fishes because species like *Nandus nandus*, *Glossogobius aureus*, *Amblypharyngodon mola, Channa marulius, Channa striata, Glossogobius giuris, Macrognathus aculeatus, Rita rita, Clarias batrachus, Apocryptes bato, Chagunius chagunio, Xenentodon cancila, Macrognathus pancalus, Esomus danricus* were not available in very large quantity. Certain conservation measures must be immediately and strictly implemented to protect endangered fish from their natural environment.

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