

## Traditional fishing gears of Bankura District, WB, India: Some uniqueness in fish catching

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### Abstract

The present study was undertaken to furnish the detailed features of the fish trapping devices and methods employed by the fish-farmers of Bankura district, West Bengal, India. It also determines small indigenous freshwater fish diversity. The study was carried out in randomly selected water bodies, ponds, rivers, streams; along with fisherfolk dominated thorps covering twenty-two community development blocks of Bankura district. The study revealed that the fishers of this area are accustomed to old and traditional fishing techniques. They also apply indigenous knowledge to develop some unique fish catching techniques like Gābāna, bamboo piece immersion and bowl trap. However, destructive fishing technique applying harmful chemicals had also been noticed in certain regions. A total of twenty-two traditional fishing gears have been recorded from the study area of which 7 gears were traps, 5 encircling gears, 2 entangling gears, 3 hooks and line, 4 scooping gears and 1 impaling gear. The study has revealed three unique indigenous fishing techniques of fish-farmers. A total of 34 small indigenous freshwater fish species (Least Concern, 29; Near Threatened, 3; Vulnerable, 1; Endangered, 1) were also identified. This study suggests that fishers of the study area still depend on traditional fishing gears and techniques to earn their livelihood.

**Keywords:** destructive fishing; fisherfolk community; fishing gears; small indigenous fish; traditional fishing techniques

### Introduction

Bankura district occupies a transitional zone in India, between the western corrugated plateau of Chota-Nagpur and eastern low-lying alluvial plains. The area is surrounded with red ferruginous laterite soil, jagged terrain land and intermittent dense forest. Bankura district belongs to the tropical dry sub-humid climatic zone. The land receives an annual rainfall of about 1400 mm and almost 80% of the net annual rainfall occurs during

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the monsoon season. The area is traversed by Damodar, Dwarakeswar, Gandheswari, Kangsabati, Shilabati and Sali riverine network along with numerous ponds and reservoirs which have made this drought-trodden district as the highest producer of inland freshwater resources (52,341 ha) within the state. 100 species of fish were documented from Bankura district by Roy *et al.* (2013). A good variety (92 species) of fishes in Bankura district was reported by Ganguly *et al.* (2018a).

Small indigenous fishes (maximum length in mature stage: 25-30 cm) are major contributor of nutritional security to the rural people. Nowadays, indigenous fishes are declining alarmingly due to siltation of natural breeding grounds, massive electro-fishing, indiscriminate use of small meshed net and insecticides in water-bodies; that also gives an adverse impact on aquatic ecosystem and food security (Ganguly *et al.*, 2018b; Ganguly *et al.*, 2019). Simultaneously, a large part of fishers is being forced to take tough stance for alternative source of income. Therefore, it becomes necessary to adopt a sound approach for sustainable development of the community.

Indigenous fishing techniques are eco-friendly and cost effective. There are various types and methodologies of the traditional fishing gears. Each gear possesses a unique pattern of operation and is highly variable according to the fabrication material, area and depth of water-bodies as well as season of operation.

A lot of study has been conducted on significant advancement of fishing gears and techniques throughout the India. Manna *et al.* (2011) reported 10 fishing gears from river Krishna. Use of 36 types of fishing gears in Nalbari District of Assam was revealed by Chakravartty and Sharma (2013). Baruah *et al.* (2013) identified 28 different types of fish traps from Brahmaputra valley of Assam. A comprehensive study was conducted by Chourey *et al.* (2014) to record the traditional fishing instruments used in Bhopal district. Operations of 7 traditional gears in Ukari reservoir of Gujrat was stated by Bhakta *et al.* (2016). Study conducted by Rao *et al.* (2016) in Lake Kolleru of Andhra Pradesh documented ten varieties of gear commonly used implements in fish capture. Islam and Hussain (2018) have made an extensive study to evaluate the presence of 43 types of fishing gears in Kumari beel of Goalpara district, Assam. Syed *et al.* (2020) elaborately describes the design and technical characteristics of fishing craft and gear, operated in Wular Lake, Kashmir. Jabeen and Soren (2021) reported one type of fishing craft and nine different types of gears operated by fishermen in the Manas river in Assam. Petetta *et al.* (2021) evaluated the application of pots as an alternative and sustainable fishing gears in the Mediterranean Sea.

However, a very little approach has been made to explore the traditional fishing methodologies of West Bengal. Das and Barat (2014) reported the existence of 22 types of traditional fishing gears in Cooch Behar. Samajdar and Saikia (2014) documented 23 types of indigenous fishing gears in Birbhum district. Twelve different types of fishing gears were obtained by Sandhya *et al.* (2019) from the floodplain wetlands of lower Gangetic plains of West Bengal. Uses of five different kinds of crafts and twelve different kinds of gear in Sundarban region were recorded by Madhu *et al.* (2021). No such attempt has been taken to document the detail features of fishing practice and gears operated by the fish-farmers of Bankura district. Dutta and Mondal (2016) have observed 15 types of fishing gears in Rajagram village of the district. Therefore, the present study is the first kind of effort for documentation of fishing patterns of the entire Bankura district making a multi-faceted impact across a range of fields from their health and food security to cultural and socio-economic improvement.

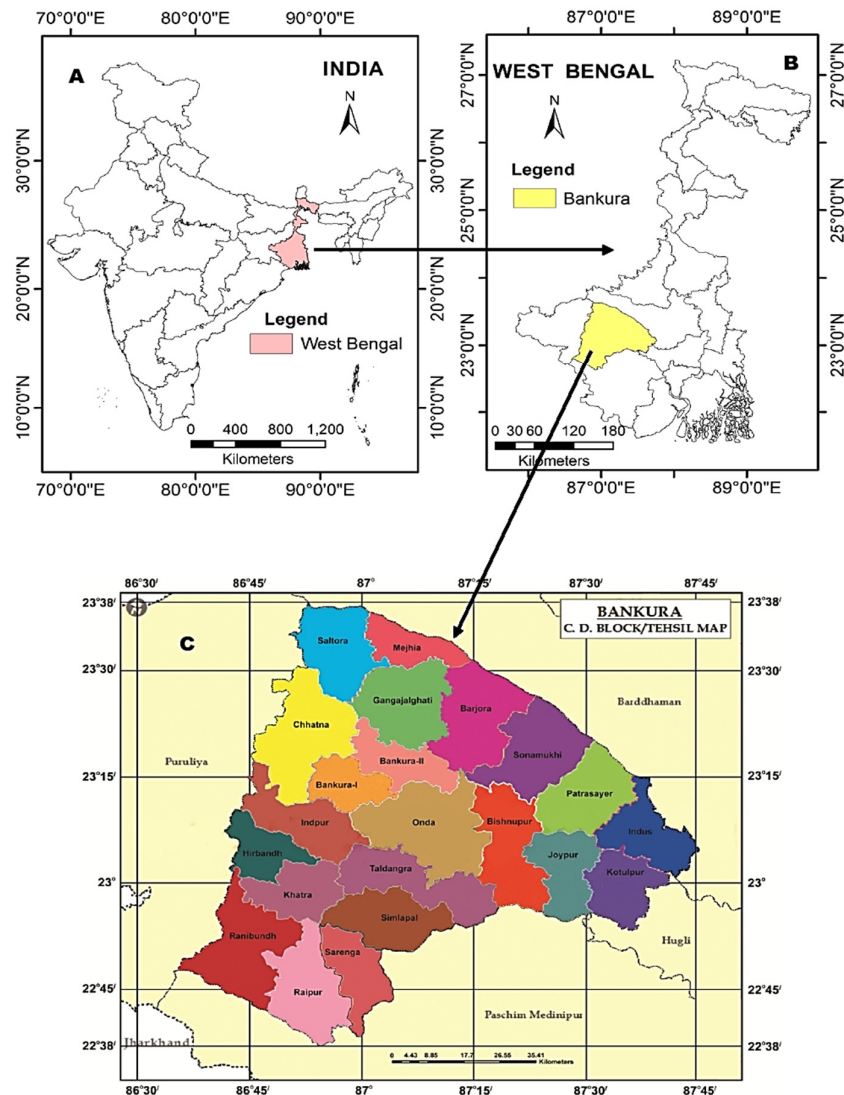
## Materials and Methods

### *Description of the study site*

Bankura district (Figure 1) covers a vast area of about 6,882 km<sup>2</sup>, lies between 22°38' to 23°38' N latitude and 86°36' to 87°46' E longitude. A simple random survey was conducted for acquisition of data from the local fish markets and waterbodies covering twenty-two blocks of Bankura district during the period of June, 2018 to May, 2019.

*Geo-spatial representation*

The GPS navigation device (eTrex Vista Hcx; Garmin® International, Inc., USA) was used to obtain specific location status. For the mapping, a satellite image was extracted from Google earth which was Landsat 8 imagery with 30-meter resolution. The image was then projected on UTM projection with the help of ArcGIS software and for more accuracy in the coordinate system, it was Geo-referenced.



**Figure 1.** Geographical location of the study area: (A) Map of India; (B) Map of West Bengal; (C) Map showing the study area (Bankura district with twenty-two blocks)

*Field survey*

The study was conducted by the Participatory Rural Appraisal (PRA) method. At first, 4-5 fish-farmers dominated thorps were randomly chosen from each of twenty-two block and a standard questionnaire has been made to collect the relevant data regarding the fishing gears. Special emphases were conferred on fabrication material, dimension, mesh size, price, season, mode of operation etc.

The primary data was retrieved from the fish farmers, traders and store-houses of each sorted thorp through interactive approach. The semi-structured interviews and group discussions were then conducted with about the 5-10 fishermen of each sorted thorp. Instinctive knowledge and sagacity of fishermen assisted in collecting the required information about traditional fishing gears. Interaction with fishing gear makers and fishing gear retailers also helped to rectify and enrich the recorded data. The mode of operation of the fishing gears was precisely observed and recorded from the onsite during fishing. Appropriate length, height, breadth, mesh size of the fishing gear was measured critically using measuring equipment. The mesh size was calculated by measuring the distance between the centers of two opposite knots in the same mesh when fully extended in N-direction (Petetta *et al.*, 2021). A Measuring tape has been used and cross-checked with vernier caliper to measure the mesh size of fishing gears.

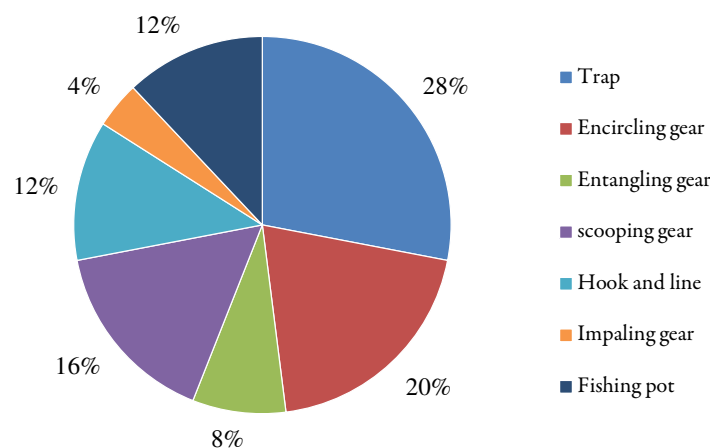
Fishing techniques and uses of traditional fishing gear were documented through photography using a camera (Nikon d5300). Finally, all the obtained data was cross-checked through group discussion with professional fisherman and Govt. Agencies. Microsoft office excel, 2016 software has been used to statistically analyze the recorded data

#### *Sample collection*

The conventional fishing gears were also used to collect fish specimen with the help of fish farmers from the study area. The samples were precisely collected and preserved (4-6% formalin) for further identification (Roy *et al.*, 2013). The identification of those samples was performed according to Talwar and Jhingran (1991). The International Union for Conservation of Nature (IUCN, 2021) red list of threatened species was used to evaluate the present conservation status of the obtained species.

### **Results**

Survey result indicated that the fishers of Bankura district mostly handled old fashioned, traditional fishing gears (Figure 3-5). A total of 22 types of traditional fishing gears and 3 types of fishing pots have been observed during the survey. These gears were further subdivided into six categories as per their mode of operation viz. trap, encircling gear, entangling gear, scooping gear, hook and line fishing and impaling gear (Figure 2). Fishing gears along with their detailed features are summarized in Table 1.



**Figure 2.** Distribution of various traditional fishing gears in Bankura district

**Table 1.** Types of fishing gears used by fish-farmers of Bankura district, West Bengal, India

Sl. No	Fishing gears	Local name	Types of gear	Ingredient	Dimension	Mesh size (mm)	Price (INR)	Season	No. of fisherman required	Targeted species	Freq. of use
1	Box trap	Ghuṭi	Trap	Bamboo	30-110 cm length and breadth 10-18 cm and height 20-35cm	—	50-380	Monsoon and post-monsoon	1	<i>Trichogaster chuna</i> , <i>Esomus danricus</i> , <i>Puntius ticto</i> , <i>Parluciosoma daniconius</i> , <i>Salmostoma bacaila</i> , prawn	Frequent
2	Box trap	Raba Ghuni	Trap	Bamboo	60-90 cm length and breadth 10-18 cm and height 20-35cm	—	120-200	Monsoon and post monsoon	1	<i>Trichogaster chuna</i> , <i>Esomus danricus</i> , <i>Puntius ticto</i> , <i>Parluciosoma daniconius</i>	Moderate
3	Barricade tap	Siṭārā	Trap	Bamboo	50-90 cm length with 30-60 cm height	—	35-40	Monsoon	1-2	All type of fishes	Frequent
4	Tubular trap	Ghugī	Trap	Bamboo	80-100 cm length and top opening radius 5-7 cm	—	50-80	Monsoon	1	<i>Esomus danricus</i> , <i>Amblypharyngodon mola</i> , <i>Puntius ticto</i> , <i>Anabas testudineus</i> , <i>Channa punctata</i>	Frequent
5	Cover pot	Palu'i	Trap	Bamboo	Height 35-45 cm and top opening radius of 5 cm with bottom radius of 25-30 cm	—	160-250	Winter and summer season	1	<i>Mastacembelus armatus</i> , <i>Channa punctata</i> , <i>Heteropneustes fossilis</i> , <i>Wallago attu</i>	Frequent
6	Fyke net	Chāka ni jāla	Trap	GI rod and net	110-130 cm length with opening radius of 15-20 cm	4	180-200	Monsoon	1	<i>Anabas testudineus</i> , <i>Mastacembelus pancalus</i> , <i>Esomus danricus</i> , <i>Puntius ticto</i>	Moderate
7	Cone shaped trap net	Ghugī jāla	Trap	Net	4-5 m length and bottom radius 1.5-2 m	10-15	250-400	Monsoon	1-2	<i>Catla catla</i> , <i>Cirrhinus mrigala</i> , <i>Ctenopharyngodon idella</i> , <i>Hypophthalmichthys molitrix</i>	Rare
8	Drag net	Maṣāri jāla	Encircling gear	Net	30-50 m length and 3-4 m breadth	2-3	300-450/ kg	Whole year	4-6	All type of fishes	Frequent
9	Drag net	Tānā jāla	Encircling gear	Net	40-80 m length and 3-4 m breadth	40-60	200-300/ kg	Whole year	8-16	<i>Channa striata</i> , <i>Chitala chitala</i> , <i>Labco calbasu</i> , <i>Catla catla</i>	Frequent
10	Drag net	Caṭa jāla	Encircling gear	Jute fibre	6-7 m length and 3-4 m breadth	10	1500	Whole year	6-8	<i>Labco calbasu</i> , <i>Hypophthalmichthys molitrix</i> , <i>Aristichthys nobilis</i> , <i>Catla catla</i> , <i>Cirrhinus mrigala</i>	Rare
11	Small Danish seine	Ghāṭa jāla	Encircling gear	Net	0.5 - 1 m length and middle breadth 0.6 m	3-10	150-300	Whole year	1-2	<i>Clarias gariepinus</i> , <i>Channa gachua</i> , <i>Channa punctata</i>	Moderate
12	Cast net	Khiyā jāla	Encircling gear	Net	2-4 m length and bottom radius 1-2m	5-10	650-1200	Whole year	1	<i>Cirrhinus mrigala</i> , <i>Catla catla</i> , <i>Aristichthys nobilis</i>	Frequent
13	Gill net	Phām' di jāla	Entangling gear	Net	20-30 m length and 3-4 m breadth	50-80	1000-1500	Whole year	2-4	<i>Ctenopharyngodon idella</i> , <i>Cyprinus carpio</i> , <i>Labco rohita</i> , <i>Heteropneustes fossilis</i> , <i>Wallago attu</i> , <i>Clarias gariepinus</i>	Moderate
14	Small meshed gill net	Kārēnṭ a jāla	Entangling gear	Net	6-8 m length and 1-2 m breadth	20-35	30-60	Whole year	2-3	<i>Labco bata</i> , <i>Anabas testudineus</i> , <i>Puntius ticto</i>	Frequent
15	Push net	Thēlā jāla	Scooping gear	Bamboo and net	Triangular with each side length of 90-120 cm	5-7	100-120	Whole year	1	<i>Aspidoparia jaya</i> , <i>Chanda nama</i> , prawn, snails	Rare
16	Small scoop net	Ghuṭa jāla	Scooping gear	Bamboo and net	Open radius 20-25 cm	3-4	30-45	Monsoon, post monsoon	1	<i>Puntius ticto</i> , <i>Amblypharyngodon mola</i> , <i>Danio rerio</i> , prawn	Frequent
17	Big scoop net	Ghuni jāla	Scooping gear	Bamboo and net	Open radius 40-60 cm	3-7	120-150	Whole year	1	<i>Trichogaster sp.</i> , <i>Esomus danricus</i> , <i>Puntius sp.</i> , prawn	Frequent
18	Circular scoop net	Hāta jāla	Scooping gear	Bamboo and net	Circular net of 15 cm radius and bamboo rod of 2-3 ft long	10-15	35-40	Whole year	1	<i>Clarias gariepinus</i> , <i>Clarias batrachus</i> , <i>Heteropneustes fossilis</i>	Moderate
19	Hook and line	Hāta chipa	Hook and line	Bamboo, line and barshi	5-6 ft length	—	20-80	Whole year	1	<i>Anabas testudineus</i> , <i>Trichogaster fasciata</i> , <i>Puntius ticto</i> , <i>Oreochromis mossambicus</i>	Frequent
20	Hook and line	Hu'ila chipa	Hook and line	Bamboo, line, wheel and barshi	7-7.5 ft length	—	150	Whole year	1	Indian Major Carp, <i>Notopterus notopterus</i> , <i>Oreochromis niloticus</i> , <i>Colossoma macropomum</i>	Moderate
21	Hook and line	Jhima chipa	Hook and line	Glassfiber stick, line and barshi	3 ft length	—	200-1000	Whole year	1	<i>Labco rohita</i> , <i>Labco calbasu</i> , <i>Heteropneustes fossilis</i> , <i>Clarias gariepinus</i>	Rare
22	Piercing gear	Kēcā	Impaling gear	Bamboo and iron hook	Iron hook is of 30-40 cm long and bamboo piece length is 90-135 cm	—	70-80	Whole year	1	<i>Ctenopharyngodon idella</i> , <i>Cyprinus carpio</i> , <i>Hypophthalmichthys molitrix</i> , <i>Aristichthys nobilis</i>	Rare
23	Bamboo basket	Khalui	Fishing pot	Bamboo	15-25 cm height with opening radius of 5-7 cm	—	60-200	Whole year	1	—	Moderate
24	Bamboo basket	Jhuṭi	Fishing pot	Bamboo	25-30 cm height with opening radius of 15-20 cm	—	100-150	Whole year	1	—	Frequent
25	Pipkin	Hāmṭi	Fishing pot	Aluminium	40-60 cm height with opening radius of 20-30 cm	—	1000-1200	Whole year	1	—	Frequent

\* June – August = Monsoon; September – November = Post monsoon; December – February = winter; March – May = summer. INR = Indian Rupee

*Fishing gears*Trap

## Ghuṇi

It is a rectangular-shaped cage trap made up of finely sliced thin bamboo sticks. Sticks are encased with nylon string in a regular gap of 2-3 mm. On the front side, it has 2-4 longitudinal, rectangular notches, and each notch has a vertical opening that directed the fishes to get into the trap. Trapped fishes are collected through the hole situated at any one corner of the upper portion. The length of Ghuṇi differs significantly (30-110 cm) as per the site of operation while the height and breadth are almost identical for all types (height 20-35 cm and breadth 10-18 cm). It is mostly used in monsoon and post-monsoon season when adequate water passes through the canal, stream, and gutter. It is submerged along a blockade made up of mud in shallow and slowly flowing water-bodies (Figure 3A). The front side of Ghuṇi always placed in the opposite direction of water. Ghuṇi is kept overnight in the bushy area and taken out on next morning to collect the entrapped fishes. Mainly prawn and small fishes (*Trichogaster chuna*, *Esomus danricus*, *Puntius ticto*, *Parluciosoma daniconius*, *Salmostoma bacaila* etc.) are entrapped in Ghuṇi.

## Rābā ghuṇi

Rābā ghuṇi on the contrary of Ghuṇi does not possess any vertical notches though they are functionally equivalent. It consists of 3-4 circular openings of a radius of 2 cm, circumambient by thin bamboo sticks that narrows and loosely interspersed inward (Figure 3B).

## Siṽārā

It is a traditional fishing gear made up of chopped bamboo or thin bamboo sticks or cane. Sticks are designed vertically at a regular gap and fastened with plastic or nylon rope. Siṽārā is often fabricated and handled by tribes, and they structured this as per their necessity. Therefore, its length and height vary greatly (50-140 cm in length and 30-120 cm in height). It is used for versatile purposes. Fishes that migrate opposite the current of water are interrupted by Siṽārā. Small Siṽārā (Figure 3C) is placed in the narrow canal, streams, and drenched paddy fields whereas Big Siṽārā (Figure 3D) is used as a barricade in steeped ponds and beels to prevent the fish migration. Small Siṽārā is frequently used along with Ghugī to catch fishes, and this entire set up is locally recognised as Āṛāḍāñā.

## Ghugī

It is a funnel-shaped trap made up of finely sliced, flat bamboo sticks (Figure 3E). The proximal opening is circular (5-7 cm in radius) and the body is (80-100 cm in length) gradually narrows towards the tail. The body is made up of flat interweaved bamboo sticks and the tail portion is tied up with small bamboo or wood piece that provides support to the structure. It is usually kept beside the Siṽārā in canal, ponds, and paddy fields by making an oozy slope. Fishes (e.g. *Esomus danricus*, *Amblypharyngodon mola*, *Puntius ticto*, *Anabas testudineus*, *Channa punctata*) that can migrate opposite the water current are interrupted by Siṽārā and trapped into the Ghugī.

## Palu'i

It is a half oval shaped trap, operated by single person. It is made up of nearly 160-180 finely chopped bamboo sticks which are tied together by 4-5 set of nylon rope at an interval of 10-12 cm. It has two circular openings: a narrow anterior opening (5 cm radius) and a wide distal opening (25-30 cm radius). Height of the trap is about 35-45 cm. A bamboo made ring of apt diameter is inserted inside the trap to provide the support and circular shape (Figure 3F). It is mostly used in dry season to catch medium size fishes (*Mastacembelus armatus*, *Channa punctata*, *Heteropneustes fossilis*, *Wallago attu* etc.) that survive in stagnant muddy water. The distal end of the trap is pushed into mud then the entrapped fishes are collected by hand through the anterior opening.

#### Chākani jāla

It is a funnel-shaped trap made up of two circular rings of galvanized iron (GI) rod and nylon net. The first ring that act as an opening are connected through net with the second ring at a distance of 30 cm in the form of a hollow tube (Figure 3G). After the second ring, the net gradually narrows like a funnel to capture fishes. Both rings have a radius of 15-20 cm. It is mainly installed in steeped paddy fields in monsoon to catch indigenous fishes (e.g., *Anabas testudineus*, *Mastacembelus pancalus*, *Esomus danricus*, *Puntius ticto*).

#### Ghugī jāla

It is a funnel-shaped net (Figure 3H) made up of nylon strings. Its circular anterior opening placed in the direction of water in canal and streams. Mesh size of the net is about 10-15 mm. The device is mainly used to catch large fishes like *Catla catla*, *Cirrhinus mrigala*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*. It also plays the role of a barrier alongside the ponds to prevent migration of fishes.

#### Encircling gear

##### Maśāri jāla

It is the most densely meshed fishing gear made up of nylon strings. Mesh size of Maśāri jāla is about 2-3 mm. It is effectively operated in ponds as a drag net (Figure 3I) to catch a wide variety of fishes; can be installed as a barrier to restrict horizontal migration of fishes or can be used to set up a four-sided cell (Figure 3J) inside water-bodies to cultivate fish-seed and spawn.

##### Ṭānā jāla

This large and heavy fishing gear (Figure 4A) requires considerable human resources to operate. Its length, breadth and mesh size alter mainly according to the area of operation. Net is dragged by men or using craft either from both sides or from a side and meet at a point to collect the trapped fishes. It is used throughout the year to catch large fishes (*Channa striata*, *Chitala chitala*, *Labeo calbasu*, *Catla catla*) from the dam and large water-bodies.

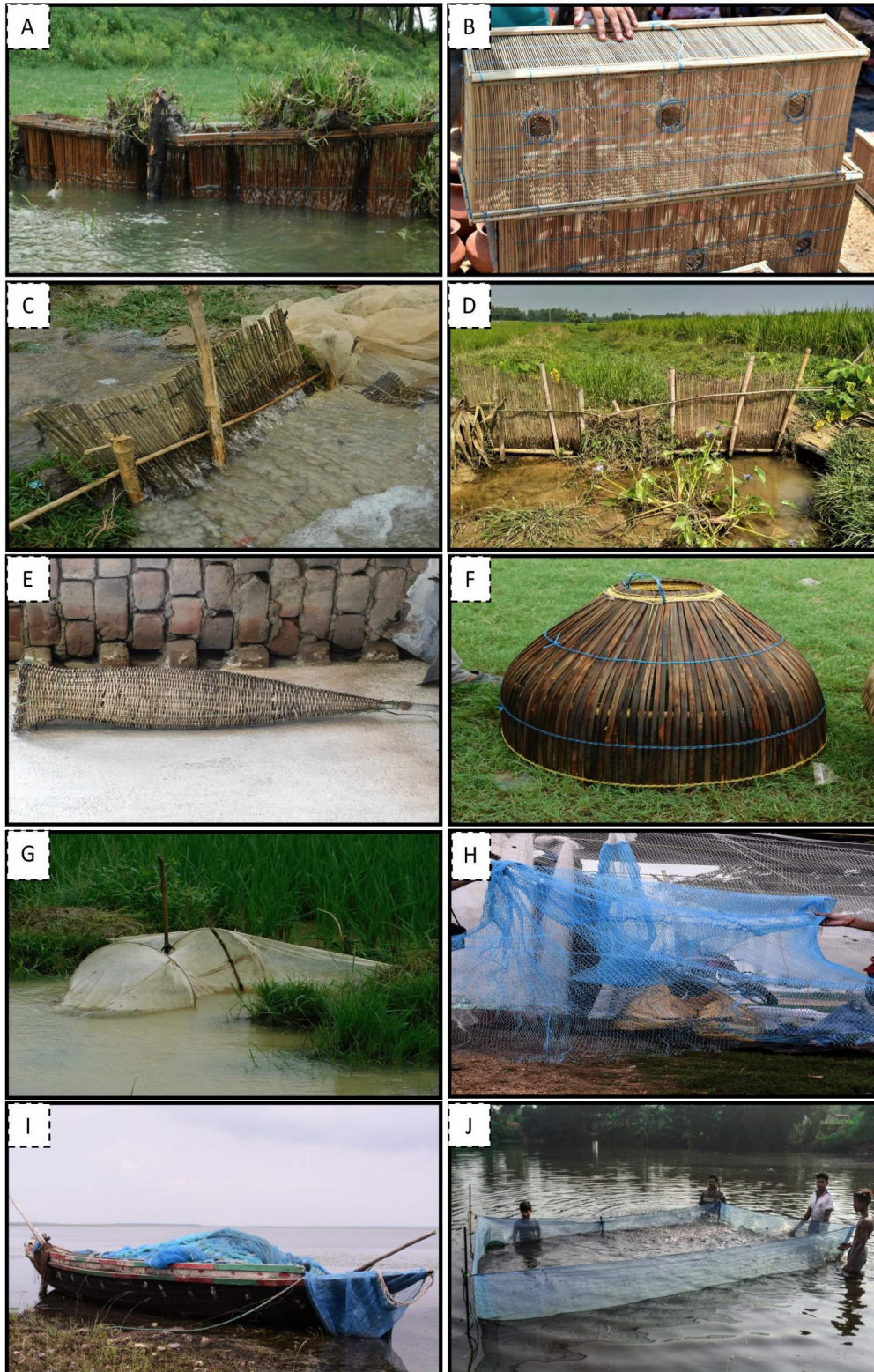
##### Caṭa jāla

Caṭa jāla is made up of very finely meshed jute fibre (Figure 4B). It has a life span of about 6-8 months. Its length and breadth vary between 6-7 m and 3-4 m respectively. The mesh size is about 10 mm. Ten-twelve Caṭa jāla are fastened and operated as a Ṭānā jāla in ponds and beels. Major carps like *Labeo calbasu*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Catla catla*, *Cirrhinus mrigala* are caught through this gear.

##### Ghāṭa jāla

It is a triangular net bag with a cork-line and a lead-line that gradually narrows towards the edges to form two wings (Figure 4C). A 2-3 m long bamboo piece is tied with each of two wings to handle it. The length of the net is about 0.5-1 m, and mesh size ranges from 3-10 cm. Bottom-dwelling fishes like *Clarias gariepinus*, *Channa gachua*, *Channa punctata* are mainly targeted through this gear.





**Figure 3.** Traditional fishing gears: (A) Ghuṇi; (B) Raba ghuni; (C) Small Siyārā; (D) Big Siyārā; (E) Ghugī; (F) Palu'I; (G) Chākani jāla; (H) Ghugī jāla; (I) Maśāri jāla; (J) Maśāri jāla



#### Khiyā jāla

It is the most frequently used fishing gear, being operated single-handedly in weed-free water throughout the year. It is also locally known as Māthā ghurānī jāla. This cone-shaped circular net (Figure 4D) is made up of nylon and cotton fibre. A strong rope of 4-5 m remains fastened to the apex of the net, and numerous tubular iron or lead sinkers are fixed with the bottom margin of the net to sink the net during operation. Mesh size of the net varies from 10-20 mm as per targeted fishes. Fishermen throw it over the water surface either from the boat or shoreline or banks of the water-bodies. As the net sinks into the water, fishes are trapped and then the net is lifted with the help of the strong rope. Mainly medium size fishes (e.g., *Cirrhinus mrigala*, *Catla catla*, *Aristichthys nobilis*) are targeted by this gear.

#### Entangling gear

##### Phāmđi jāla

It is an entangling fishing gear operated in both flowing and stagnant water. It is fabricated with nylon monofilament (Figure 4E). Thermocol and plastic bottles are tied with the upper margin of the net to float whereas cylindrical iron or lead masses are fastened at the bottom edge of the net to immerse it in water during the operation. Its length and breadth vary according to the area and depth of the waterbodies. Fishermen set the net horizontally in the river, dam or large ponds for overnight and picked up early morning to collect the entangled fishes. Mesh size of the net ranges between 50-80 mm. Therefore, it is most commonly used to catch medium and large size fishes (*Ctenopharyngodon idella*, *Cyprinus carpio*, *Labeo rohita*, *Heteropneustes fossilis*, *Wallago attu*, *Clarias gariepinus*).

##### Kārēṇṭa jāla

It is a shorter variant of Phāmđi jāla. It is also fabricated with nylon monofilament. Its length and breadth vary from 6-8 m and 1-2 m respectively. Mesh size ranges between 20-35 mm. It is largely operated in small beels, streams, and canals to entangle small fishes like *Mystus tengra*, *Labeo bata*, *Anabas testudineus*, and *Puntius ticto*.

#### Scooping gear

##### Ṭhēlā jāla

It is made up of 3 bamboo pieces (3-4 ft length) and a net of mesh size of 5-7 mm. Bamboo pieces are tied together to make a triangular frame and the net is then fitted with it (Figure 4F). Fishermen operate it by pushing under bushes of lentic and lotic water bodies and then lifted up from the water to collect the fishes. It is mainly used to catch the snails, prawns and small fishes like *Aspidoparia jaya*, *Chanda nama*.

##### Ghuṇa jāla

It is the most widely operated fishing gear of the study area. It is made up of bamboo and net. A flatly sliced bamboo stick is bent to make a circular ring (radius: 20-25 cm) connected with a conical net (Figure 4G). Peoples use it to catch small indigenous fishes (*Puntius ticto*, *Amblypharyngodon mola*, *Danio rerio* etc.) in shallow waterbodies.

##### Ghuṇi jāla

Ghuṇi jāla is made up of circularly bent bamboo ring and conical net. Generally, the frame consists of circular bamboo ring fitted with four bamboo poles (2-3 ft in length) which are tied together at the top to form a cone (Figure 4H). Prawn, snails and small fishes (e.g. *Trichogaster sp.*, *Esomus danricus*, *Puntius sp.*) are caught through this gear.

# Hāta jāla

It is a circular pocket like net of mesh size 10-15 mm, attached to a 2-3 ft long bamboo rod (Figure 4I). It is mainly used to catch slow-moving air-breathing fishes (*Clarias gariepinus*, *Clarias batrachus*, *Heteropneustes fossilis*) and crabs at night.



**Figure 4.** Traditional fishing gears: (A) Ṭānā jāla; (B) Caṭa jāla; (C) Ghāṭa jāla; (D) Khiyā jāla; (E) Phāmḍi jāla; (F) Ṭhēlā jāla; (G) Ghuṇa jāla; (H) Ghuni jāla; (I) Hāta jāla; (J) Hāta chipa

### Hook and line

#### Hāta chipa

It is made up of a bamboo stick and a cotton twine (Figure 4J). Cotton twine is tied with the narrow tip of the stick while the other end of the twine is embedded with one or more barbed hook. A thin plate of lead is used as weight and a float is being attached to the twine at a distance of 1.5-2 ft from the hook. Hooks are baited with wheat flour, earthworm, grasshopper, etc. and sinks into the water. As the fishes swallow the bait, the hook stuck in the fish body, and the fisherman lifts the chip with a jerk to collect the fishes. Small fishes like *Anabas testudineus*, *Trichogaster fasciata*, *Puntius ticto*, *Oreochromis mossambicus* are caught using hooks of different sizes.

#### Hu'ila chipa

It is also made up of bamboo stick and nylon string. A wheel is fixed with the stick near the thick end, in which the string remains folded (Figure 5A). Another end of the string is tied with 2-4 barbed hooks. The hooks with bait (Figure 5C) are thrown into the water far away from the shore. As the fish swallows the bait and get pierced, nylon string is roll up by wheel to collect the tangled fishes. It is used to catch medium size fishes (*Notopterus notopterus*, *Oreochromis niloticus*, *Colossoma macropomum* etc.)

#### Jhima chipa

Jhima chipa, although they resemble hook and line fishing gears like Hāta chipa and Hu'ila chipa, handled in a different fashion. The fishing rod is composed of glass-fibre or graphite (Figure 5B) and is about 3 ft of length. A long nylon string, tied up with 2-4 hooks, is fixed to the rod by the fishing reel. The fishing reel is used in winding and stowing away the line. This gear is usually operated by the professional fishermen to catch large fishes like *Labeo rohita*, *Labeo calbasu*, *Heteropneustes fossilis*, and *Clarias gariepinus* in the river, dam and large ponds.

### Impaling gear

#### Kēcā

It is an impaling gear<sup>4</sup> mainly used by young tribal people. It has a bamboo stick as a handle and 6-10 iron rods. These rods (20-25 cm in length) are remained firmly attached at one end of the bamboo piece (Figure 5D). The piercing nozzle of these rods consists of a barb at the tip that stuck in the fish body. The fisherman stands still in the shallow water, waits and then pierces the running fish with the sharp end. It is used to catch large fishes (e.g. *Ctenopharyngodon idella*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*) throughout the year.

#### Fishing pots

##### Khalu'i

It is a fishing pot made up of split interweaved bamboo. It has an opening of 5-7 cm radius covered by a net (Figure 5E). It is used along Khiyā jāla to keep trapped fishes.

##### Jhuṛi

It is a semi-circular (Figure 5F) fishing pot used to keep caught fishes. It is also made up of split bamboo.





**Figure 5.** Traditional fishing gears: (A) Hu'ila chipa; (B) Jhima chipa; (C) Bait; (D) Kēcā; (E) Khalu'i; (F) Jhurī; (G) Hāmṛī; (H) Bamboo piece immersion; (I) Bowl trap; (J) Bamboo slicing

#### Hāmṛī

This fishing pot is made up of Aluminium (Figure 5G). It is used to keep large quantities of fishes. It is frequently used along Ṭānā jāla and Mašāri jāla. It is easy to handle due to its light weight.

*Indigenous fishing methods*Gābāna (Group hand picking)

It is a traditional fishing method, mainly practiced by tribal women and children in pre-monsoon in decreased water level. They caught fishes skillfully with their hands from muddy water or mire, without utilizing any fishing gear. *Mastacembelus pancalus*, *Xenentodon cancila*, *Channa punctata*, *Channa sp.* are usually harvested by this method.

Bamboo piece immersion

It is a kind of indigenous fishing method. In this technique, one side-open hollow bamboo stalks are immersed in weed beset solitary water. After few days, bamboo stalks are taken out from the water by blocking the open end with palm (Figure 5H) and the fishes that have entered stalk are collected. Small indigenous fishes (e.g. *Channa punctata*, *Channa sp.*, *Anabas testudineus*) are generally caught by this technique.

Bowl trap

It is also an indigenous fishing method, practiced largely by farmers in rivers, streams, and other flowing water. At first, the open portion of the bowl is covered with white cloth and a small aperture is being made at the middle of the cloth (Figure 5I). The wheat flour is used as bait in the bowl to attract fishes. The bowl is then placed at the bottom of the water surface. Small fishes like *Parluciosoma daniconius*, *Amblypharyngodon mola*, *Aspidoparia jaya* enters into the bowl and trapped. After few hours, bowl is taken out from the water, and trapped fishes are collected.

*Destructive fishing*

Apart from the traditional and indigenous fishing methods, some instances of destructive fishing were also observed in Bishnupur, Panchmura, Ramsagar and Indpur blocks. Some fishermen use toxic chemicals (e.g. pesticides, insecticides) that alarmingly decrease the dissolved oxygen content of the waterbody (Table 2). As a result, aquatic animals were compelled to come on the upper surface region of the water and get trapped. Thus, the entire aquatic system is getting endangered due to predation of both targeted and non-targeted species. However, electro-fishing was not observed in the study area.

**Table 2.** Chemicals used for fishing in study area

Serial No.	Name	Type	Cost (INR)	Effect
1	Mahua oil cake	Derivative from the plant <i>Bassia latifolia</i>	22/kg	It shrinks the erythrocytes and conduce haemolysis of cells of fishes (Homechaudhuri <i>et al.</i> , 1986).
2	<i>Fenpropathrin</i> (Meothrin)	Pyrethroid insecticide	630/500 ml	Meothrin is responsible for fish convulsions cough, ataxia, intermittent paralysis and annihilate (Bingsheng <i>et al.</i> , 1994). It also reduces the tissue energy level by decreasing glycogen level in liver, muscle and gonads (Chaudhari and Yadav 2013).
3	Sulfoxaflor	Systemic insecticide	780/150 ml	It poses no significant risk to fishes.
4	Cypermethrin	Synthetic pyrethroid insecticide	250/kg	It adversely affects their behavioural patterns, shifting aerobic pathway of fish respiration towards anaerobic pathway and also inhibiting energy production by suppressing ATP synthesis (Tiwari <i>et al.</i> , 2012).

INR= Indian Rupee



*Small indigenous fish diversity*

A total number of 33 small indigenous freshwater fish species were identified during the study period (Table 3). The study area contained 5 globally endemic small indigenous freshwater fish species (*Near Threatened*= 3; *Vulnerable*= 1; *Endangered*= 1). The entire northern and southern part of Bankura district is significantly rich in the context of species availability. Saltora, Mejhia and Barjora block located on Damodar basin; Sarenga and Raipur of Kangsabati basin and seven bundhs besiege Bishnupur are major habitats of small indigenous fishes. Maximum amount of fishes were found during the monsoon (June-August) and post monsoon season (September-November) while the less amount were observed during the winter season (December-February).

**Table 3.** Small indigenous fishes of Bankura district

Sl. No.	Scientific name	Local name	IUCN status
1	<i>Esomus danricus</i> (Hamilton, 1822)	Dārķē	LC
2	<i>Glossogobius giuris</i> (Hamilton, 1822)	Bhalkōrā/Bēlē	LC
3	<i>Puntius sophore</i> (Hamilton, 1822)	Pum̃ṭi	LC
4	<i>Puntius ticto</i> (Hamilton, 1822)	Ciṭpum̃ṭi	LC
5	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	Maurālā	LC
6	<i>Parluciosoma daniconius</i> (Hamilton, 1822)	Dārķē	LC
7	<i>Aplocheilichthys panchax</i> (Hamilton, 1822)	Tēcōkhā	LC
8	<i>Aspidoparia morar</i> (Hamilton, 1822)	Ciṛā	LC
9	<i>Aspidoparia jaya</i> (Hamilton, 1822)	Chuyā	LC
10	<i>Crossocheilichthys latius</i> (Hamilton, 1822)	Simsum̃ṭi	LC
11	<i>Salmostoma bacaila</i> (Hamilton, 1822)	Chuyā	LC
12	<i>Securicula gora</i> (Hamilton, 1822)	Ghōṛācēlā	LC
13	<i>Glyptothorax dorsalis</i> (Vinciguerra, 1890)	Tēlsūm̃ṭi	LC
14	<i>Anabas testudineus</i> (Bloch, 1792)	Dēśīkō'i	LC
15	<i>Gudusia chapra</i> (Hamilton, 1822)	Khaṛārā	LC
16	<i>Channa orientalis</i> (Bloch & Schneider, 1801)	Cyāṛṁ	VU
17	<i>Channa stewartii</i> (Playfair, 1867)	Tēlcyaṛṁ	LC
18	<i>Channa punctata</i> (Bloch, 1793)	Lyāṭā	LC
19	<i>Parambassis lala</i> (Hamilton, 1822)	Lāl Cām̃ṭakōm̃ṛā	NT
20	<i>Eutropiichthys vacha</i> (Hamilton, 1822)	Bāchā	LC
21	<i>Heteropneustes fossilis</i> (Bloch, 1794)	Śīṅgī	LC
22	<i>Ompok pabda</i> (Hamilton, 1822)	Pābdā	NT
23	<i>Clarias magur</i> (Hamilton, 1822)	Dēśī Māgur	EN
24	<i>Mystus tengara</i> (Hamilton, 1822)	Tyānrā	LC
25	<i>Chanda nama</i> (Hamilton, 1822)	Cām̃ṭakōm̃ṛā	LC
26	<i>Trichogaster chuna</i> (Hamilton, 1822)	Cūnā	LC
27	<i>Trichogaster lalius</i> (Hamilton, 1822)	Khōlsē	LC
28	<i>Trichogaster fasciata</i> (Bloch and Schneider, 1801)	Khōlsē	LC
29	<i>Ailia coila</i> (Hamilton, 1822)	Bām̃śapātā	NT
30	<i>Oreochromis niloticus</i> (Linnaeus, 1758)	Nilantīkā	LC
31	<i>Mugil cephalus</i> (Hamilton, 1822)	Pārsē	LC
32	<i>Lepidocephalus guntea</i> (Hamilton, 1822)	Guṭē	LC
33	<i>Xenentodon cancila</i> (Hamilton, 1822)	Gāntārā	LC

LC= Least Concern; NT= Near Threatened; VU= Vulnerable; EN=Endangered

## Discussion

A wide variety of traditional fishing gears and techniques with different mode of operation were practiced by fish farmers of Bankura district. A total of twenty-two traditional fishing gears (*bamboo=5; bamboo and net=4; bamboo-line and hook=3; bamboo and metal hook=1; GI rod and net=1; jute fibre=1; net=7*) have been recorded from the study area. Use of bamboo made fishing traps were pre-eminently observed specially during monsoon and post-monsoon seasons. However, operation of fishing gears with nylon net was prevalent throughout the year. Ṭānā jāla, Maśāri jāla and Khiyā jāla were common in appearance whereas Caṭa jāla, Jhima chipa, Kēcā were rarely been observed. Khiyā jāla was reported from a vast region of all-over India in different local names (Samajdar and Saikia, 2014; Syed *et al.*, 2020; Bhat *et al.*, 2021; Madhu *et al.*, 2021). Frequent use of bamboo made traps like Ghuṇi, Palu'i were also noticed in several areas of Assam and West Bengal (Das and Barat, 2014; Islam and Hussain, 2018; Sandhya *et al.*, 2019; Madhu *et al.*, 2021). Appalling increase in the use of gill net was observed from the study area. It was noticed to kill a wide spectrum of non-fish species like snake, frog, migrating birds. Similar kind of results was reported by Shaji and Laladhas (2013). Present study reveals the use of jute fibre fabricated Caṭajāla in the study area. Jute fibre is bio-degradable; hence, it is most environmentally acceptable and should be operated as an alternative of nylon strings made net.

Traps are made up of bamboo stick which is inexpensive and easily available in the study area. Hence it is primarily adopted by the fisherfolk communities for catching small indigenous fishes from stagnant muddy water, steeped paddy fields, shallow and slowly flowing water-bodies. But, most of the encircling gears are large and heavy fishing gear. These are widely used for catching relatively big fishes in high amount from large water-bodies like dams, ponds and beels. Existence of three indigenous fishing techniques (Gābāna, bamboo piece immersion, bowl trap) was revealed through the study. These indigenous techniques were usually practiced by young tribal people to catch fishes to fulfill their nutritional and economic scarcity. These techniques were highly dependent on fisher's skill. The Bamboo piece immersion method of fishing was also reported by Das and Barat (2014).

Traps were predominantly been structured by local workers. Bamboo strips play a principal role as a raw material of most of the traditional fishing gears. Before slicing (Figure 5J) the bamboo as per the required length and breadth, it was immersed in water for a fortnight and sundried for ensuring resistance to the insects. A large volume of fishing net (except Maśāri jāla) was previously knitted by local people, but nowadays in the era of modernization, handmade nets are downshifted by machine-made nets due to considerable low price (e.g., cost of a hand-knitted Khiyā jāla is around 2000-2500 INR, while the cost of machine-made net of the same dimension is only 650-1200 INR). Therefore, it adversely affected the gear makers as it was the source of their daily wages. Traditional fish trapping methods supply reliable income (approximately 3000-7000/month) for impecunious communities who reside in the rural area of the district. Some of them also perform various subsidiary activities (e.g., waged labour in agriculture, construction) besides fishing to strengthen their economy. Thus, it plays an emergent role in the improvement of socio-economic life as well as provides nutritional security to thousands of people.

From the study, it was observed that the Bankura district is very rich in the context of fish species availability. The diversity study indicated presence of several near threatened, vulnerable and endangered species in rural waterbodies. *Parambassis lala*, *Ompok pabda* and *Ailia coila* were identified under the near threatened category. *Channa orientalis* and *Clarias magur* represented vulnerable and endangered fish species respectively. However, they are never been the target prey of fishing due to their endangered nature and being caught accidentally. Gilman *et al.* (2022) proposed a decision tool for integrated fisheries bycatch management that may provide precautionary protection for the most vulnerable aquatic populations.

A large proportion of rural peoples of Bankura district are involved in fish catching with the help of various traditional fishing gears. Those obtained fishes play an important role by providing nutritional security to rural people who can't afford to purchase major carps and other costly fishes. It also noticed that a large

amount of SIIFs is generally been caught and sold by women and thus contribute to livelihood of rural sector. Study conducted by Ganguly *et al.* (2018a) depicted similar findings.

However, siltation of natural water resources, urbanization, unprecedented uses of fine mesh-sized nets (<10 mm) and other illegal procedures were also noticed which possess a threat to the fish community. Indiscriminate uses of insecticides may have wide impact on freshwater flora and fauna diversity as it roundly destroys the natural ecosystem of those water-bodies. Simultaneously, water quality that is the life-line of the entire ecosystem was also been affected. These factors lead to alarmingly decreases in the availability of fish species that also adversely affected the socio-economic status of rural people.

## Conclusions

A perspective of fishing techniques and gears used by the fish-farmers along with the fish species availability of Bankura district has been illustrated in the study. It is very evident that the fishers of the study area still depend on traditional fishing gears and techniques to earn their livelihood. A major portion of rural-backward people rely upon traditional fishing for nutritional security. However, most of the fishermen of the study area are basically thriving under poverty. Hence, a transition from the operation of traditional gears to illegal fishing was observed in some cases. Therefore, planned and attractive incentives, proper education and health benefits are needed to ensure the economic prosperity of the rural farmers. The Government and other stakeholders must encourage such indigenous, eco-friendly, cost-effective approaches for the conservation of bioresources. The globally endemic fish species must be exclusively cultivated in their natural habitats to restore fish diversity. Simultaneously, strong legal action must be enacted to restrict the malpractices of destructive fishing. A concerted effort has to be confronted for the sustainable development of the fisherfolk community.

## Authors' Contributions

Conceptualization – Dr. Arindam Ganguly, Dr. Pradeep Kumar Das Mohapatra; Investigation – Ujjal Konar, Animesh Kundu, Sandeep Chatterjee, Sristishil Nandi; Methodology – Dr. Arindam Ganguly, Dr. Pradeep Kumar Das Mohapatra; Resources – Madhuchhanda Duari, Rajesh K. Guin; Supervision – Dr. Pradeep Kumar Das Mohapatra; Validation - Dr. Pradeep Kumar Das Mohapatra; Writing (original draft) – Dr. Arindam Ganguly, Ujjal Konar; Writing (review & editing) – Dr. Asish Mandal, Dr. Pradeep Kumar Das Mohapatra

All authors read and approved the final manuscript.

## Ethical approval (for researches involving animals or humans)

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## Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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