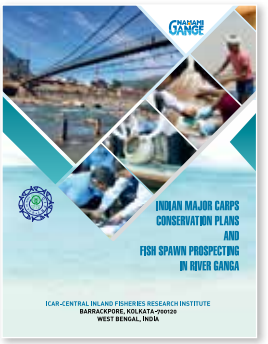
INDIAN MAJOR CARPS CONSERVATION PLANS

AND

FISH SPAWN PROSPECTING IN RIVER GANGA

ICAR-Central Inland Fisheries Research Institute
Barrackpore, Kolkata – 700 120
West Bengal, India



Indian Major Carps Conservation Plans and Fish Spawn Prospecting in River Ganga

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PREFACE

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The Ganga river forms the mainstay of Indian riverine system. The river basin provides numerous ecosystem services which are beneficial to more than 450 million people residing at the river banks. The Ganga River holds immense cultural, religious, and livelihood significance. Historically, it served as the primary source of fish seeds, contributing over 70 percent of the total carp seed production, including *Labeo rohita*, *Labeo catla*, and *Cirrhinus mrigala* in the country. However, with the advancement of carp seed production technology, reliance on river systems for juveniles has diminished Over the years, several factors such as river pollution, damming, alteration of hydrology and introduction of exotic species have affected the population of Indian Major Carps in the Ganga river, causing a sharp decline in its population. Furthermore, the substantial fishing pressure and the adoption of unscientific fishing methods have led to a significant decrease in the population of Indian Major Carps. Research indicates that effective conservation measures for the major carp population could be instrumental in revitalizing the fish species within the Ganga River system.

Fish Conservation studies on the river have consistently captured the interest of researchers and policymakers. An essential approach to address the declining population of carp species in the Ganga river involves the ex-situ conservation of Gangetic wild Indian Major Carp. The ICAR-Central Inland Fisheries Research Institute has compiled a comprehensive document titled "Indian Major Carps Conservation Plans and Fish Spawn Prospecting in River Ganga" under the "National Mission for Clean Ganga." This document provides a thorough overview of ex-situ conservation, river ranching protocols and spawn prospecting in the river Ganga. The valuable information presented in this document is anticipated to serve as a fundamental reference for researchers, policymakers, and academicians.

Date : 10.01.2023
Place : Barrackpore

(B. K. Das)
Director, ICAR-CIFRI

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RIVER DEVELOPMENT & GANGA REJUVENATION

FOREWORD

The Ganga River, originating from the Gangotri Glacier is considered the most sacred and worshipped river in India. Originating from the Western Himalayas, it is also the longest river of the country with a length of 2525 kms. The river has diverse aquatic life providing livelihood to millions of people residing along its river banks. However, in past few decades, challenges like water abstraction, pollution, river modification, climate change, overexploitation of fish stocks, etc. have caused loss to fishery and fish diversity.

In the present study, a total of 190 fish species have been documented from the main-stem of river Ganga. Gangetic Indian Major Carps are the most well represented and commercially important fish group found in all the freshwater stretches of river Ganga, and are a major contributor in the river's fishery. However, indigenous Gangetic Indian Major Carps are rapidly declining at the cost of exotic species. Hence, the need of the hour is to develop fish conservation methodologies and strategic plan for the declining fish population.

In this context, this comprehensive documentation on conservation aspects of the indigenous Gangetic Indian Major Carps along with present fish spawn structure of river Ganga through the ICAR-Central Inland Fisheries Research Institute under the project "Assessment of fish and fisheries of the Ganga River system for developing suitable conservation and restoration plan" will add to the available vital information for basic and strategic research in the Ganga River system.

This book titled "***Indian Major Carps Conservation Plans and Fish Spawn Prospecting in River Ganga***" is a systematic and untiring effort to highlight ex-situ conservation aspects of the prized Indian Major Carps of river Ganga. I appreciate the endeavor of the project team of ICAR- CIFRI for bringing out this useful and didactic publication. I hope this publication will be an important referral point for restoration and conservation strategies for policymakers, researchers, academicians and resource persons who are involved in Gangetic fish faunal management.

19.12.22

Dated : 19th Dec 2022

(G. Ashok Kumar)

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(Authors)

CONTENTS

Introduction

Background:

India is a country with a vast and widespread river system. River Ganga is the one of the most crucial river of this system, has a great role in the life of the people living in its basin in respect of livelihood, cultural activities and religious faith. It originates from the *'Gomukh'* ice-cave at the '*Gangotri'* Galcier and flows southwards by passing through different states like Uttarakhand, Uttar Pradesh, Bihar, Jharkhand & West Bengal; finally, it discharges into the Bay of Bengal. River Ganga flows through an approximate total length of 2,550 Km. The water flow of river Ganga is regulated by Farakka Barrage after entering in West Bengal; the main river flows towards the south east and enters in Bangladesh as river Padma and finally discharges into Bay of Bengal. A 41 km long feeder canal goes below the barrage and meets with river Bhagirathi at Jangipur. The Bhagirathi flows southwards and joins Hooghly estuary at Nabadwip. afterwards this river flows towards south through Kolkata and finally meets with the Bay of Bengal. The river basin drains though a vast area of nearly 1,060,000 Km^2 which is about one-fourth of the total area of the country. The tributaries of River Ganga are Chambal, Ghaghara, Tons, Yamuna, Ramganga, Koshi, Gandak, Sone, Ajoy and Damodor. Different dams and barrages were constructed on Ganga and its tributaries such as Farakka Barrage on River Ganga, Bansagar Dam on river Sone and Tehri Dam on river Bhagirathi.

The fisheries of river Ganga is contributing a major role for the livelihood generation of the people living in the banks of the river. Different natural calamities like drought, delayed monsoon, increase of temperature and continuous human interference are directly or indirectly affecting the fish catch. The increasing temperature of the Ganga river basin has been predicted through climate models as a rising trend of the mean annual temperature of 1-4°C in the upto 2050 (Moors et al, 2011). As the rainfall has a major role for fish spawning during monsoon season but different issues like a delayed monsoon decreased rainfall in monsoon and increased rainfall in post-monsoon has marked an impact in natural breeding. In recent studies, it was indicated that the rainfall has

Fig. 1. CIFRI sampling points throughout River Ganga

decreased by 56% over 133 districts throughout the entire Ganga basin due to changing climatic conditions (Bera, 2017). Other than these climatic conditions, the human interferences also playing a major role for decrease the fish stock in Ganga. The construction of barrages and dams over the river is severely affecting the natural river flow which leads the restricted fish movements. River encroachment for different urbanization processes and dumping of garbage is also affecting the river's health and directly affecting the fish habitat. By these encroachment processes, many river-connected wetlands are losing hydrological connectivity with the river, badly affecting the riverine biodiversity.

River Ganga supports a diverse fish fauna of more than 266 fish species, mainly from Cypriniformes (barbs and allies); Siluriformes (catfish) and Perciformes (Talwar and Jhingran, 1991) and most recently it recorded 143 species by Sarkar et al, 2012. It was observed that 29 freshwater fish species listed as threatened under vulnerable and endangered category (Lakra *et al*., 2010). In recent studies of ICAR-CIFRI (2017-2020), a total numbers of 190 fish species were identified throughout the river (Das *et al*., 2021). Out of these 190 species 13 fish species were reported under IUCN red list which are *Ailia coila, Arius gagora, Bagarius bagarius, Bagarius yerralli,Chitala chitala, Scoliodon laticaudus, Tor putitora, Ompok bimaculatus, Ompok pabda, Ompok pabo, Parambasis lala, Wallago attu, Schizothorax richardsonii*. As all these fishes having high economic importance, effective conservation plans and sustainable management practices must be implemented to restore the biodiversity of the river. The unsystematic shifting of different invasive fish species in river Ganga has created a wide spectrum of changes in the substance of native fish species. it has also reported that 8 numbers of invasive fish species (*Hypophthalmicthys molitrix, Hypophthalmicthys nobilis, Ctenophryngodon idella, Oreochromis niloticus, Cyprinus carpio, Clarius gariepinus, Pterigoplicthys disjunctivus*) are found in different sampling stations throughout the river (ICAR-CIFRI).

Status of Indian Major Carps in river Ganga:

The Indian Major Carps are the most prized fish species by its huge demand and for its economic and nutritional value. It was observed that the IMC catch of the river Ganga is gradually declining. Due to the various anthropogenic activities and environmental factors, the native carp fishery has continuously declined in the past few decades (Jhingran *et al*, 1978). According to *Jha et. al*, 2017 the IMC has been decreased in Prayagraj stretch from 90.85 tonnes in 1956-1967 to 27.29 tonnes in 2005-2015. The reasons behind the decrease of IMC in Ganga are overexploitation of fishes, monsoon variation, pollution and changes in temperature. But it cannot change the fish stock decline scenario in the river as it still decreasing rapidly due to natural impacts on IMC breeding and as a result, the fewer numbers of IMC spawn availability were recorded in river Ganga (Das *et al*, 2013). The declining scenario of IMC in river Ganga is alarmimng. Under the NMCG programme, ICAR-CIFRI has conducted a qualitative evaluation of Gangetic spawns in which IMC percentage was found only 30% of the total catch.

Indian major carps are considered as important species in capture fisheries and aquaculture in India. So, the conservation of, these species is vital to get sufficient brooders for seed production

through captive breeding and for maintaining the river biodiversity. To increase the population of IMC in river Ganga, conservation of these fish species and restoration in different depleted stretches can be an excellent measure to revive the depleted riverine stock. For the conservation of these wild fish species, *Ex-situ* conservation is the most appropriate way for getting quality fish seed. ICAR-CIFRI has undertaken an *Ex-situ* conservation programme as a part of *National Mission for Clean Ganga* (NMCG) programme for stock enhancement of indian major carps to overcome the problem and to achieve the inland production potential, replenishment of natural stocks and sustaining the fishermen livelihood.

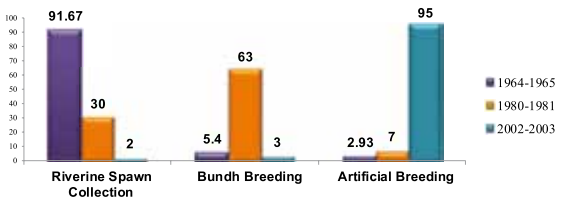


Fig.2. IMC spawn availability from different sources in different time period

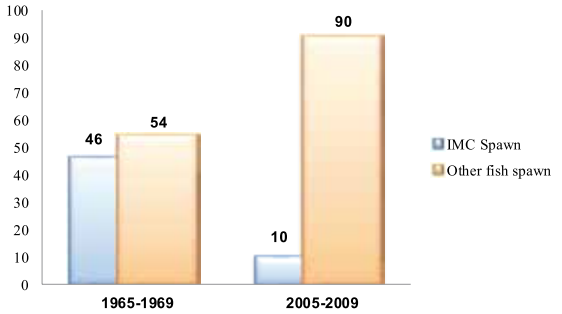
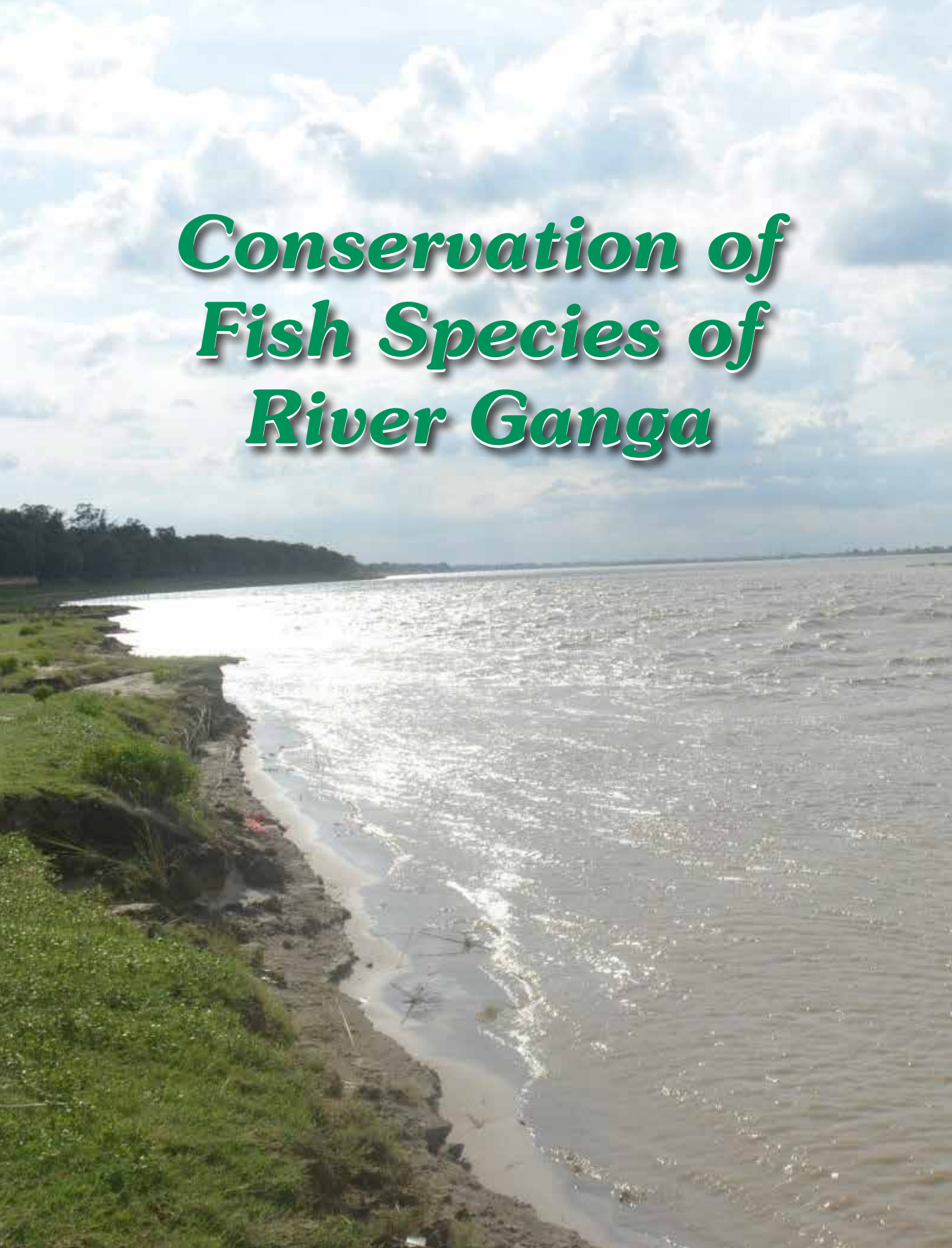


Fig. 3. Declining trend (%) of IMC spawn availability in river Ganga

Fig. 4. Different reasons for decreasing the fish stock in river Ganga

Conservation of Fish Species of River Ganga



Types of Conservation:

By restoring the species to their natural habitats, conservation is a crucial strategy for preserving the biodiversity balance. To prevent the extinction of the species, the importance of protecting the native genetic stock in its natural habitat has been increasing. Conservation is needed to safeguard the local species in those waterbodies where species populations are inevitably declining. There are potentially two different ways of conservation: 1. conservation of vulnerable and endangered species and 2. conservation of the economically valuable species but on the declining stage. The details are provided below –

- *In-Situ* Conservation
- *Ex-Situ* conservation

***In-Situ* conservation** refers to the process of preserving a species in its native environment, such as biosphere reserves, sanctuaries, and national parks.

***Ex-Situ* conservation** refers to the practise of protecting a species, away from its natural habitat. It has been applied through a range of techniques, including gene banks, brood banks, captive breeding, species translocation, gamete cryopreservation, zoos, aquariums, etc.

a. ***Gene bank:*** different genetic materials like sperm, ovum, seed etc. can be preserved in the gene bank and used as required.

b. ***Brood bank:*** To ensure genetic purity, high-quality brooders are taken from wild sources and raised for captive breeding. These brooders are employed in the selective breeding effort to create a wider range of improved species.

c. ***Captive breeding:*** The species was taken out of its natural habitat, bred in captivity, and finally released back into its natural habitat.

d. ***Species translocation:*** The species collected from its natural habitat and introduced in a new habitat for conservation.

e. ***Zoological gardens:*** The endangered animals are collected from the wild and cultured in zoological gardens in the suitable environment. They are fed with appripriate feed for long-term captive reproduction.

f. ***Aquaria:*** The role that aquariums play in the conservation of marine and freshwater aquatic species is crucial. Previously, it has been used exclusively for demonstration but at present, captive breeding has become popular in many aquariums.

g. ***Cryopreservation:*** In the conservation procedure such as cryopreservation, the germplasm is kept in liquid nitrogen at extremely low temperatures (-196°C). The cells' metabolic activity (physical and biological reactions) are halted indefinitely.

Selection of species:

In the selection of IMC for conservation, species with huge demand and good market value in the Indian market should be prioritized for profitable aquaculture across India. But the availability of these fishes in the river Ganga has been tremendously fell down in the past few decades, resulting in the non-availability of potential brood fishes from natural habitat.

Among the different *ex-situ* conservation methods, captive breeding followed by river ranching of produced fishes must be the most suitable method to conserve the Indian Major Carps in river Ganga. The live fishes were collected from different stretches of river and reared upto maturation. The captive breeding (using inducing agents) was done in a controlled condition. These fishes were used for the captive breeding programme to conserve the pure genetic stock. The produced seed reared up to fingerling size and reintroduced in their natural habitat for the stock enhancement in the river.

Fig.5. Fingerlings of *C. mrigala*

Fig.6. Fingerlings of *L. calbasu*

Fig.7. Fingerlings of *L. catla*

Fig.8. Fingerlings of *L. rohita*

Fig. 9. Different steps of Ex situ conservation of Indian major Carps

Site Selection for Brood Fish Sollection

Importance of selected site:

The conservation procedure mainly operated from Balagarh, Dist.-Hooghly, State- West Bengal. The reasons for selecting this place are :

- The place is located on the bank of river Ganga,
- A good amount of availability of riverine wild IMC brooders in this stretch,
- The gears for live fish collection operated in this stretch,
- Availability of aquaculture ponds for nursery rearing and brooder maintenance,
- Availability of hatchery for induced breeding of IMC, and
- Presence of good transportation system for ranching programmes organised in different places.

There are two broodstock management pond and eight nursery rearing ponds in Balagarh, Hooghly, West Bengal. Besides this, one pond at ICAR-CIFRI, Barrackpore used for riverine brooder management and two numbers of ponds used for nursery rearing at Swami Vivekananda Police Academy, Barrackpore.

Procedure of selection:

On the basis of previous study by ICAR-CIFRI throughout the Ganga, distribution and contribution of fisheries, an exploratory survey throughout different river sampling sites of river Ganga, identifying the depleted stretches of the river in respect of IMC population helped in selecting the site for Brood fish collection. While the selection of the site for different activity under this ex-situ conservation process, some important issues may be considerered:

- The place should be nearby the river Ganga
- the place must have well-connected roadways,
- a hatchery set up to be established
- brooder collection site may be in the adjecent area,
- Cooperation from local fishers and people is required, and
- Availability of aquaculture ponds with proper water supply for broodstock and nursery rearing.

Collection and Transportation of Brood Fish

Gear used for collecting live fish:

1.	Manpower Engaged	8-10 nos.
2.	Installation Time	1-2 days
3.	Harvesting Time	2-3 days
4.	CPUE	25-30 kg
5.	IMC (% caught)	40-50
6.	Survival of IMC for live fish collection (%)	85-90

Table 1. Mode of operations of *Komor Jaal* FAD

The wild fishes were collected only from different areas of river Ganga or adjacent river connected floodplain wetlands (Fig. 11) to avoid genetic contamination. During the collection, it was ensured that the brooders are in healthy condition. There are many types of gears used to catch the fishes in river Ganga and the most common gear used is *'Gill Net'*, but the catch of this gear may get injured the fishes during catching So it was hard to collect the live fishes from this gear. Different types of '*Bag net*' catch may be more effective for the collection of brooders, but most of the '*Bag net*' is used for the collection of small-size fishes, and rarely the large fishes. So it was difficult to collect huge numbers of brooders from this gear. To overcome this scarcity of brooder availability, a few of techniques should be followed. There is a very unique and popular fish aggregating device, '*Komor Jaal*' used to collect the brooders in this area which is also known as *'Pala'*. A shallow and sluggish region with low water current mostly in the river channel and river connected wetland with lower water depth (>20feet), water quality parameters, depth, water flow, turbidity are preferred for setting up the *'Komor Jaal'* . To make the device, big size tree branches were cut and fixed in the shallow part of the river or adjacent wetland. "*Komor Jaal*" is a semi-permanent or temporary structure, made from a bamboo pole, net and tree branches that helps in the aggregation of fish, depending upon water current and depth. Water area (0.052 ha) having a depth of 16-20 ft is surrounded with 35 to 40 bamboos. It creates a shelter for the fishes. Feed and other attractants used in this area to aggregate the fishes. After a few days, this area is surrounded by seine nets and fishes are cought. The benefits of this device are that the fishes collected from this device are live

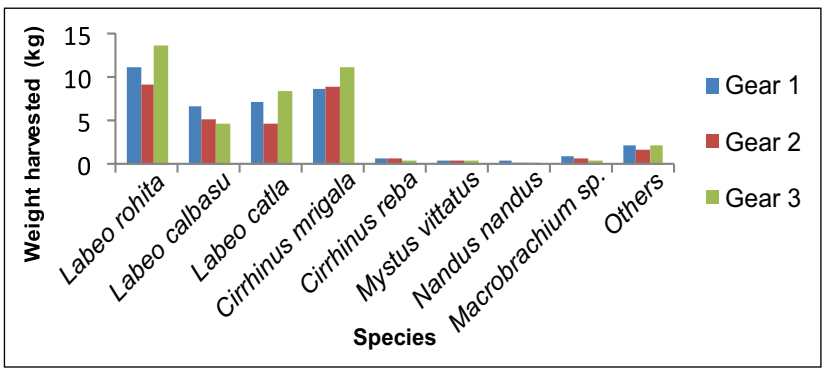


Fig. 10. Species wise catch composition of three different '*Komor Jaal*'

and healthy. The number of IMC collected is usually more than that of other gears and they are easy for transportation. From this gear, the IMC catch share is 40%-50% of the total catch and the survival rate of the broodfishes are between 85%-90%.

Collection sites:

The brooders were mainly collected from the different stretches of the river Ganga in West Bengal at Nabadwip (23°24'33.5"N 88°22'46.9"E), Kalna (23°13'25.6"N 88°22'24.8"E), Somra Bazar (23°08'06.2"N 88°26'53.6"E), Balagarh (23°07'31.1"N 88°28'20.9"E) area (Fig.12) and from the *Chhara Ganga* wetland (23°25'56.9316" N, 88°21' 55.3392" E, 213 ha) (Fig. 11), which is a horseshoe -shaped river connected wetland at Nabadwip area. From this area, the number of collected live fishes was almost the same.

Brood fish transportation:

The water quantity was maintained to 10 liter/ kg fish body weight for transportation with proper aeration. In case of the absence of battery operated aeration system, dissolved oxygen manually increased by continuous beating in the water. Some techniques were followed during transportation to avoid the transportation hazards. The collected riverine IMC fishes (Mature brooders/adult/ sub adult) were taken by specialy designed fish transportation vehicle to captive ponds and stocked as per their size, sex and species. At first, the brooders were transferred in the aerated water filled metallic tank, fitted in the vehicle and battery operated aeration system was attached to the tank to maintain the level of dissolved oxygen in the tank. The water quantity was maintained with proper aeration. In case of the absence of battery operated aeration system, dissolved oxygen manually increased by continuous beating in the water. Commercial oxygen tablets are used to maintain the dissolved oxygen level. To keep the brooder for a long time, periodic water exchange and water pump was fitted along with the tanks. After reaching

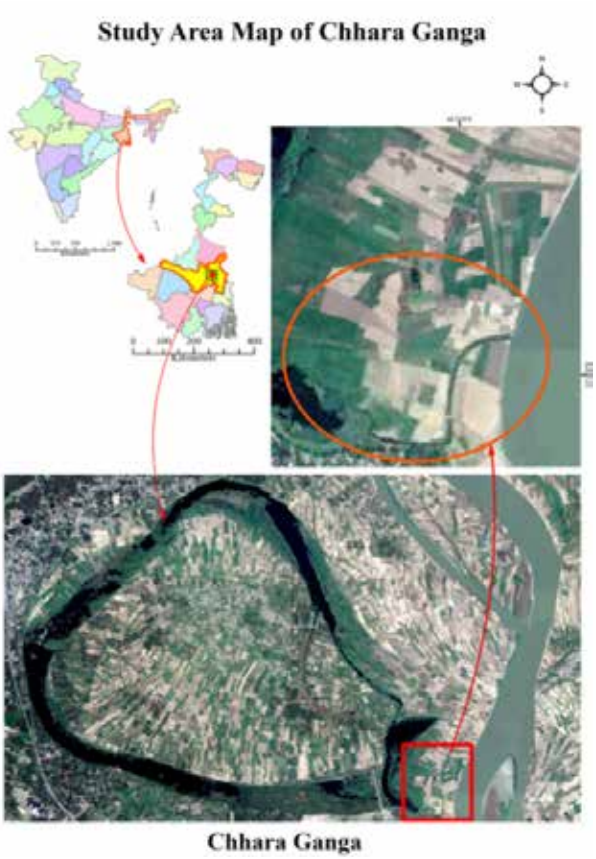


Fig. 11. River connected wetland 'Chhara Ganga'

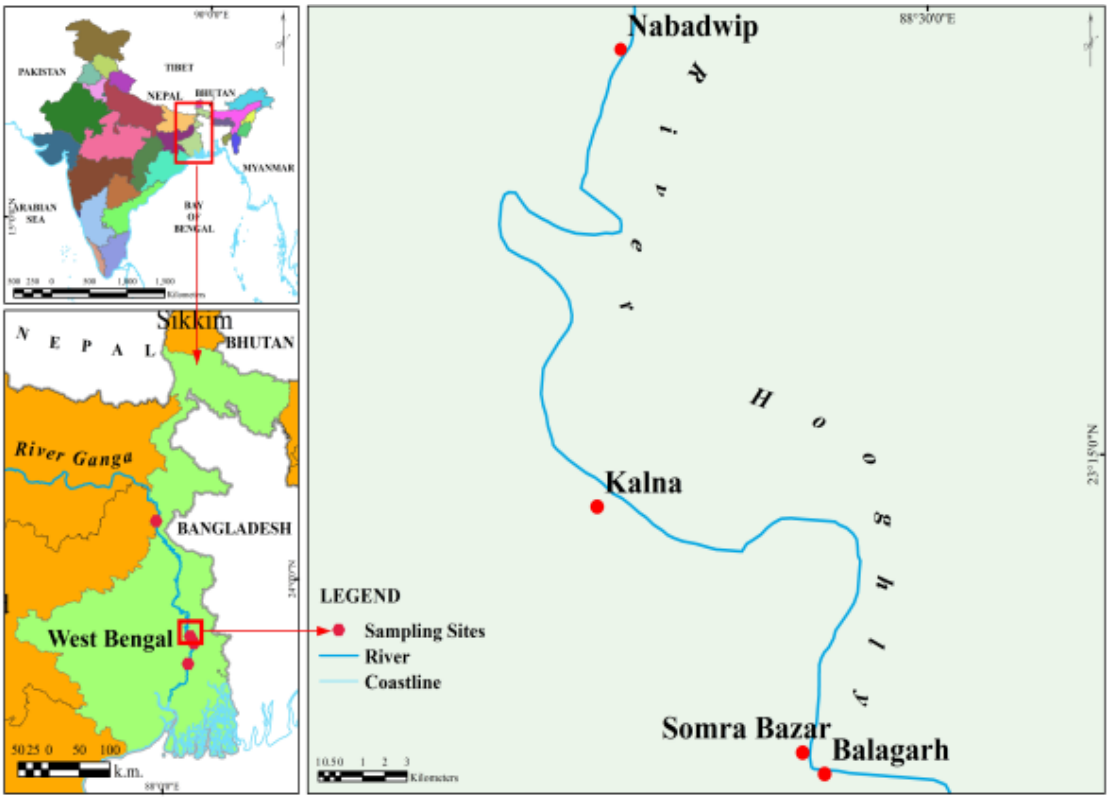


Fig.12. Different IMC brood fish collection sites in river Ganga

Fig. 13 (A-B) Operations of *Komor Jaal (a specific aggregating cum surrounding net used for brooder collection)*

the broodstock pond, fishes were kept in an aluminium *handi* and given a deep treatment with Pottasium permanganate ($KMnO_4$) solution. Then, the fishes stocked in a nylon happa fitted in the pond for acclimatization. After one hour of acclimatization with the pond environment, fishes were released in the ponds. The live fishes are being segregated as per their size and species and were stocked in different brooder ponds.

The conservation process of these four carp species was initiated in the year of 2016. In the initial stage, the first priority was to collect the wild Gangetic IMC live fish which may be used as

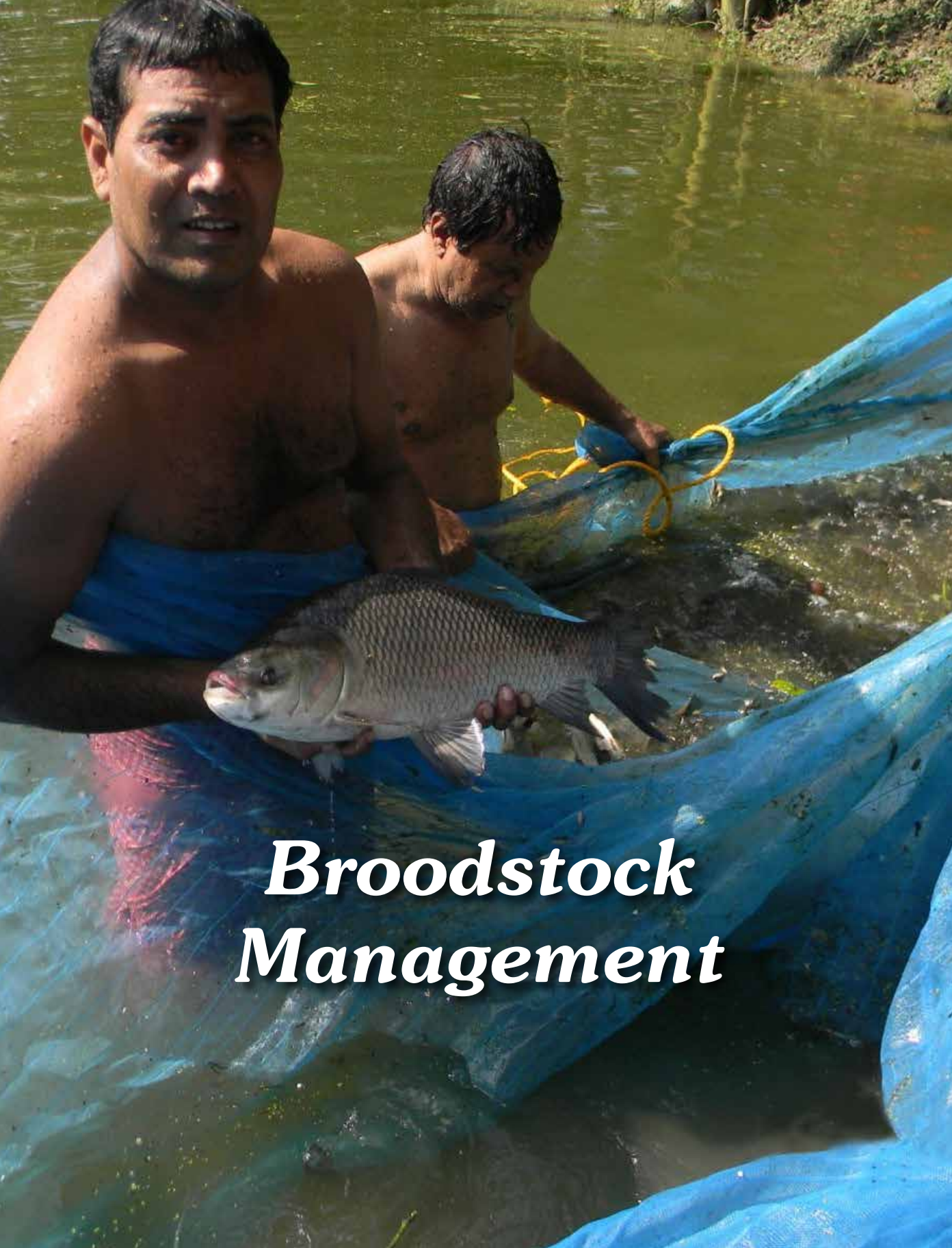
Fig. 14-15 Collection of live IMC brooder fish from *Komor Jaal*

Fig. 16A-B. Transportation of live IMC to brood fish management pond

	L. rohita (Nos.)	*L. catla (Nos.)*	*C. mrigala (Nos.)*	*L. calbasu (Nos.)*
2016	84	14	43	10
2017	11	22	76	25
2018	92	19	63	37
2019	42	16	82	14
2020	201	81	136	26

Table 2. Wild IMC brooder collected from river Ganga and adjacent wetland

brooders afterward. Throughout the years, the collection process was in motion. From different sites of river Ganga and connected adjacent wetland 152 numbers of *C. catla*, 430 numbers of *L. rohita*, 400 numbers of *C. mrigala* and 112 numbers of *L. calbasu* has been collected (Table. 2).



Broodstock Management

Brooders are the most important component for seed production programme and it requires good management practice to rearing the brooder for its better health and maturity. A successful breeding programme required good quality and healthy brooders to produce good quality of spawn. Brood fish management is also required for breeding in accurate time. Only a properly managed brooder can give the healthy and strong spawn and fry which rapidly grow and reduce the rate of mortality of fishes in every stage of their life-cycle.

Brood pond management:

Brood ponds are rectangular earthen ponds with an area of two bigha (0.2 ha) and almost having 1.5 m - 2 m of depth. The water quality of the pond is maintained at recommended levels by periodical water quality analysis and need based water treatment was carried out from time to time.The brooders are very prone to different diseases and infections. So, at suitable intervals, 15-20% water shhould be exchanged on weekly basis. It helps in the maturation of the brooders. Surface paddle-wheel aerator was fixed in brooder pond to maintain the dissolved oxygen level, especially during cloudy days and early morning.

Fig. 17. Paddle wheel aerator installed at brood fish management pond

Stocking of fish:

More than 2000 kg of brooder fish was collected over the year and reared upto maturation for breeding. The stocking densities of the brooders in the broodstock pond are maintained at 1500 kg/ ha to avoid overcrowding which may lead the brooders to got different infections as they are prone to infection.

Feeding management of brooders:

Better nutrition helps to better gonadal development and better reproductive performance of the brood fishes. It was under consideration to give a proper balanced diet for the brooders i.e. the protein, carbohydrate and lipid must be in the proper ratio. Supplementary feeding is highly required for the brood fishes along with sufficient natural feed. The density of the plankton was maintained in 2ml/ 50L of water by periodic fertilization in the ponds. The brooders were fed with *CIFABROOD*™ feed and a mixture of Mustard Oil Cake: Groundnut Oil Cake, Rice Bran having 1:1:2 ratio, fortified with vitamins and minerals on alternate days @3% of their body weight from January to April and afterwards, it is reduced upto 2% of the body weight upto breeding programme. A minimum dose was given to the brooders during the winter months (November- January) as the feed requirement is

Fig. 18. Farm made pelleted feed

Fig. 19. Feeding of brooders

low in these months. In case of *CIFABROOD*™, the feed was given in gunnybags in different places of the ponds. Farm-made pelletized feed prepared with oilcake and brans mixture fortified with fish oil and Vitamin-Mineral mixture are prepared and placed in bamboo made basket and hanged in different places of the ponds by bamboo poles. During summer months, the feed was given in the ponds in two split doses for better utilization and in a single dose when the water temperature is less than 25°C.

Health monitoring of brooders:

For better performance during breeding, the brood fishes must be stress and disease free. To prevent different infections, proper precautions were taken throughout the rearing period.

Fig. 20-21. Treatment of Brood fish


Fig. 22 (a-b). Diseased fish

Maturation status of brooders:

At the time of breeding, the maturation status of the fishes must be properly examined for a better breeding result. All the species of IMC are bisexual and sex can be distinguished only during the breeding season. The pectoral fin of a male has a rough dorsal surface and longer than that of a female. The female dorsal side of the pectoral fin is smooth. The belly of a female is soft, swollen and bulging and the genital papilla is swollen and reddish. Sometimes catheters are also used for confirmation of the maturity of the female brooder. The anal opening of the fish is protruding outside and also enlarged. The fully mature brooders are releasing milt when slight pressure is given in the abdominal area. Indian major carps generally attain sexual maturity in the second year and the male mature earlier than the female. Carps of 2+ years and upto 5 years are preferred for breeding. The potential brooders were selected based on their maturity and secondary sexual characteristics. The fishes were examined periodically for their condition and for progress in maturity and free from the parasitic infection.


Fig. 23 and 24. Maturity status of IMC checking by secondary sexual characters

Captive Breeding

Procedure of breeding:

The breeding of wild IMC brooders was carried out with following hypophysation breeding protocol where matured brooders were injected crude pituitary extract (CPE). The fishes were harvested and the maturity level was examined, prior to their breeding. Only the gravid brooders which were fully matured, healthy and without any deformities were selected for breeding. The next day, the brooders were carefully transported to a nearby hatchery. To minimize stress during

Fig.(A-G). different steps of captive breeding

transportation, special attention was given to the orientation of the brooders, as any undue stress could potentially impact their breeding performance. Upon arrival at the hatchery, the fish underwent disinfection using a 3ppm solution of $KMnO_4$ and were subsequently placed in a cemented storage tank for conditioning before the commencement of the breeding operation.

Water quality parameter	Value
Dissolved Oxygen (mg/l)	4.5 - 5.5
pH	7.6 - 8.4
Water Temperature (°C)	27-30
Total Alkalinity	60-84
Total hardness	55- 96

Table 3. Hatchery inlet water quality

After five hours, fishes were segregated gender-wise and identified by their morphological characteristics. The weight of individual fish was recorded to determine the quantity of carp crude pituitary extract (CPE). The pituitary gland was collected and preserved in 100% Ethyl alcohol on the day before breeding. The gland dried in a blotting paper and weighed accordingly the fish weight and number. The weighed gland is taken in a tissue homogenizer and add some distilled water in it then homogenize the gland to prepare a supernatant solution with 0.2ml/kg dilution of body weight of the brooders. Intraperitoneal injection by a hypodermic glass syringe (needle No.22) used to inject CPE to the fishes. The prepared CPE was injected in the female brooders as a provocative dose firstly. After a six-hour interval, a second dose of CPE was prepared and administered to both female and male fishes. Subsequently, they were placed in a cemented circular breeding pool featuring a continuous water flow and a shower system, an artficial rain conditions. The fishes were allowed to remain undisturbed in this environment for a period of five hours. After injection male and female were kept in two seperate tanks. This time the tank was covered with a nylon net to avoid escaping the fish from the tank because the injected fishes were exited and used to jump. After five hours fishes collected from the pool and stripping was carried out. At first, eggs were stripped out from the females and then milt stripped from the male fishes. The eggs and milt were then mixed well as soon as possible and the excess milt is removed with repeated washing with clean water and pour the eggs to the circular hatching pool where the water always in a circular motion with constant water exchange. An overhead water tank supplies water to every tank for continuous water exchange. The fertilized eggs were floating with water flow and unfertilized eggs were settled in cloth which was used for water exchange and these eggs were removed manually by swiping with a coir brush. After 15-18 hours the hatchlings were started to come out and in a span of 20 hours all were hatched out. The hatchlings were kept in the circular haching pool for the next 48 hours and shifted to a cloth happa fitted in a rectangular cemented tank with continuous water shower for 12-18 hours for acclimatization and transferred to the nursery rearing ponds afterward.

	Male	Female
1st Dose	Nil	2-3 mg/kg
2nd Dose	2-3 mg/kg	6-8 mg/kg

Table 4. Dose of CPE for hypophysation

Breeding details:

During the breeding activity, data on fecundity, fertilization rate, hatching rate and spawn survival rate were collected. The fecundity of the fishes was calculated by a volumetric method where the volume of the eggs measured before water absorption and the volume multiply by numbers of eggs per unit volume by which the quantity of the total eggs was calculated.

Species	Fecundity (eggs / kg of fish)
Labeo rohita	2,70,000 – 2,90,000
Cirrhinus mrigala	1,75,000 – 2,16,000
Labeo catla	1,40,000 – 2,00,000
Labeo calbasu	1,78,000 – 2,10,000

Table 5. Fecundity of Different IMC species

Fig. 26 Different stages of embryonic development of IMC

The fertilization rate varied between 97%-98% for *L. rohita*, 96% for *L. catla*, 96%-98% for *C. mrigala* and 98% for *L. calbasu* in the consecutive four years. The hatching rates of different species are also varied from 90%-94% for *L. rohita, L.catla* and *C. mrigala and 90% for L. calbasu.*The spawn recovery rate of *L. rohita* reaches 96% in 2018 & 2019, 93% in 2017 and 92% in 2020. *L. catla* recovery rate was 92% in 2018, *C. mrigala* survival rate was in an increasing manner in 2017 to 2020 with 88% to 96%. *L. calbasu* shows 88% spawn survival in the year 2019.

Species	***Labeo rohita***				***Labeo catla***				***Cirrhinus mrigala***				***Labeo calbasu***			
Year	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
Fertilization rate (%)	98	97	98	98	_	96	_	96	97	96	98	97	_	_	98	_
Hatching rate (%)	90	94	90	92	_	90	_	94	91	90	90	94	_	_	90	_
Spawn recovery rate (%)	93	96	96	92	_	92	_	92	88	94	96	92	_	_	88	_

Table 6. Fertilization rate, Hatching rate and Spawn recovery rate of different species during 2017-2020

Fig. 27. Spawn collection from hatchery and stocking in nursery rearing ponds

Spawn Production:

During four years (2017-2020) almost 2 crores of spawn was produced by these yearly breeding programmes. The per year spawn production ranges between a minimum of 12 lakh/ year to a maximum of 79.4 lakh /year.

Species	Indian major Carps			
Year	2017	2018	2019	2020
Spawn Production (Lakh)	12	57	50	79.4

Table 7. Total spawn production from 2017-2020

Spawn transportation, acclimatization and stocking:

The produced spawns were transported through open tank transportation from hatchery to nursery rearing ponds in the early morning as the temperature was comparatively lower. The spawns were acclimatizatzed with pond water prior to their stocking. The pond water was gradually mixed with the tank water for the acclimatization of the spawns. Acclimatization is very much important for better spawn survival, otherwise sudden change in water quality like pH, temperature, DO etc may lead to mass mortality of spawn. After acclimatization, the spawn were stocked in the nursery rearing ponds for attaining the fingerling size. After seven days, first netting was carried out in ponds for checking out the spawn health, growth and survival. For the first three days, spawns were fed with milk powder and egg yolk custard, fortified with vitamin–C. From the forth day, commercial powder fish feed (crude protein 41%, crude fat 5%) were given along with periodical manuring which continued for the next three weeks. The extruded pelleted feed was used after 30 days of stocking. Regular monitoring of fishes and determination of ration level was done accordingly.

Care for spent brooders:

As the spent brood fishes are the potential broods for next season, the fishes were carefully handled after breeding. A solution of 5ppm Potassium Permanganate was used for dip treatment of the spent brooders (Male and Female) to minimize the chance of possible secondary dermal infections after spawning.The spent brooders were shifted to a circular cemented tank with continuous exchange of oxygenated water for the next 24 hours.The next day, brooders were transferred to the brood fish rearing pond and proper care were taken for the next few days. Prior to their release, fish were treated with $KMnO_4$ and antibioties, if injured. A balanced diet and maintenance can make the fishes healthy and overcome mortality rate due to breeding stress.

Nursery Rearing

Nursery-cum-rearing pond management

For better growth and survival of the fish seed, the nursery ponds were maintained carefully. There are different issues like aquatic weed management, eradication of aquatic insects and unwanted predatory fishes. Prior to stocking. Monitoring and adjustment of soil and water quality were conducted as necessary. The fishes received both sufficient natural feed and supplementary feeding consistently throughout the rearing period. It is crucial to maintain the stocking density of the fishes for optimal growth performance.

Pre-stocking management:

Before the breeding was conducted, it was mandatory to prepare the nursery rearing pond for the rearing of the produced IMC seeds. The preparation of nursery rearing ponds at Balagarh is initiated sixty days prior of the seed stocking.

Weed Cleaning: The aquatic weeds create different problems in the fish rearing ponds like absorption of available nutrient, decrease the plankton densities, lowers the pond dissolved Oxygen level in the night time, increase the aquatic insects. These weeds limit space for the fishes to float freely and also cause problem for different activities like feeding, netting etc. So, it is mandatory to remove the aquatic weeds before fish stocking. In the case of nursery ponds, manual weed cleaning is more effective than chemical, biological, mechanical methods. Some of the aquatic weeds, mainly found in the nursery ponds at Balagarh are *Eichhornia, Pistia, Lemna* and *Azoll*a. The Dykes of the ponds are

Fig. 28. Floating weed cleaning from pond

Fig. 29. Manual dyke cleaning of nursery ponds

Fig. 30. Dyke cleaning by weedicide spraying

commonly infested by some weeds like *Ipomea, Ottelia, Alternenthera, Colocasia* and *Jussia*. At first, the weeds have been removed from the pond (aquatic floating, submerged, emergent) and also cleaned the dyke of the ponds.The floating weeds are gathered in space by dragging with a chain made with paddy straw and netted out with zero-mesh nylon net. The marginal weeds in the pond are removed by side upto two feet from the water level. The dyke weed which is left above two feet is controlled by spraying weedicide. The weedicide having no such adverse effect in fish, human and pond health is selected for spraying. After stocking of fish, a small amount of weed-eating fish like Grass carp and Silver barb stocked in the ponds to prevent the rapid growth of aquatic weed.

Predatory fish control:

The complete eradication of predatory and weed fish is very important, prior to stocking for survival and growth of the stocked fish. These predatory fishes are voraciously fed the IMC spawn which lowers IMC population, level of dissolved Oxygen and natural feed in the ponds. The induced breeding of IMC is generally carried out in monsoon months. In this season, most of the waterbodies are in flooded condition and the runoff of these waterbodies is entered in the nursery ponds. The predatory or weed fishes are entered in the ponds with this runoff. For removal of these fishes, two processes can be adopted - the first process is dewatering and drying of the pond and if the ponds are not dried then by using piscicides. Mahua (*Brassia latifolia*) oil cake is used as a piscicide in the ponds for the removal of the fishes. The dose of the Mahua oil cake was used as per recommended concentration (200-250 ppm). After application of the Mahua oil cake, the dead fish removal is important, otherwise the dead fishes decompose and worsens the pond water quality. The ponds are left for three weeks before stocking of fish to avoid the toxic effect of the oil cakes.

	Group	Scientific name	Vernacular name
Predatory Fish	Murrels	*Channa punctatus*	Lata
		Channa marulius	Shal / Gojal
		Channa striatus	Shol
	Featherbacks	*Notopterus chitala*	Chital
		Notopterus notopterus	Folui
	Freshwater Shark	*Wallago attu*	Boal
	Air breathing Fish	*Heteropneustes fossilis*	Singhi
		Anabas testudineus	Koi
		Clarius batrachus	Magur
Weed Fish		*Chanda nama*	Chada
		Gudusia chapra	Khoyra
		Amblypharyngodon mola	Mourola

Table 8. List of predatory and weed fishes found in nursery ponds during pond preparation


Fig.31-32. Predatory and Weed fish

For survival and proper growth of the IMC spawn, it is very important to maintain good pond health. Prior to the release of spawn different water quality parameters were analysed and taken the required corrective measures to maintain the parameters to the recommended level. Potassium Permanganet ($KMnO_4$) mixed with sand broadcasted throughout the pond as a prophylactic treatment of the pond. The pH of the pond water was corrected by application of lime, agricultural gypsum ($CaSO_4$). The DO of the pond was maintained by installing paddle wheel aeration system in the pond. After application of lime, the bottom soil raiking was done to release the obnoxious gas from the bottom sediment and also mix the lime properly with the sediment.




Fig. 33. Bottom sediment raiking prior to stocking; Fig. 34.Water quality analysis; Fig. 35. Liming of pond; Fig. 36. Application of Potassium Permanganet ($KMnO_4$))

Water quality management of nursery ponds:

The following water quality parameters were monitored at a regular interval and the range of the data is depicted in the table 9.

Water quality parameter	Value
Dissolved Oxygen (mg/l)	>5.5
pH	7.5 – 8.2
Water Temperature (°C)	28-34
Total Alkalinity (mg/l)	60-90

Table 9. Water quality maintained in nursery ponds

Fertilization of the pond:

Planktons are the main food for the IMC spawn and it is essential to maintain a good plankton density in the ponds for better feed availability to the stocked fishes. Adequate nutrient availability is required for a better phytoplankton population and enough phytoplankton population is good for the zooplankton growth which is actually required as natural fish food. Fertilization of the pond is required for maintaining the plankton density in the ponds. In this fertilization process, the fertilizers are used with organic manures for better consequences. Fermented mixture of oilcakes and brans used for manuring in the ponds. The composition of the mixtures shown in the table 10. All the ingredients are mixed properly and water is added for fermentation. After 48 hours, the fermented mixture is broadcasted throughout the ponds. A period of 24-48 hour prior to the spawn stocking, the periodic application of the manure was carried out in every 7-15 days, based on the plankton density. The over population of planktons may cause low dissolved oxygen in the pond which may affect the spawn survival.

Ingredients	Inclusion Rabio
Mustard Oil Cake	1
Groundnut Oil Cake	1
Rice Bran	2
Jaggery	0.2
Yeast	0.2

Table 10. Formula for preparing organic manure

Fig. 37. Preparation of manure

Removal of aquatic insects:

The population of aquatic insects rapidly increases after fertilization in the nursery ponds. These insects can cause severe harm to the stocked spawn. For removal of these insects, soap-oil emulsion (Soap

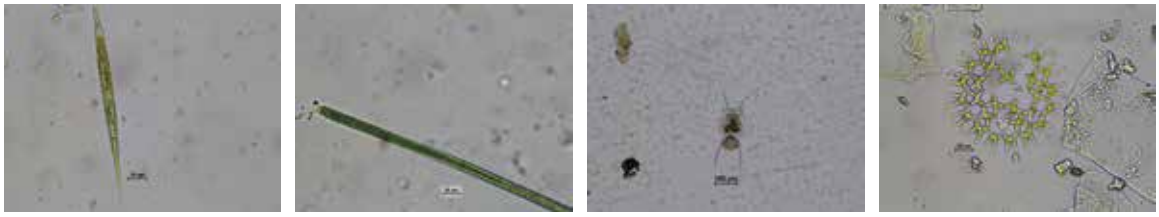


Fig. 38. (A-D)Pictures of common planktons found in brooder pond (A. *Euglena acus,* B. *Oscillatoria* sp., *C. Brachionus* sp., *D. Pediastrum duplex*)

and vegetable oil) was applied to the pond as these insects come to the surface of the water for respiration and killed by gill chocking by these layers. The emulsion was applied by broadcasting throughout the pond two days prior to the seed stocking.Repeated netting with zero mesh net was done after application of insecticide was helps to remove the dead insects as well as remaining live insects from the pond. If the pond is highly infested with insects, repeated application of insecticide may be done.

Fig. 39. Dead insects netted out after application of soap-oil emulsion

Fig. 40. Live insect

Stocking rate:

The stocking rate of the spawn was maintained on the basis of availability of natural food present in the pond and also based on pond area, depth, water quality etc. Almost 30-50 lakh (3-5 million) spawn were stocked per hectare.

Stocking management:

During stocking of spawn the following care should be taken:

A. Plankton density, B. Proper acclimatization, C. Carefully spawn replacement, D. Monitoring of water quality parameters and E. Pond devoid of insects and predatory fish.

Following the stocking process, effective management and care became crucial as the survival and growth of the seed largely relied on these factors. Proper feeding of the seeds emerged as a critical aspect, with the determination of the ration level being a key component in post-stocking management. The dose was established based on a percentage of the body weight of the stocked fishes and was adjusted fortnightly after pond sampling to calculate the average weight.

After two weeks of stocking, the early fry were netted out and the stocking density was lowered by shifting the fry in other ponds. Regular monitoring of water quality has been done and applied different water quality maintaining agents as per requirement.

Fig. 41 IMC fry

Fig. 42 Netting of pond

Fig. 43 (A-E) Different life stages (spawn to advanced fingerling) of IMC in nursery rearing

Safety measures:

i. Protection from Birds:

The fry/fingerlings of fish are an easy target for several fish eating birds like Cormorant, Herons, Kingfishers etc. As a single bird can capture numbers of fishes per day and some of these birds move in the flock, so it can be a huge loss if the pond do not properly restrict the entry of the bird. Lines of thin nylon thread tied up with ropes are being fitted above three feet higher from the dyke height to make the predatory birds stay away from the pond (fig. 44).

Fig. 44 Bird protection net fitted above nursery ponds

ii. Avoid fish escaping:

The breeding of IMC is usually conducted in monsoon months. So, the culture period starting mostly in the rainy season when the ponds are about to flooded condition. Therefore, it is mandatory to prevent fish from escaping during the flooded situation. Nylon zero mesh net fencing fitted with split bamboo is required to surround the pond dykes.

Fig. 45 Nylon net fencing on dyke to prevent fish escaping during flood

iii. Water level maintaining:

Throughout the rearing period, the pond water level must be maintained at least 3ft. from the bottom. The decrease of water level must be a serious problem for the stocked fishes during the summer months. The addition of the required quantity of water is needed for maintaining the level. Ground water may be a good source for it which may be pumped up and directly added to the pond. Apart from this, a regular water exchange is also optimum for maintaining the water quality of the ponds.

Fig. 46 Ground water added to maintain water level

Fingerling Transportation

Once the seed/fingerlings attained more than the size of 100mm then they are ready for ranching. Small size fish should not be preferred for ranching because of their lower survival rate and they are more prone to predation. The fingerlings were transported to the different ranching sites to carry out the ranching programmes.

For reanching programme, fingerlings of IMC were transported from West Bengal to different sites of Jharkhand, Bihar and Uttar Pradesh. The long transportation needs proper care and management for better post-transportation survival rate.

Management during transportation:

During the transportation and post-transportation of fingerlings, specific pre and post-transportation management measures need to be followed. The process of the conditioning of the fingerlings starts two days prior to transportation of fingerlings such as the supplementary feeding was stopped one day prior to transportation and pre-netting was carried out two days prior to their transportation. Fingerlings are then placed in a happa for two hours, where a low dose of Mahua oil cake was put into the pond. On the day of transportation, the fish are netted out and kept in the happa for 6-8 hours to allow for gut evacuation. Continuous water showering in the happa minimizes stress and maintains dissolved oxygen levels.

Fingerlings are transported mostly in open tank transportation. For transportation in open tanks, commercially available oxygen tablets were periodically used to boost dissolved oxygen levels and reduce transportation stress. Additionally, salt (0.4 ppt) and glucose were applied for long-distance transportation to provide energy and maintain balance. Sedatives were employed during transportation to lower metabolic activity. Upon reaching the ranching site, fingerlings were acclimatized to the river environment by keeping them in a happa fitted in the river water before releasing intoi the river. In cases of long-distance transportation of spawn and fry, polybags filled with water and medical-grade oxygen are used. The density of seeds in transportation tanks is contingent on the distance to the ranching sites.

Fig. 47 Oxygen packed transportation of fingerling

Fig. 48 Open tank transportation of fingerling

Throughout the entire transportation period, it is crucial to monitor and maintain certain water quality parameters, including water temperature, pH, and Dissolved Oxygen (DO). Specifically, these parameters were kept within the range of 26-29°C (±2.86), 8.01-8.4 (±0.23), and 4.48-6.68 mg l^{-1} (±2.20), respectively, at the time of transportation. Additionally, both unionized (NH_3) and ionized (NH^+_4) ammonia levels were carefully considered during the transportation process. The average concentrations of ionized and unionized ammonia were sustained within the optimal range for fish survival, with values falling within 0.03 mg l-1 (± 0.01) and 0.49 mg l-1 (± 0.30), respectively. It is essential to implement proper care measures, such as water exchange, the provision of medical-grade oxygen, the use of oxygen-enhancing tablets, and the application of sedatives, during transportation. The specific care protocols should be tailored based on the duration and distance of the transportation.

River Ranching and Awareness Campaigning

As a comprehensive part of the CIFRI-NMCG project entitled 'Assessment of fish and fisheries of the Ganga River System for Developing Suitable conservation and restoration plan', a fish ranching programme was initiated in different depleted stretches of river Ganga. Under this activity, ICAR-CIFRI conducted 43 ranching-cum-awareness programmes and released more than 30 lakhs of IMC and Mahseer fingerlings (produced by breeding of the Gangetic brooders) in the river Ganga during 2017-2020 for conservation and restoration of IMC and Mahseer in the river. Under this ranching activity, ICAR-CIFRI has also conducted mass awareness programmes for fishers to sensitize them on the negative effects of destructive methods of fishing like using mosquito nets and toxic chemicals. They were advised to restrict catching the juvenile and brood stocks especially in the breeding seasons (June-August) for their sustenance in the river Ganga. The objective of these CIFRI initiative is to restore the prized fishes of the river Ganga which created an effective impact on the local fishers.

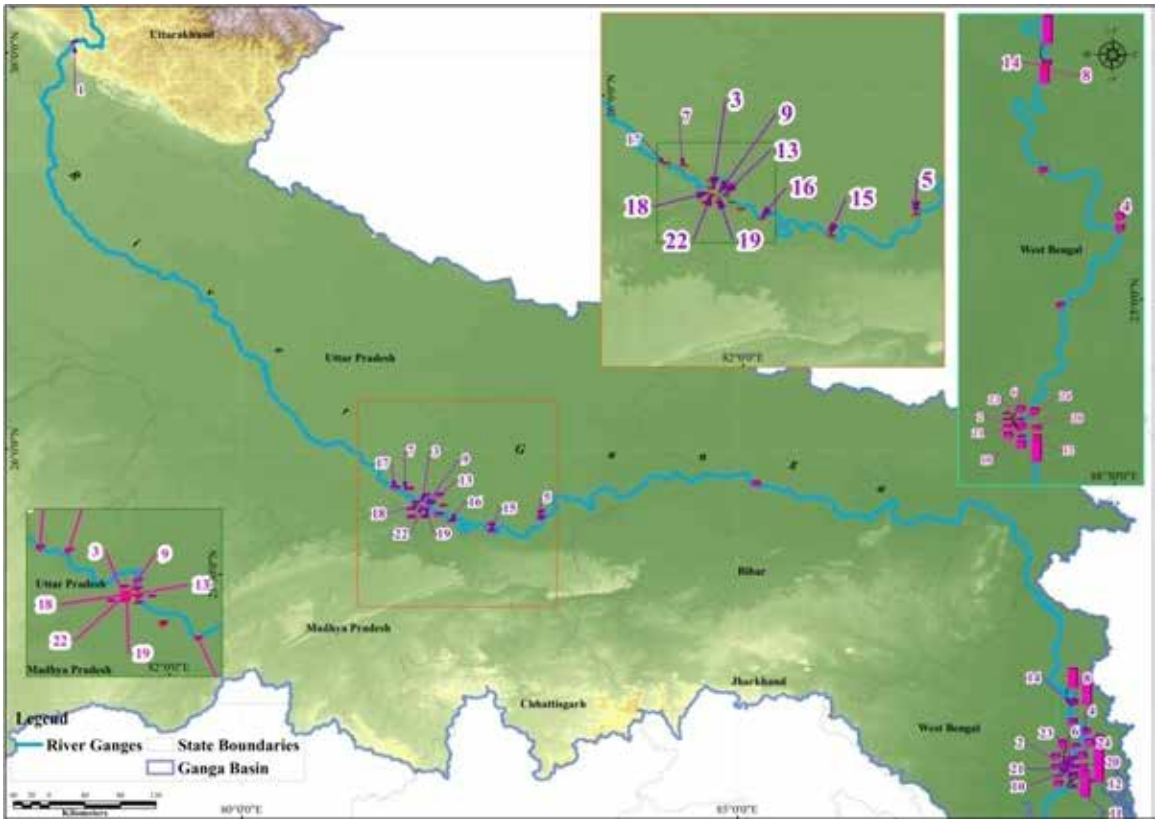


Fig. 49 Map showing ranching sites in difffrenet states

Rishikesh, Uttarakhand (23rd May, 2017)

The objectives and mandate of the programme of ranching at Rishikesh and its implications on restoration and conservation of biodiversity in river Ganga, focusing Mahseer and Trouts in the hilly stretch were briefly described by Dr. B. K. Das, Principal Investigator of the project. In this programme, five hundred Mahseer seeds (*Tor putitora*) were ranched in river Ganga. Scientists and officials of Central and state government departments, several non-governmental organizations, students from different universities, fishers of nearby areas and local fish traders attended the programme.

Fig. 50 (A-B). Ranching programme at Rishikesh

Barrackpore, West Bengal (26th May, 2017)

Honourable Union Minister of Water Resources, River Development and Ganga Rejuvenation Sushri Uma Bharti Ji visited ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore, Kolkata on 26th May, 2017. On this occasion, two prized warm water fishes such as Rohu (*Labeo rohita*) and Catla (*Labeo catla*) were released by Sushri Uma Bharti in river Ganga at Barrackpore, West Bengal.

Fig. 51(A-B). Ranching programme at Barrackpore

Prayagraj, Uttar Pradesh (1st August, 2017)

Ranching of seeds of Indian Major Carps such as Catla (*Labeo catla),* Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*) in the river Ganga was organized by ICAR-Central Inland Fisheries Research Institute (Regional Centre. Prayagraj) under its pilot project, NMCG (National Mission for Clean Ganga). The event was attended by the students from universities, fishers of nearby villages, fish traders of Sadiapur, Daraganj and Mehdauri, and local people living on the bank of the Ganga and Yamuna. The event was graced by Hon. Minister of State (Dept. of Animal Husbandry and Fisheries) Shri Jai Prakash Nishad. Dr. B.K. Das, PI of the project expressed his concern of recruitment overfishing of broodstock during the breeding season and growth overfishing of the juveniles of the fishes (fingerlings) during rainy season which in turn hampers the biodiversity, and finally affecting the livelihood of fishermen community. Representatives from Ganga Vichar Manch and several other NGOs suggested measures to reduce pollution and to increase the population of fishes in the river. On this occassion, pamphlet on "Ganga Ko Aviral Bahne Do" as a guiding principle to restore Ganga and livelihood of fishermen community was released by the Hon'ble Minister.

Fig. 52 (A-B) Ranching programme at Prayagraj

Balagarh, West Bengal (3rd November 2017)

ICAR- Central Inland Fisheries Research Institute, Barrackpore under its mega project '*Namami Gange*' with cooperation from Sripur Balagarh Matsyajibi Cooperative Society (Balagarh, West Bengal) ranched 60,000 seeds of Indian Major Carps in River Ganga with the participation of more than 100 local fishermen for the sustainable development of aquatic life. Besides stressing upon self-reliance of the fishers, Dr. Basanta Kumar Das, Director, ICAR-CIFRI and Principal Investigator urged to utilize the invaluable resource of river Ganga by adopting the conservation practices. He emphasised that with more pro-activism, Ganga fishery can only be restored through 'Community participation' for that Govt. organizations and fishermen have to work together to achieve the goal. Member of Legislative Assembly (M.L.A), Govt. of West Bengal, Mr. Ashim Majhi requested to avoid littering activities in river Ganga and highlighted that traditional practices should not be overpowered by prejudice.

Fig. 53 (A-B) Ranching programme at Balagarh

Varanasi, Uttar Pradesh (11th November, 2017)

ICAR-CIFRI organized a fish ranching event on 11th November 2017 at Dasaswamedh Ghat, Varanasi, Uttar Pradesh. In this programme, ranching of 5000 nos. of advanced fingerling of IMCs was done in River Ganga at Dasaswamedh Ghat, Varanasi. Dr. Rakesh Singh (Banaras Hindu University, Varanasi) Chief Guest shared his experiences and suggested for restoration of fisheries of river Ganga. Fishers were made aware about the rising concerns of river pollution and its impacts on the ecosystem. The event was attended by large numbers of students and local people.

Sringverpur, Prayagraj, Uttar Pradesh (5th December, 2017)

Fish ranching and awareness programme was organized by ICAR-CIFRI, Prayagraj on 5th December 2017 in which 10000 nos. of IMC fingerlings were released in river Ganga. Mr. P.S. Pandey, Ex-MLA, Uttar Pradesh graced the occasion and highlighted on the importance of the programme.

Fig. 54 (A-B) Ranching programme at Prayagraj

Barrackpore, West Bengal (21st November, 2017)

ICAR-CIFRI celebrated 'World Fisheries Day' at Barrackpore on 21st November, 2017. On this occasion, a total of 20,000 (Twenty thousand) seeds of Indian Major Carps has been released in river Ganga at Daspara Ghat, Barrackpore under *Namami Gange* Project. Dr. D. K. De, renowned expert in Hilsa (*Tenualosa ilisha*) highlighted on the construction of the huge number of barrages/ dams causing water abstraction and thereby hindering migration of fishes. Director, ICAR-CIFRI emphasised on the importance of ranching which can increase fishers' income from rivers and yield 'Green fish in Blue economy' and thereby improving the livelihood of disadvantaged fisherfolks.

Fig. 55(A-B) Ranching & awareness programme at Barrackpore, WB

Nabadwip, West Bengal (21st January, 2018)

The institute has undertaked ranching of 50,000 (Fifty thousand) seeds of Indian Major Carp in river Ganga at Nabadwip, West Bengal. The entire event took place in the holy place at Prachim Mayapur, Nidaya Ghat. On this occassion. Mr. Nibasi Ch. Das, Assistant Fishery Officer, Govt. of West Bengal requested fishers not to use zero mesh drag net and described different Government schemes which may improve the livelihood of fishers. Mr. Pundarikakhya Saha, MLA, Nabadwip

Fig.56(A-B) Ranching & awareness programme at Nabadwip, WB

visited the meeting site and extended his full support to the programme. On his behalf, Mr. Sukumar Rajbanshi, local Councilor, Nabadwip Municipality requested the State and Central Govt. officials to take immediate measures to stop severe river bank erosion in the area. He requested fishers not to catch the released fishes but allow them to grow and breed so that the fish stock can be restored.

Barrackpore, West Bengal (15th March, 2018)

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata celebrated its Platinum Jubilee on 15 March 2018. On this grand occasion, a total of 50,000 (fifty thousand) Rohu, Catla, Mrigal fingerlings have been released in the river at Barrackpore to restore prized Major Carp fisheries of river Ganga. The event was graced by several eminent scientists and dignitaries including Dr. J.K. Jena, Deputy Director General (Fy. Science); Padmashree Prof. R. K. Sinha, the Dolphin man of India and Dr. Sandeep Behera, Consultant, Biodiversity, NMCG, New Delhi. Dr. Sandeep Behera emphasized the need for ranching, conservation of wetlands in the Ganga basin and conducting awareness programs to sensitize the community living in the vicinity.

Fig.57(A-B)Ranching and awareness programme at Barrackpore, WB

Prayagraj, Uttar Pradesh (27th March, 2018)

ICAR-CIFRI, Prayagraj conducted a mass awareness program-cum-ranching of IMC seeds in Ganga river at Fatepurghat on 27th March, 2018 under NMCG (National Mission for Clean Ganga) for restoration and conservation of the depleting fish stock in the river Ganga. A total of 20,000 (twenty thousand) advanced fingerlings of IMC were ranched in the river. Dr. R. S. Shrivastava, Head of Centre, ICAR-CIFRI, Prayagraj hilighted the different causes for the depleting of fish diversity of the river Ganga. under this *Namami Gange* programme. Scientists–fishers interaction was held. More than 60 fishers participated in the programme.

Bally, West Bengal (5th September, 2018)

A Ranching-cum-awareness campaign was organized on 5th September, 2018 at Barendrapara

Ghat, Bally, Howrah, West Bengal. A total of 5 lakh fry of Rohu, Catla, Mrigal and Calbasu were ranched in the event. Dr. B. K. Das, Director of the Institute and Principal Investigator, CIFRI-NMCG project highlighted the progress made by the institute, covering habitat data, biotic communities, fish diversity, stock assessment etc. He highlighted the need for ranching in river Ganga which in turn will ensure unremitting livelihood for the fishers encompassing the biodiversity and ecological integrity. On the occasion, Swami Atmapriyanandaji Maharaj, Vice-Chancellor, Ramakrishna Mission Vivekananda Educational and Research Institute, Belur addressed the gathering and emphasied on the preachings of Swami Vivekananda regarding the purity of our holy River Ganga. He highlighted that the purity of the river will sustain only with a coordinated approach. Swami Girashananda Ji Maharaj, Manager, Ramkrishna Matha and Ramkrishna Mission, Belur Math delivered the presidential address at the event. Acknowledging the endeavors of the Central Inland Fisheries Research Institute, Swamiji stressed on the deteriorating state of the sacred river and urged local residents to actively coordinate and take initiative.

Fig. 58 (A-B) Ranching and awareness programme at Bally, WB

Barrackpore, West Bengal (2nd October, 2018)

To commemorate the 150th Birth anniversary of Mahatma Gandhi and as a part of *Namami Gange* initiative, ICAR-CIFRI organised a fish ranching programme on 2nd October, 2018 at three

Fig. 59(A-B) Ranching programme at Gandhi Ghat, Barrackpore

consecutive Ganga ghats (Seoraphully, Mangal Pandey and Gandhi Ghat) at Barrackpore, Kolkata, West Bengal. On this occasion, Shri Nabin Naik, Director, Nehru Yuva Kendra Sangathan graced the event. As a part of the event, a total of 2.8 Lakhs of fingerlings of Rohu, Catla, Mrigal were released in river Ganga and Bilingual pamphlets were distributed among the local fishermen to enlighten them about the rising concern.

Sangam, Prayagraj Uttar Pradesh (2nd October, 2018)

Five thousand IMC (Rohu, Catla and Mrigal) seeds were ranched in river Ganga in this programme in presence of Dr. R. S. Srivastava, Head, CIFRI Regional Centre, Prayagraj.

Fig. 60 Ranching programme at Sangam, Prayagraj

Mayapur, West Bengal (6th November, 2018)

ICAR-Central Inland Fisheries Research Institute organized a river ranching-cum-fishermen awareness programme on 6th November, 2018 at Swarupganj Ghat, Nabadwip, Nadia,West Bengal under the '*Namami Gange*' programme. As a part of the programme, 3 lakh seeds of Calbasu, Mrigal and Rohu were released in the river Bhagirathi (Ganga) in front of the holy ISKCON temple, Mayapur. The programme was attended by more than 150 local fishermen and their family members. The event was well-covered by local print media and electronic media.

Fig. 61 (A-B) Ranching and awareness programme at Mayapur, WB

Barrackpore, West Bengal (20th November, 2018)

A ranching-cum-awareness programme was organized on the occasion of World Fisheries Day at Daspara Ghat, Barrackpore, West Bengal on 20th November, 2018. As a part of this programme, 2 lakh IMC fingerlings were released in river Ganga. Shri Nabin Naik, Director, Neheru Yuva Kendra Sangathan expressed his view on the status of fisheries of river Ganga to the fishers.

Fig. 62 (A-B) Ranching programme at Barrackpore, WB

Ramayaghat, Mirzapur Uttar Pradesh (26th November, 2018)

One fish ranching programme at Ramayaghat, Mirzapur was conducted on 26th November 2018. On this occassion, 10000 IMC (Rohu, Catla, Mrigal) were released in the river Ganga. Dr. Varshi, DDF, Govt. of U.P. was present in this occasion and enlightened the fishers on the status of the fish and fisheries of river Ganga.

Karaghat and Kousambi, Prayagraj Uttar Pradesh (4th and 5th December, 2018)

A concurrent ranching-cum-mass awareness programme at Sirsaghat (Prayagraj) and Kade Dham ghat (Kaushambi), Uttar Pradesh was organized on 4th and 5th December 2018 respectively. A total of 30000 advanced Indian Major Carp (Rohu, Catla and Mrigal) fingerlings were ranched in the river Ganga with wide mass media coverage. Mr. M. N. Pathak, Ret. Principal, Sirsa Inter-College delivered his valuable comments on fish and fisheries of river Ganga at Sirsaghat.

Kumbh Mela, Prayagraj Uttar Pradesh (15th January to 4th March 2019)

In the presence of Honourable Minister, Shri Nitin Gadkari (Ministry of Water Resources, River development and Ganga Rejuvenation, Govt. of India) a total of 10,000 juveniles of Indian Major Carp have been ranched in river Ganga on 08th February 2019 during Kumbh Mela, 2019 at Prayagraj.

Fig. 63 (A-B) Ranching programme at Sirsa and Karaghat, Kousambi, Prayagraj, UP

Fig. 64 (A-B) Ranching programme at Kumbh Mela, Prayagraj, UP

Barrackpore, West Bengal (10th July, 2019)

A river ranching programme-cum-mass awareness campaigning was organised by ICAR-CIFRI, Barrackpore on the occasion of National Fish Farmers Day 2019 at Daspara Ghat, Barrackpore. A total of 30000 IMC fingerlings were ranched in presence of Sri Bankim Hazra, Honourable MLA, Sagar Island; Dr. V. V. Sugunan, Former ADG (Inl. Fy.), ICAR;l Dr. Madhumita Mukherjee, Additional Director (Technical), Govt. of West Bengal and Dr. B. C. Jha, Former HOD, ICAR-CIFRI, Barrackpore. More than 100 fishers and entrepreneurs from West Bengal, Bihar, Jharkhand and Madhya Pradesh participated in the programme.


Fig. 65 (A-B) Ranching programme at Barrackpore, WB

Nawabganj Ghat, Ichhapur, West Bengal (27th July, 2019)

A ranching-cum-awareness programme was organized at Nawabgunj Ghat, Ichhapur, West Bengal on 27th July, 2019. As a part of this programme 60000 IMC fingerling were released in river Ganga. Dr. C. Vasudevappa,Vice Chancellor, NIFTEM, Haryana and other dignitaries 5th expressed their views in fisheries of river Ganga to the fishers.


Fig. 66 (A-B) Ranching and awareness programme at Nawabgunj Ghat, Ichhapur, WB

Gandhi Ghat, Barrackpore (Team NMCG, Delhi) (10th November, 2019)

ICAR-CIFRI along with NMCG expedition team, *'Ganga Amantran'* performed a river ranching programme at Gandhi Ghat, Barrackpore. Besides highlighting on the project activities to the team members, more than 40000 fingerlings of Indian major Carps were ranched on this occasion.

Fig. 67 (A-B) Ranching and awareness programme at Gandhi Ghat, Barrackpore, WB

Law college Ghat, Patna (20th November, 2019)

ICAR-CIFRI, Barrackpore with the support from the Department of Fisheries, Govt. of Bihar performed a river ranching programm at Law College Ghat, Patna, Bihar. The programme was attended by several officials from the state fisheries department including Mr. V. S. Gunjiyal, Director of Fisheries, Govt. of Bihar. The event was attended by more than 50 local fishermen. More than 40,000 fingerlings of Indian Major Carp seeds were ranched in the river.

Fig. 68 (A-B) Ranching and awareness programme at Law college Ghat, Patna, Bihar

Daspara Ghat, Barrackpore, West Bengal (12th December, 2019)

A ranching-cum-awareness programme was organized at Daspara Ghat, Barrackpore, West Bengal on 12th December, 2019. As a part of this programme, 10000 IMC fingerlings were released in river Ganga. Dr. Huang Jie, Director General, Network of Aquaculture Centres in Asia-Pacific and other dignitaries expressed their views in fisheries of river Ganga to the fishers.

Fig. 69 (A-B) Ranching and awareness programme at Daspara Ghat, Barrackpore, WB

Gandhi Ghat, Barrackpore, West Bengal (26th January, 2020)

On the occasion of 71st Republic Day, ICAR-CIFRI under NMCG project ranched 50,000 fish fingerlings of Indian Major Carps at Gandhi Ghat, Barrackpore, West Bengal. The occasion was graced by Mr. Dipankar Bhattacharyya (IPS) and other senior officials from West Bengal Police department.

Fig. 70 Ranching and awareness programme at Gandhi Ghat, Barrackpore, WB

Narayani Ashram, Prayagraj, Uttar Pradesh (28th January, 2020)

A total of 10,000 number Indian Major Carps fingerlings were ranched at Prayagraj with a huge and productive mass awareness generation among local fishers residing at the Ganga river bank.

Fig. 71 (A-B) Ranching and awareness programme at Dashashwamedh Ghat, Prayagraj, UP

Dashashwamedh Ghat, Prayagraj, Uttar Pradesh (6th February, 2020)

Ten thousand fingerlings of Indian major carps (*Labeo catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) were ranched on 6th February 2020 at Dashashwamedh Ghat, Prayagraj. Colonel Amit Pandey, Commanding Officer, Ganga Task Force was the Chief Guest of the programme. A leaflet (Hindi) on riverine ranching was released during the programme for a huge and productive mass awareness generation with local fishers residing at the Ganga river bank, students and several Magh Mela pilgrims.

Sangam, Prayagraj, Uttar Pradesh (11th February, 2020)

Twenty thousand fingerlings of Indian major carps (*Labeo catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) were ranched at *Sangam Nose (Ganga river and Yamuna river confluence point),* Prayagraj on 11th February 2020. Mr. Atharv Raj, NMCG, Ministry of Jal Shakti, Govt. of India was the Chief Guest in this programme. Mr. Rajesh Sharma (Ganga Vichar Manch), Mr. Sanjay Mamgai (Zonal Ofiicer), Mr. K. P. Upadhaya, Dr. Nityanand Pandey and delegates of Ganga Prahari, WWI, Dehradun, Uttrakhand also participated in this programme. Two leaflets (Hindi) on "**Fish diversity and contribution of women in fisheries and optional earning**" were released during the programme.

Fig. 72 (A-B) Ranching and awareness programme at Sangam, Prayagraj, Uttar Pradesh

Manaiyaghat, Prayagraj, Uttar Pradesh (25th February, 2020)

Fifteen thousand fingerlings of Indian major carps (*Labeo catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) were ranched at *Manaiya Ghat,* Jhunsi, Prayagraj on 25th February 2020. Dr. S.C. Tiwari, Pro-Vice chancellor, Nehru Gram Bharti Deemed University (NGBU) was the Chief Guest of this programme. He released a leaflet (Hindi) on "**Golden Mahseer: An effort toward Conservation**". On this occasion, Prof. Ramkripal (Dean Science, NGBU) and Dr. Asish Shivam (Head, Zoology

Fig. 73 (A-B) Ranching and awareness programme at Maniyaghat, Prayagraj, Uttar Pradesh

Department, NGBU) were present. Students from NGBU and Fishermen (residing along the Ganga River) participated in this programme.

Vindhyanchal, Uttar Pradesh (29th February, 2020)

Fifteen thousand fingerlings of Indian major carps (*Labeo catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) were ranched at *Divan Ghat,* Jhunsi, Prayagraj on 29th February 2020. Dr. K.W. Warsi, Deputy Director, Fisheries Department, Uttar Pradesh was the Chief Guest of this programme. He released a Hindi leaflet on **"Phytoplankton - A Source of Oxygen in Riverine ecosystem"**. The Fisheries Inspector of Mirzapur, Mr. Sarang was present in this programme. Staff of Fisheries department, Fishers, Pilgrims, Priests and local Shopkeepers have also participated in this programme.

Fig. 74 Ranching and awareness programme at Vindhyanchal, Prayagraj, Uttar Pradesh

Assi Ghat, Varanasi Uttar Pradesh (5th March, 2020)

Twenty thousand fingerlings of Indian major carps (*Catla catla, Labeo rohita, Labeo calbasu* and *Cirrhinus mrigala*) were ranched on 5th March 2020 at Assi Ghat,Varanasi. Mr Ravindra

Fig. 75 Ranching and awareness programme at Assi Ghat, Varanasi, Uttar Pradesh

Prasad (C.E.O.) Department of fisheries, Govt. of Uttar Pradesh, Varanasi was the Chief Guest of the programme who made the fisherman aware about the conservation and restoration of the river Ganga through his valuable speech.

Fig. 76 Ranching and awareness programme at Assi Ghat, Varanasi, UP

Barrackpore, West Bengal (17th March, 2020)

ICAR-CIFRI under its ongoing NMCG Project celebrated its 74th Foundation Day on 17th March, 2020 with a river ranching programme at Barrackpore, West Bengal. The programme started with the ranching of 50,000 advance fingerlings of Indian Major Carps (IMC) in River Ganga. The occasion was graced by Dr. (Smt) Vijayalakshmi Saxena, General President (Elected) of Indian Science Congress Association and Dr. Ashok Kumar Saxena, Former President of Indian Science Congress Association. The programme was overall guided by Dr. B. K. Das, Director, ICAR-CIFRI and PI, NMCG project.

River Ranching & Dolphin awareness Week (11th June, 2020 to 15th June, 2020)

As a part of the campaign, a total of 2.20 Lakh number of fishes have been released during the

Fig. 77 (A-E) Ranching and awareness programme at Nabadwip, Kalna, Balagarh, Tribeni & Barrackpore

entire ranching week. Sites namely, Nabadwip, Kalna, Balagarh, Tribeni and Barrackpore were covered within a period of 7 days for the campaign. Local fishermen and stakeholders present in the programme were sensitized about the factors behind declining fish biodiversity and total fish catch from river Ganga like indiscriminate destruction of brooders and juvenile fishes through use of zero-mesh destructive fishing gears and requesting for their active cooperation towards success of river ranching programme for restoration of the fishery of Indian major carps in Barrackpore stretch of River Ganga. Dr. B. K. Das, Director, ICAR-CIFRI and PI, CIFRI-NMCG project highlighted the importance of celebration of the day as it calls for sustainable fishery of open waters, conservation of aquatic biodiversity, restoration of fish habitat, etc. He emphasised that ranching can increase fishers' income from rivers and yield 'Green fish in Blue economy'; thereby improving the livelihood of disadvantaged fisher folks. The event was successful and the efforts made by CIFRI

S No.	Sites	Date	Species	Number released
1.	Kalna (Dist- Burdwan)	11.06.2020	IMC	40000
2.	Nabadwip (Dist- Nadia)	12.06.2020	IMC	50000
3.	Balagarh (Dist- Hooghly)	13.06.2020	IMC	30000
4.	Tribeni (Dist- Hooghly)	14.06.2020	IMC	50000
5.	Barrackpore (Dist- North 24 Parganas)	16.06.2020	IMC	50000

Table 10. List of place of ranching during 'River Ranching Week'

under its National Mission for Clean Ganga Project (NMCG) were highly appreciated by both local authorities and fisher communities residing along with proximity of the river.

Farakka, West Bengal (23rd September, 2020)

Ranching of more than 1,20,000 advanced fingerlings of Rohu (*Labeo rohita*), Catla (*Labeo catla*), Mrigala (*Cirrhinus mrigala*) and Calbasu (*L. calbasu*) was conducted in river Ganga at Farakka, West Bengal on 23rd September, 2020. Shri D.S.G.S.S. Babji, Executive Director, NTPC,

Fig. 78 (A-B) Ranching programme at Farakka, Murshidabad, West Bengal

Farakka, West Bengal; Dr. B.K. Das, Director, ICAR-CIFRI, Barrackpore, Kolkata; Shri R.K. Singh, Superintending Engineer, Farakka Barrage Authority and Shri Sanjeev Kumar, Assistant Director, IWAI were present as the Special Invitees on the occasion.

Maharajpur & Sahibgunj, Jharkhand (24th September, 2020)

Two consecutive ranching programmes at Maharajpur and Sahibgunj, Jharkhand were conducted in presence of local fishers and fishermen Co-operative societies. A total of 2,00,000 advanced fingerlings of Indian Major Carps were released. Besides the fish ranching programme ICAR-CIFRI has also organized a *Dolphin awareness week* covering the four districts. The present initiative highlighted several conservational aspects of the National Aquatic Animal (*Platanista gangetica*) as their population has declined over the years in river Ganga due to various anthropogenic reasons. In addition, the event was also highly appreciated by the local enthusiast and was fervently covered by several leading electronic and print media houses in local and national news.

Fig. 79 (A-B) Ranching and awareness programme at Maharajpur & Sahibgunj, Jharkhand

Table. 11 Details of fish ranching programme by ICAR- CIFRI under NMCG Project in River Ganga (2017-2020)

Sl No.	Date	Place	Species	No.	Species ratio (R:C:M:K)
01	23.05.2017	Rishikesh, Uttarakhand	Mahaseer	500	-
02	26.05.2017	Barrackpore, West Bengal	IMC	2,500	1:2:2:2
03	01.08.2017	Narayani Ashram, Prayagraj, Uttar Pradesh	IMC	10,000	3:1:1:1
04	03.11.2017	Balagarh, West Bengal	IMC	60,000	1:2:1:1
05	11.11.2017	Dasashwamedh Ghat, Varanasi, Uttar Pradesh	IMC	5,000	2:1:1:1
06	21.11.2017	Barrackpore, West Bengal	IMC	>20,000	3:2:2:1
07	05.12.2017	Sringverpur, Prayagraj, Uttar Pradesh	IMC	10,000	2:2:1:1
08	21.01.2018	Nabadwip, West Bengal	IMC	>1,00000	3:1:1:1
09	27.03.2018	Fatehpurghat, Kausambi Prayagraj, Uttar Pradesh	IMC	10,000	2:2:1:1
10	15.03.2018	Barrackpore, West Bengal	IMC	50,000	3:1:1:1
11	05.09.2018	Barendrapara Ghat, Bally, Howrah, West Bengal	IMC	5,00000	1:1:2:1
12	02.10.2018	Barrackpore, West Bengal	IMC	2,80,000	2:1:1:1
13	02.10.2018	Sangam, Prayagraj, Uttar Pradesh	IMC	5000	2:1:1:1
14	06.11.2018	Mayapur, West Bengal	IMC	3,00000	2:1:1:1
15	26.11.2018	Ramyaghat, Mirzapur, Uttar Pradesh	IMC	10000	1:2:1:1
16	04.12.2018	Sirsa, Prayagraj, Uttar Pradesh	IMC	10000	3:1:1:2
17	05.12.2018	Karaghat, Kausambi, Uttar Pradesh	IMC	20000	1:1:3:1
18	08.02.2019	Prayagraj, Uttar Pradesh	IMC	10000	2:1:1:1
19	26.02.2019	Sangam, Prayagraj, Uttar Pradesh	IMC	15000	3:3:1:1
20	15.03.2019	Barrackpore, West Bengal	IMC	10,000	2:2:2:1
21	17.03.2019	Barrackpore, West Bengal	IMC	50,000	1:1:1:2
22	29.03.2019	Sangam, Prayagraj, Uttar Pradesh	IMC	15000	2:1:2:1
23	10.07.2019	Barrackpore, West Bengal	IMC	30000	2:1:3:1
24	27.07.2019	Nawabganj Ghat, Ichapur, West Bengal	IMC	60000	2:1:3:1
25	10.11.2019	Gandhi Ghat, Barrackpore (Ganga Amantran Team NMCG, Delhi), West Bengal	IMC	40000	1:2:1:1
26	20.11.2019	Law college Ghat, Patna, Bihar	IMC	40000	2:1:1:1
27	12.12.2019	Barrackpore, West Bengal	IMC	10000	1:1:1:1

Sl No.	Date	Place	Species	No.	Species ratio (R:C:M:K)
28	26.01.2020	Gandhi Ghat, Barrackpore, West Bengal	IMC	50000	1:2:2:1
29	28.01.2020	Narayani Ashram, Prayagraj	IMC	10000	1:2:2:1
30	06.02.2020	Dashashwamedh Ghat, Prayagraj, Uttar Pradesh	IMC	10000	2:2:1:1
31	11.02.2020	Sangam, Prayagraj, Uttar Pradesh	IMC	15000	1:2:2:2
32	25.02.2020	Manaiyaghat, Prayagraj, Uttar Pradesh	IMC	20000	3:2:2:1
33	29.02.2020	Vindhyanchal, Uttar Pradesh	IMC	15000	2:1:1:1
34	05.03.2020	Assi Ghat, Varanasi, Uttar Pradesh	IMC	20000	3:1:1:2
35	17.03.2020	Barrackpore, West Bengal	IMC	20000	2:2:2:1
36	11.06.2020	Kalna, West Bengal	IMC	40000	1:2:2:1
37	12.06.2020	Nabadwip (Swarupganj Ghat), West Bengal	IMC	50000	3:2:2:1
38	13.06.2020	Tribeni, West Bengal	IMC	30000	1:2:2:1
39	15.06.2020	Balagarh, West Bengal	IMC	50000	2:1:3:1
40	16.06.2020	Barrackpore, West Bengal	IMC	50000	3:1:2:1
41	23.09.2020	Farakka, West Bengal	IMC	120000	2:1:1:1
42	24.09.2020	Sahebgunj, Jharkhand	IMC	100000	2:1:1:1
43	24.09.2020	Maharajpur, Jharkhand	IMC	100000	2:1:1:1
Total fish seed released till October 2020 (IMC*- Indian Major Carps) R=Rohu, C= Catla, M=Mrigal & K=Calbasu				>30.00 (Lakhs)	

Awareness activities

An Awareness campaign focused on sustainable fisheries and conservation, aimed at curbing destructive fishing methods, regulating mesh sizes, and implementing fishing ban period with community mobilization was carried out throughout the entire stretch of the river during the project period. Mass awareness programmes, along with fish ranching initiatives were organized to educate local fishers and stakeholders about conservation and sustainable fisheries in various depleted stretches of the Ganga River. Under this initiative, ICAR-CIFRI conducted 46 awareness programs, reaching a total of 3,890 fishers across five states: Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. The awareness campaign addressed the detrimental effects of destructive fishing methods, advocating for the prohibition of zero mesh size nets and other harmful fishing gears, as well as toxic chemicals. Fishers were advised not to catch juveniles and brooders, particularly during breeding seasons (June-August) to ensure sustainable fisheries in the River Ganga. CIFRI's efforts to restore prized fishes in the Ganga under the project have created a positive impact on local fishers. The successful implementation of the awareness programme with active participation from the fishing community, emphasized the importance of achieving sustainable development goals to enhance fish stocks in the Ganga River and boost fisheries production in the future.

Fig. 80 (A-D) Pictures of some awareness activities

Table. 12. Details of awareness programme by ICAR- CIFRI under NMCG Project (2016-2020)

S No.	Date	Place	No of fishermen participated
01	21.03.2016	Vindhyanchal, Mirzapur, Uttar Pradesh	200
02	23.05.2017	Rishikesh, Uttarakhand	50
03	22.07.2017	Balagarh, West Bengal	210
04	26.05.2017	Barrackpore, West Bengal	150
05	01.08.2017	Narayani Ashram, Prayagraj, Uttar Pradesh	70
06	03.11.2017	Balagarh, West Bengal	100
07	11.11.2017	Dasashwamedh Ghat, Varanasi, Uttar Pradesh	30
08	21.11.2017	Barrackpore, West Bengal	150
09	05.12.2017	Sringverpur, Prayagraj, Uttar Pradesh	50
10	21.01.2018	Nabadwip, West Bengal	100
11	15.03.2018	Barrackpore, West Bengal	50
12	27.03.2018	Fatehpurghat, Kausambi Prayagraj, Uttar Pradesh	60
13	05.09.2018	Barendrapara Ghat, Bally, Howrah, West Bengal	150
14	02.10.2018	Barrackpore, West Bengal	60
15	02.10.2018	Sangam, Prayagraj, Uttar Pradesh	30
16	06.11.2018	Mayapur, West Bengal	100
17	20.11.2018	Daspara Ghat, Barrackpore, West Bengal	60
18	26.11.2018	Ramyaghat, Mirzapur, Uttar Pradesh	50
19	04.12.2018	Sirsa, Prayagraj, Uttar Pradesh	50
20	05.12.2018	Karaghat, Kausambi, Uttar Pradesh	30
21	08.02.2019	Prayagraj, Uttar Pradesh	100
22	26.02.2019	Sangam, Prayagraj, Uttar Pradesh	70
23	15.03.2019	Barrackpore, West Bengal	50
24	17.03.2019	Barrackpore, West Bengal	50
25	29.03.2019	Sangam, Prayagraj, Uttar Pradesh	20
26	10.07.2019	Barrackpore, West Bengal	100
27	27.07.2019	Nawabganj Ghat, Ichapur, West Bengal	70
28	10.11.2019	Gandhi Ghat, Barrackpore (Ganga Amantran Team NMCG, Delhi), West Bengal	50
29	20.11.2019	Law college Ghat, Patna, Bihar	50

S No.	Date	Place	No of fishermen participated
30	12.12.2019	Barrackpore, West Bengal	
31	26.01.2020	Gandhi Ghat, Barrackpore, West Bengal	50
32	28.01.2020	Narayani Ashram, Prayagraj, Uttar Pradesh	100
33	06.02.2020	Dashashwamedh Ghat, Prayagraj, Uttar Pradesh	50
34	11.02.2020	Sangam, Prayagraj, Uttar Pradesh	150
35	25.02.2020	Manaiyaghat, Prayagraj, Uttar Pradesh	50
36	29.02.2020	Vindhyanchal, Uttar Pradesh	100
37	05.03.2020	Assi Ghat, Varanasi, Uttar Pradesh	150
38	17.03.2020	Barrackpore, West Bengal	200
39	11.06.2020	Kalna, West Bengal	50
40	12.06.2020	Nabadwip (Swarupganj Ghat), West Bengal	120
41	13.06.2020	Tribeni, West Bengal	70
42	15.06.2020	Balagarh, West Bengal	100
43	16.06.2020	Barrackpore, West Bengal	70
44	23.09.2020	Farakka, West Bengal	100
45	24.09.2020	Sahebgunj, Jharkhand	150
46	24.09.2020	Maharajpur, Jharkhand	70

Work duly appreciated by Indian Council of Agricultural Research and published more than 10 times on its website/News

Fig.81 Screenshots of NMCG Activities published in ICAR website

River ranching programmeme and awareness activity covered in media

Fig. 82 NMCG Activities published in Newspapers

Tagging of Fish

Objectives:

Fish tagging is a very old tool to study different scientific assessments and stock management of fishes for more than a hundred years. The purpose of the tagging is to study the migration pattern of the species, growth study, population status in a particular area and fish catch quantity etc. Important information related to the conservation of fish species and fisheries management practices can be generated by the tagging study which is equally important for scientific studies as well as livelihood development of the fishers. To re-establish the IMC population in the river Ganga through ex-situ conservation, it is very essential to study the exact situation of the fish in the river like its population status, migration pathway, breeding grounds, stock assessment, area-wise capture percentage by the fishers etc. Tagging of the fishes might be one of the best tools to collect all the vital data.

Types of tagging:

Different types of tags used for fish tagging mainly depend on the purpose of these tags. The most primitive way for tagging was fin clipping of the fish where one or two fins has been clipped for marking. The main drawback of this tagging method is that the individual fish cannot be identified during recapturing and if the fish captured after a long time the fins might be grown again and cannot be differentiated from non-tagged fishes. There are many types of the external tag is available for fish tagging like *Petersen tag, Atkins tag, Body cavity tag, T-bar anchor tag* etc.

Care during tagging:

- ***Acclimatization with river water***: As these fishes were reared in the pond, the water quality and environment are totally different from that of river. So it is important to acclimatize the fishes prior to their release in the river to avoid the stress hazard. A nylon net happa fitted in the river water was used to stock the fishes for acclimatization for two to three hours.
- ***Proper tagging procedure***: During tagging, it should be ensured that minimum stress is given to the fishes. Loss of scales, dermal injury and muscle injury may be caused due to improper tagging technique. So, tagging may be done very carefully with proper insertion of the needle, handling of fish etc by experienced person.
- ***Treatment of wounds:*** Following tagging, the fishes underwent a dip treatment using a 5 ppm solution of Potassium permanganate ($KMnO_4$) and antiseptic medicine to reduce the risk of potential secondary dermal infections.

Tagging procedure

Tagging can be applied to various areas of the fish body, such as the body cavity, interdorsal

Fig. 83. A Tagged fish being released into the river

Indian Council of Agricultural Research

(Ministry of Agriculture and Farmers Welfare)

Main menu

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ICAR-CIFRI tags Indian Major Carps under Namami Gange Programme

16th June, 2020, Barrackpore, Kolkata

The ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata tagged 100 Indian Major Carps and released in river Ganga for studying the migration behavior and movements of the fish under the *"Namami Gange"* Project today.

Fig. 83 B. Reports published in ICAR website

Fig. 84 Pistol grip tagging gun

Fig. 85 Scissor grip tagging gun

Fig. 86 Bunch of tags

muscle, and interpelvic muscle. The standard-sized Floy T-bar anchor tags, featuring printed serial numbers were specifically inserted into the dorsal muscle, positioned just below the dorsal fin. In the tagging process, the fish was securely held on a flat surface to expose the tagging area. Using a needle attached to the tagging gun, the tag was inserted under the scale and placed within the dorsal muscle at a 45˚ angle, ensuring it penetrated half an inch into the muscle, and then the gun was pressed to securely affix the tag.

Activity:

The ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata tagged 100 Indian Major Carps and released them into river Ganga for studying the migration behavior and movements of the fish under the "*Namami Gange"* Project. Dr. Basanta Kumar Das, Director, ICAR-CIFRI and Principal Investigator, ICAR-CIFRI-NMCG Project highlighted the importance of tagging process and sensitized the local fisherman about the purpose of tagging. As a part of the ranching programme, the institute initiated the tagging for monitoring and developing proper sustainable management of exploited IMC fish stock in the Ganga River system. During the process of tagging, the adult fish more than 500g of Indian Major Carp (*Labeo rohita, Labeo catla* and *Cirrhnus mrigala*) popularly known as Rohu, Catla and Mrigal were tagged and released into the river for identifying the fundamentals of the migration range. The tagged fishes were produced through the artificial breeding of native fish species of River Ganga.

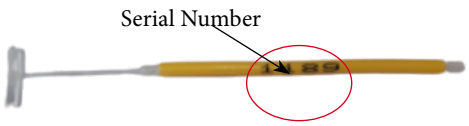


Fig. 87 Single tag showing serial number

Fig. 88 Tagging of IMC

Fish Spawn Prospecting of River Ganga

Fish Spawn Prospecting

With the day-to-day changes in the Hydrological condition and human interference by the means of various developmental and anthropogenic activities on the river Ganga, its productivity and fish catch are decreasing day-by-day (Sarita et.al, 2017). Fish Spawn collection is a popular and traditional method of fish seed collection from the river across the country. The nearby resident fishers collect fish seed from river and culture in their ponds, but advancement in the technologies resulted in the introduction of Bundh breeding and Chinese circular hatchery, which deceased the activity of spawn collection from the river. The major factor behind the decreased spawn collection rate from the river is cost-efficacy which is higher in the case of riverine spawn collection than that of other sources of spawn production. It has also been observed that the rate of fish landing in the river regularly decreased which may be due to enhanced blasting population which resulted in the increased anthropogenic activities and pollution sources in the river. River Ganga was the source of 91.67% of fish seed collection during 1964-65. Similarly, the rate of spawn production of Indian Major Carps from the river has been decreased to a greater extent as on 1956-67. It contributed around 51.21% of total fish catch from the river which decreased to 16.04% of the total fish catch during 2005-2015. So, to investigate the present situation of fish spawn availability in river Ganga, ICAR-CIFRI initiated a study on 'Qualitative and quantitative evaluation of fish spawn of river Ganga in 2018 under the '*Namami Gange'* programme.

Fig.89 Riverine spawn collection

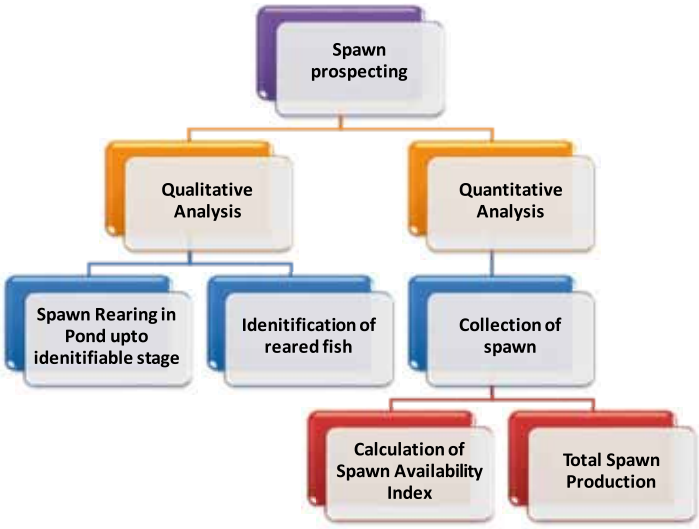


Fig. 90 The study of spawn prospecting includes the following substeps

Site Selection for Study

The primary data were collected based on the following aspects:

1. Pre-monsoon survey information from the local residents and fishers to identify the spawn collection sites.
2. The study sites of ICAR-CIFRI during 1964-65.
3. Major tributaries and their confluence points of river Ganga.

A total of 31 distinct study sites were chosen from states along the course of the mighty river, including Uttar Pradesh, Bihar, Jharkhand, and West Bengal. These study areas were further categorized into five distinct study zones: Varanasi Zone, Patna Zone, Bhagalpur Zone, Rajmahal Zone, and Farraka Zone (Refer to Table 13 and Fig 92).

Fig. 91 Data collection at spawn collction site

Table. 13 Spawn prospecting sites

S. No	District, State	Sites	GPS coordinates
1	Baliya, U.P	Bharauli Pool	25°33.763´N 83°59.021´ E
2	Baliya, U.P	KotwaNarayanpur	25°33.819´N 83°56.310´ E
3	Ghazipur, U. P	Birpur Ganga Ghat	25°31.342´N 83°51.341´ E
4	Buxar, Bihar	Ahrauli Pool	25°35.741´N 83°51.341´ E
5	Ghazipur, U.P	Jamalpur Bridge (Veer Abdul Hameed Bridge)	25°35.301´N 83°36.306´ E
6	Ghazipur, U.P	Collector Ghat	25°34.689´N 83°35.027´ E
7	Ghazipur, U.P	Mahaveer Mandir Ghat	25°33.787´N 83°33.697´ E
8	Ghazipur, U.P	Koyla Baba Ghat	25°36.672´N 83°41.998´ E
9	Patna, Danapur, Bihar	Pipa pool ghat	25°38.368´N 85°2.492´ E
10	Vaishali, Bihar	Mahnar Ghat	25°35'11.08"N 85°30'56.76"E
11	Saran, Bihar	Rasulpur Ghat	25°45'23.51"N85° 5'51.74"E
12	Patna, Bihar	Math kedar Ghat	25°37'19.46"N85°10'15.39"E
13	Patna, Bihar	Jethuli Ghat	25°32'0.88"N 85°17'16.11"E
14	Patna, Bihar	Masan Ghat	25°31'21.70"N 85°17'45.03"E
15	Patna, Bihar	Triveni Ghat	25°31'2.40"N 85°18'1.03"E

S. No	District, State	Sites	GPS coordinates
16	Patna, Bihar	Mohamadpur Ghat	25°31'2.40"N 85°18'1.03"E
17	Patna, Bihar	Nawada Gaon	25°30'14.66"N 85°43'47.11"E
18	Patna, Bihar	Railipachmala	25°30'18.99"N 85°46'2.47"E
19	Mokama, Bihar	Mokama Ghat	25°23'37.98"N 85°57'4.91"E
20	Munger, Bihar	Yaduvanshi Ghat	25°18'18.71"N86°24'5.93"E
21	Bhagalpur, Bihar	Jhangira	25°14'35.74"N 86°41'57.31"E
22	Bhagalpur, Bihar	Sultanganj Ganga Ghat	25°15'15.77"N 86°44'18.33"E
23	Katihar, Bihar	Tin gharia ghat	25°26'14.82"N 87°16'5.70"E
24	Sahibganj, Jharkhand	RajmahalGhat	25°3'15" N 87°49'11" E
25	Sahibganj, Jharkhand	Maharajpur Ghat	25°12'26" N 87°44'58" E
26	Murshidabad, WB	Farakka Ghat	24°47'51" N87°54'38" E
27	Murshidabad, WB	Lalbagh Hajar Duari Ghat	24°11'0" N 88°16'5" E
28	Murshidabad, WB	JangipurSadaipur Ghat	24°27'4" N 88°6'31" E
29	Murshidabad, WB	Lalgola Ghat	24°7'45" N88°14'58" E
30	Hooghly, WB	Guptipara Kya Ghat	23.20550° N, 88.40497 ° E
31	Bardhaman, WB	Uddharampur Ghat, Katwa	23.4043° N, 88.819° E

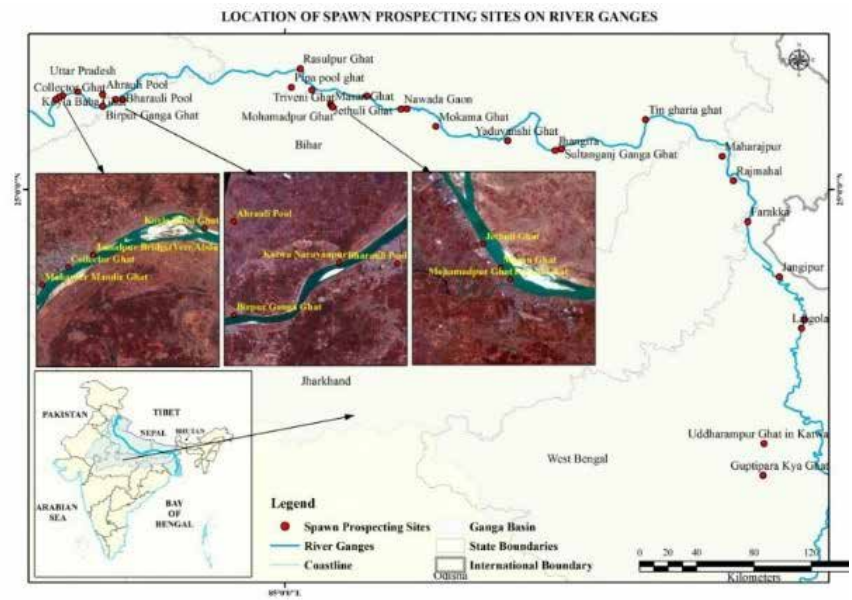
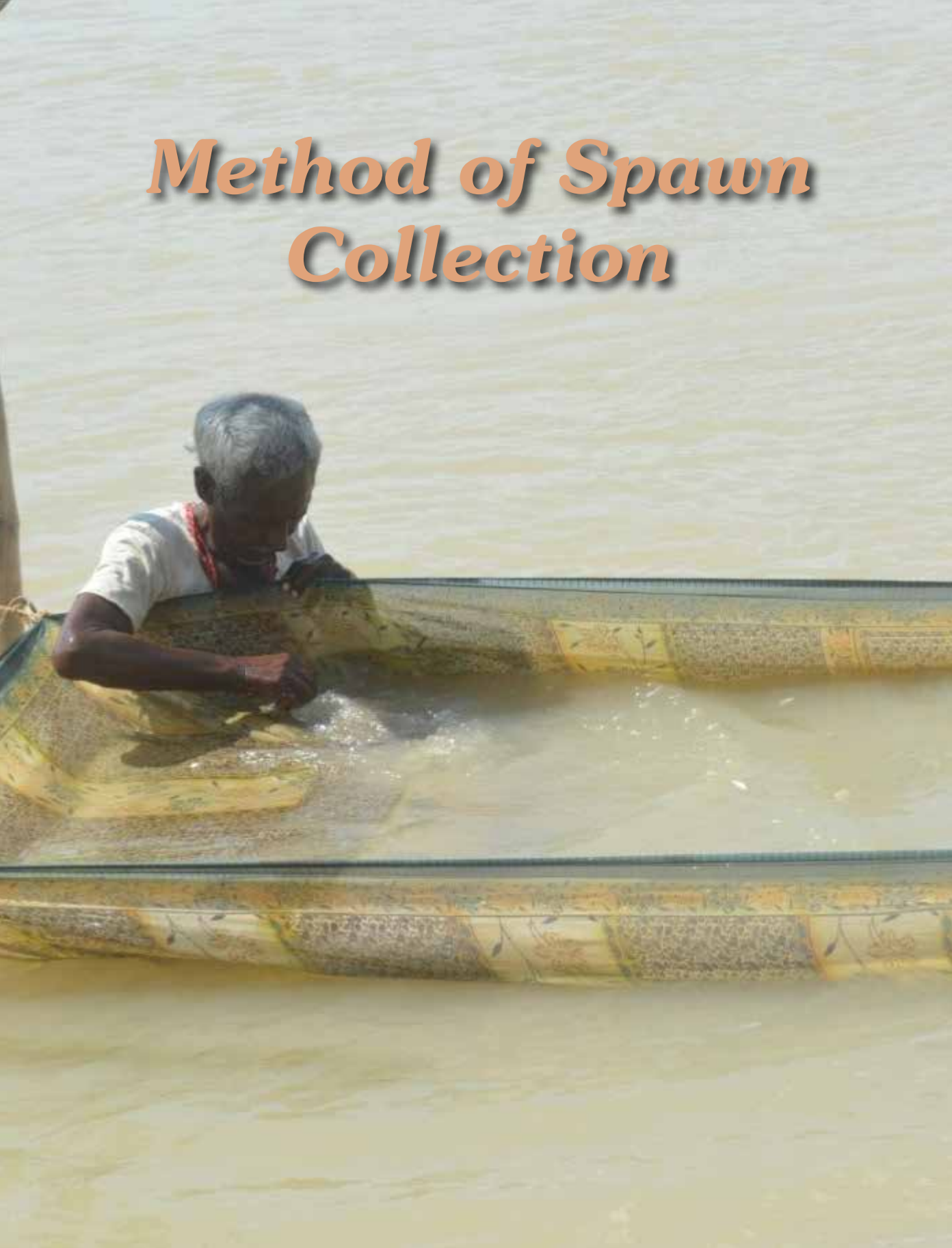


Fig. 92 GIS map of spawn prospecting sites

Method of Spawn Collection



Fish Spawn Collection Gears

A. Description of Gear

The number of net operations chiefly depends upon the amount of spawn collection which encourages the spawn collection processes i.e. the greater the number of spawns, the more will be the number of net operations. A typical bagnet commonly called as shooting net is used for collection of spawn. It is made of nylon and having common tail-cum-Happa chamber which is generally made up of cotton (gamchas) or synthetic clothes (sarees). It also act as a short-term storage chamber for spawn. The length of the net diversely varies from 280-660 cm and The width varies from 240-564 cm. The ring diameter varies from 17-24 cm. The net is operated at a depth of 2.5 to 10.2 ft. For this purpose, there are 7-9 bamboos are used during the operation of the shooting net.

Fig. 93 (A-B) Shooting net used for operation

Fig. 94 Circular ring installed at the end of net

Fig. 95 Happa-cum-collection chamber installed in shooting net

Fig. 96 Series of Shooting net in operation.

Seasons of collection and measurement of fish spawn

Though the procedure of spawn collection is only meant for operation during an extensive monsoon period (July to August), the fishers operating the nets in different locations of the river do not follow any specific date to commence. In the present investigation, the engagement of the shooting nets usually starts during the mid of July month because river water velocity gradually attains its peak during this period. The operation of net usually carried out during mid-August to September, preferably during 15th to 17th day of the month when the water level gradually gets lowered. Flood has a positive impact on spawn availability (CIFRI Bulletin 1971 & 1966). It was observed that the numbers of spawn production reach maximum when the river water appears a reddish tinge (turbid/red) in color owing to the addition of water from adjacent tributaries (Son and Ajay).

Due to its very tiny size, spawn cannot be measured by its actual number. For marketing and on-field assessment, the spawns are measured by metal or glass cups (locally termed as 'Bati'). The size of the cups varies widely and it is region-specific (45- 120 ml). However, in the present study, the counted spawn ... and it has come around 480-600 nos./

Fig. 97 (A-D) Different fish spawn measuring devices used in river Ganga during the collection period

Storage of spawn

For storage of spawn, various types of spawn collection techniques are being traditionally used.

A. Short term storage

For short-term storage, 3 types of storage techniques are being used.

I. Happa installed in the river

For short-term and initial storage of spawn, happa is being used for storage of spawn from the river in which the collected spawn is immediately placed in the happa installed in the river. It provides the optimum and favourable conditions for their maximum survival rate with the regular exchange of riverine water. But the maximum time span for their storage is 24-72 hrs. After this, the collected spawn was either bought to the local market or are taken to the culture pond for their growth. The catch usually contains mixed catch of all the fish species which breed during the season.

II. Storage in earthen pit

For short-term storage of spawn apart from happa, the technique used is earthen pit storage. The pits are made on the banks of the river and spawn collection site with the depth of 2-3 ft in which water from the river is filled and collected spawn from the shooting net is transferred. It is further taken to the rearing pond. The most probable reason behind the storage is temperature regulation as the earthen base provides the adequate temperature and favourable condition to the stored spawn samples with the slow collection rate. It encourages the fishers to the collection of spawn for consecutive days. The spawn samples were kept in the earthen pit.

Fig. 98 Happa storage of Spawn

Fig.99 Spawn stored in earthen pit

III. Storage in earthen utensils

Storage is done in earthen utensils in which the earthen pots were kept in the banks of the river and river water is filled in the earthen utensils which helps in temperature regulation and short-term storage of spawn i.e. generally for 24 to 72 hrs.

Fig. 100 (A-B) Earthen Utensils used for storage of spawn samples

Spawn Transportation

The spawns, initially collected from the river, were stored along the riverbanks. However, for cultivation purposes, the spawns were transported to various locations as required. Different transportation methods were employed to transfer the spawns from the river to nursery ponds. These methods included open tank transportation, polythene bags filled with oxygen, and aluminum containers (selected based on the distance). In certain situation, a specialized mixture of red soil and Ganga river water was utilized during transportation to enhance the solubility of the spawn.

A. Long transportation

For Long-distance transportation. the motorized vehicles are used with spawn samples filled in oxygen packets.

Fig. 101 Packed Seed transportation to the bank of the river

Fig. 102 Packing of oxygenated packets of Spawn

Fig. 103 Long Distance transportation of spawn in the truck

B. Short Transportation

For short-distance transportation, spawn samples are transported by motorized and non-motorized movable vans. For transportation of spawn, riverine water was used to increase the rate of survivability.

Fig. 104 (A-C) Short distance open transportation of spawn

Rearing of spawn:

The collected spawn samples from different study sites were reared at different sites for further qualitative analysis of the spawn.:

1. Cemented tanks at ICAR-CIFRI, Barrackpore.
2. FRP tanks at different study sites of ICAR-CIFRI.
3. Pond facilities of local fish farmers.

Preparation of pond for spawn rearing

Prior to stocking the collected riverine spawn, the nursery rearing ponds were prepared. The pond preparation process was initiated 60 days before stocking. The pond preparation procedure followed as per the standard nursery rearing protocol.

Fig. 105 Rearing of spawn at CIFRI fry rearing unit

Fig. 106 Rearing of fish spawn in the pond

Fig. 107 Rearing of spawn in Cemented Tank

Fig. 108 Rearing of fish spawn in FRP tanks

Feeding of spawn

As the food and feeding habit of the collected riverine spawns were not known. So, the different types of feed. i.e. Glucose powder, Mixture of milk and egg yolk, Infusoria and mixed plankton were used for the rearing of riverine spawns and were fed up to their satiation level.

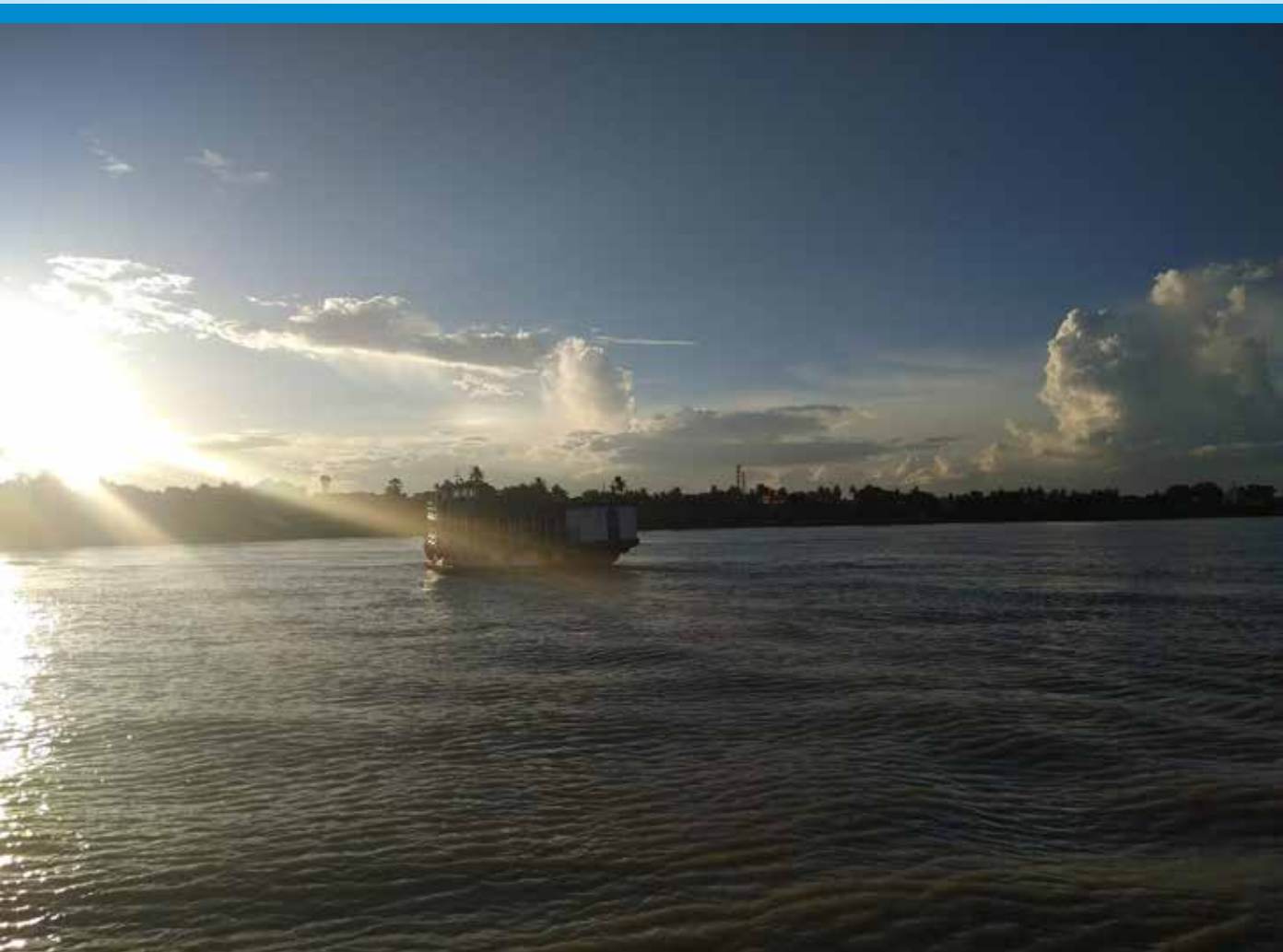
Fig. 109 Commercial powdered feed

Fig. 110 Culture of *Artemia naupli*

Fig. 111 Milk powder and egg yolk mixture

Fig. 112 Tubifex

Fish Seed Production



Fish seed production in river Ganga

Previous reports on fish spawn availability from the river have indicated decreasing trend (10%) of wild IMC spawn in the period 2005-2009 in per cent contribution compared to other fish stocks (90 %), (Das et al., 2013). On the other hand, a considerable decline in fish seed availability has also been noticed from 78.82 % (1960's) to 34.48% (2004) (Vass et.al, 2009). The number of fish spawn (approx.) varies greatly depending upon the time of commencement of the monsoon. Generally, the entire Ganga river basin receives heavy rainfall (80%) during the period from June to September with an average of 1200 mm (Nandargi et. al 2018). However, recent studies have indicated a decrease of rainfall by 56 % over 133 districts along the entire Ganga basin largely due to climate change (Bera, 2017). As a result, the river experiences several floods during the collection period i.e. extending over a period of 30 days. The bulk appearance of the spawn is observed only during the first two floods during the peak season, while the remaining yield only traces of spawn. The collection reaches up to 10 bati /day/ net from 4 bati /day/ net.

Identification of fish species

At the preliminary level spawns were identified with the help of a microscope. After rearing, the samples were identified with the help of various taxonomical keys such as Talwar and Jhingran, 1991 and websites such as Fishbase.org.

Quantitative and Qualitative Evaluation of fish spawn

The current survey encompassed both qualitative and quantitative assessments of fish seed production from the river. The average production of fish spawn was estimated at 21 ml (equivalent to 435 million) along the middle and lower stretches of the River Ganga. Qualitative investigations conducted in the lower stretch of the river, specifically Farakka, Lalgola, and Guptipara in West Bengal, revealed a total of 46 fish species belonging to 36 genera, 19 families, and 8 orders during the 2018-19 period. Species identification was based on representative samples from three different locations in the river (Table 13). Guptipara exhibited the highest availability of fish species (0.38%), followed by Farakka (0.36%) and Lalgola (0.25%), respectively.

Economically significant catfishes contributed only 4.33%, indicating a lower abundance of these species during the sampling period. In the reared fish samples, Indian Major Carps accounted for only 30% of the total, and among the cyprinids, the contribution of Indian Major Carps was merely 43%.

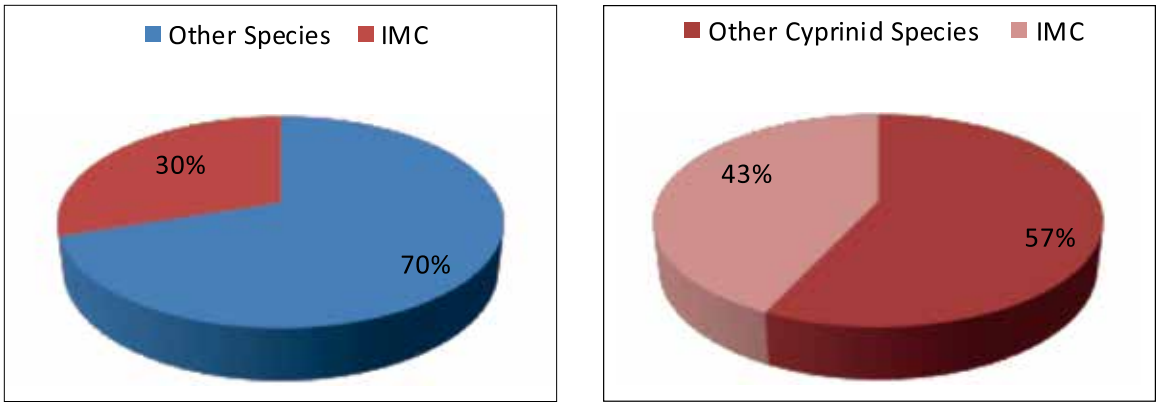


Fig. 113 (A-B) Percentage contribution of Indian Major carps among the different reared spawn samples.

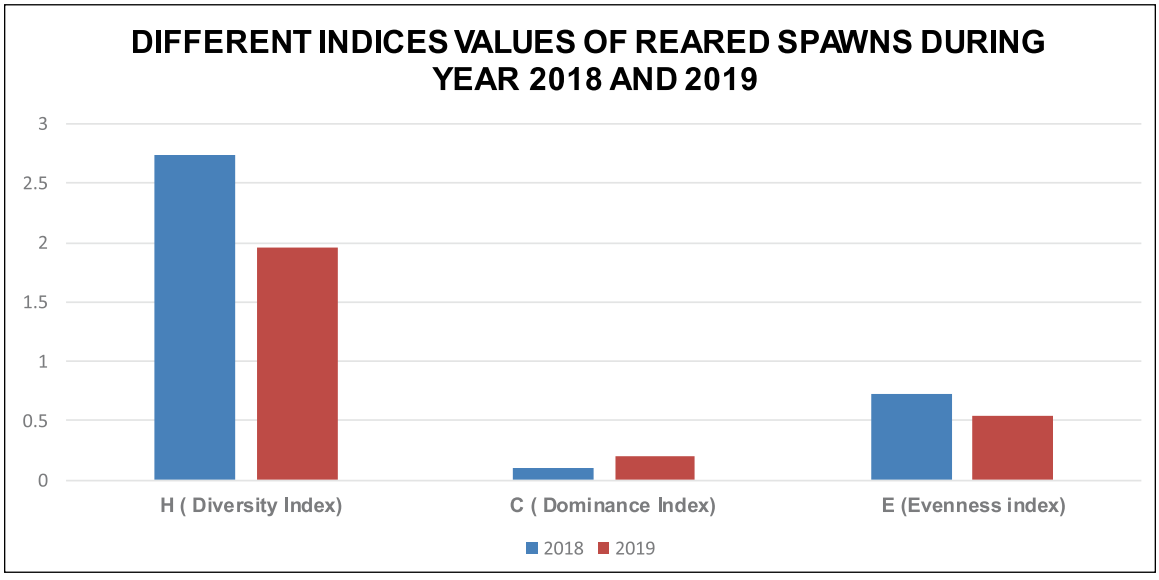


Fig. 114 A Different indices values of reared spawn

Cluster analysis of spawn prospecting sites

Bray-curtis Cluster analysis was performed to know the hierarchical similarity between the different spawn production sampling stations (Fig. 115). The hierarchical dendrogram with Cophencorr value of 0.92 shows that Rajmahal and Varanasi show a similar pattern of spawn production with 96 % of similarity. While Patna and Farraka show a similar pattern with a similarity of 98 %. Among all the stations, the Bhagalpur shows a different pattern of spawn.

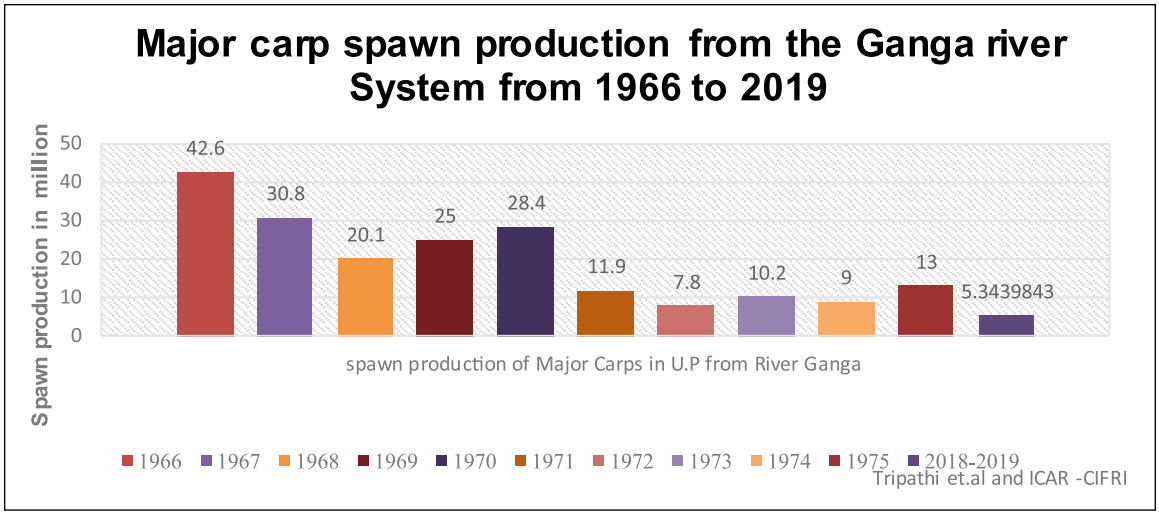


Fig. 114 B IMC spawn production from river Ganga

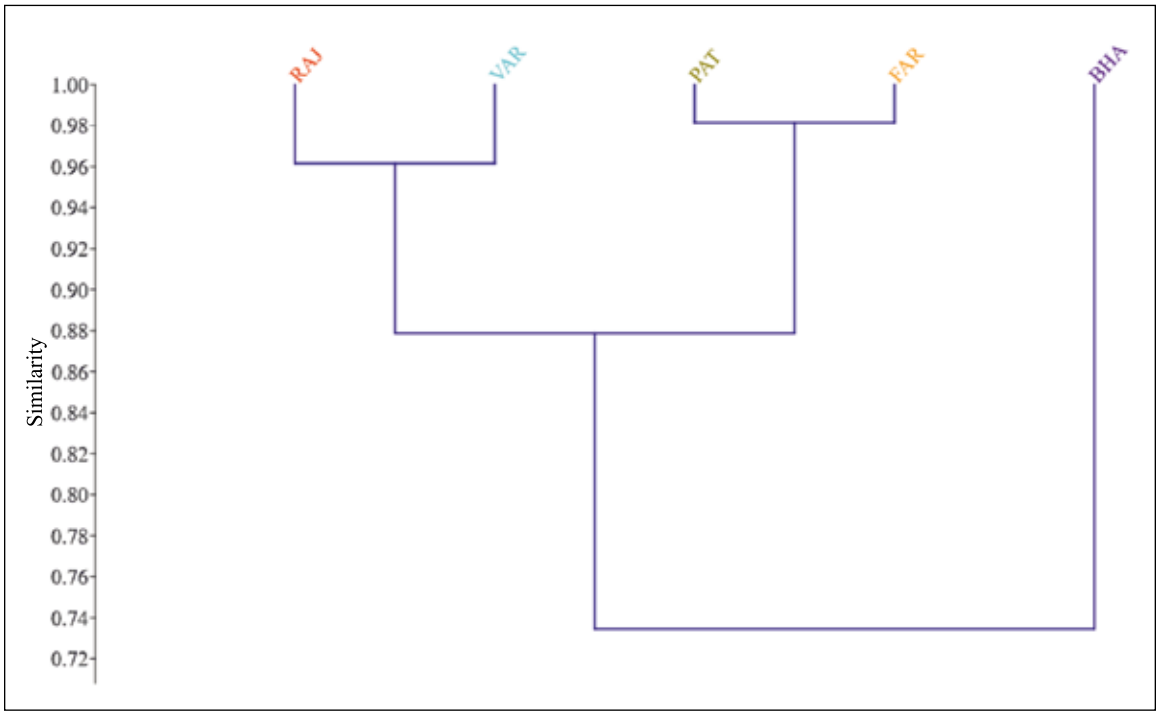


Fig.115. Cluster analysis of different spawn prospecting sites of river Ganga

Table. 14 Species abundance in three different sampling sites

S. No.	Species	Family	Farakka	Lalgola	Guptipara
1.	*Amblypharyngodon mola* (Hamilton, 1822)	Cyprinidae	-	-	+
2.	*Aplocheilus pancax* (Hamilton, 1822)	Cyprinidae	-	-	+
3.	*Bagarius bagarius* (Hamilton, 1822)	Sisoridae	+	-	-
4.	*Batasio batasio* (Hamilton, 1822)	Bagridae	-	-	+
5.	*Chanda nama* (Hamilton, 1822)	Ambassidae	+	+	-
6.	*Channa punctata* (Bloch, 1793)	Channidae	-	-	+
7.	*Channa striata* (Bloch, 1793)	Channidae	-	-	+
8.	*Chitala chitala* (Hamilton, 1822)	Notopteridae	+	+	+
9.	*Cirrhinus mrigala* (Hamilton, 1822)	Cyprinidae	+	+	+
10.	*Cirrhinus reba* (Hamilton, 1822)	Cyprinidae	+	+	+
11.	*Crossochielus latius* (Hamilton, 1822)	Cyprinidae	+	+	+
12.	*Rasbora daniconius* (Hamilton, 1822)	Cyprinidae	+	-	+
13.	*Danio devario* (Hamilton, 1822)	Cyprinidae	-	-	+
14.	*Danio rerio* (Hamilton, 1822)	Cyprinidae	-	-	+
15.	*Eutropiichthys vacha* (Hamilton, 1822)	Schilbidae	+	+	-
16.	*Labeo catla* (Hamilton, 1822)	Cyprinidae	+	+	+
17.	*Glossogobius giuris* (Hamilton, 1822)	Gobiidae	+	+	-
18.	*Gudusia chapra* (Hamilton, 1822)	Clupeidae	+	-	-
19.	*Heteropneustes fossilis* (Bloch, 1794)	Heteropneustidae	-	-	+
20.	*Labeo bata* (Hamilton, 1822)	Cyprinidae	+	+	+
21.	*Labeo calbasu* (Hamilton, 1822)	Cyprinidae	+	+	+
22.	*Labeo rohita* (Hamilton, 1822)	Cyprinidae	+	+	+
23.	*Leiodon cutcutia* (Hamilton, 1822)	Tetraodontidae	+	-	-
24.	*Macrognathus aral* (Bloch & Schneider, 1801)	Mastacembelidae	+	-	-
25.	*Macrognathus pancalus* (Hamilton, 1822)	Mastacembelidae	+	+	-
26.	*Mastacembelus armatus* (Hamilton, 1822)	Mastacembelidae	+	+	+
27.	*Mystus bleekeri* (Day, 1877)	Bagridae	-	-	+
28.	*Mystus cavasius* (Hamilton, 1822)	Bagridae	+	-	+
29.	*Mystus tengra* (Hamilton, 1822)	Bagridae	-	-	+
30.	*Notopterus notopterus* (Pallas, 1769)	Notopteridae	-	-	+

S. No.	Species	Family	Farakka	Lalgola	Guptipara
31.	*Pachypterus atherinoides* (Bloch, 1794)	Schilbidae	+	+	+
32.	*Parambassis baculis* (Hamilton, 1822)	Ambassidae	+	-	-
33.	*Pisodonophis boro* (Hamilton, 1822)	Ophichthidae	-	-	+
34.	*Pethia conchonius* (Hamilton, 1822)	Cyprinidae	+	+	+
35.	*Pethia ticto* (Hamilton, 1822)	Cyprinidae	+	+	+
36.	*Puntius sophore* (Hamilton, 1822)	Cyprinidae	+	+	+
37.	*Rhinomugil corsula* (Hamilton, 1822)	Mugilidae	+	-	-
38.	*Salmostoma baciala* (Hamilton, 1822)	Cyprinidae	+	-	+
39.	*Salmostoma phulo* (Hamilton, 1822)	Cyprinidae	-	-	+
40.	*Sperata aor* (Hamilton, 1822)	Bagridae	-	-	+
41.	*Systomus sarana* (Hamilton, 1822)	Cyprinidae	+	-	+
42.	*Trichogaster fasciata* (Bloch & Schneider, 1801)	Osphronemidae	-	-	+
43.	*Trichogaster lalius* (Hamilton, 1822)	Osphronemidae	-	-	+
44.	*Wallago attu* (Bloch & Schneider, 1801)	Siluridae	-	-	+
45.	*Xenentodon cancila* (Hamilton, 1822)	Belonidae	+	+	+
46.	*Hyporhamphus limbatus* (Valenciennes, 1847)	Belonidae	+	-	-

Major threats for the Ganga spawn production:

The major obstructive and responsible factor for the Ganga fisheries are:-

1. Construction of Dam, Barrages and hydropower projects

Construction of dams, barrages and hydropower projects leads to hindrance in the riverine flow which causes a reduction in the riverine spawn production of native fishes of the river for which the riverine flow is an important factor for their breeding and migration.

2. Changing pattern of rainfall and increase in temperature

With the increasing impact of global warming, the average temperature of the environment is getting raised day by day leads to an obstructive breeding pattern of the native fish fauna and the most important factor responsible for the breeding is rainfall which is getting delayed day by day with its effect.

3. Fragmentation of hydrological connectivity between rivers and wetlands

Wetlands are considered as kidneys of the riverine system which play a vital role in the rejuvenation of the riverine system. But day-by-day the hydrological connectivity of the river is getting lost with the river due to various issues.

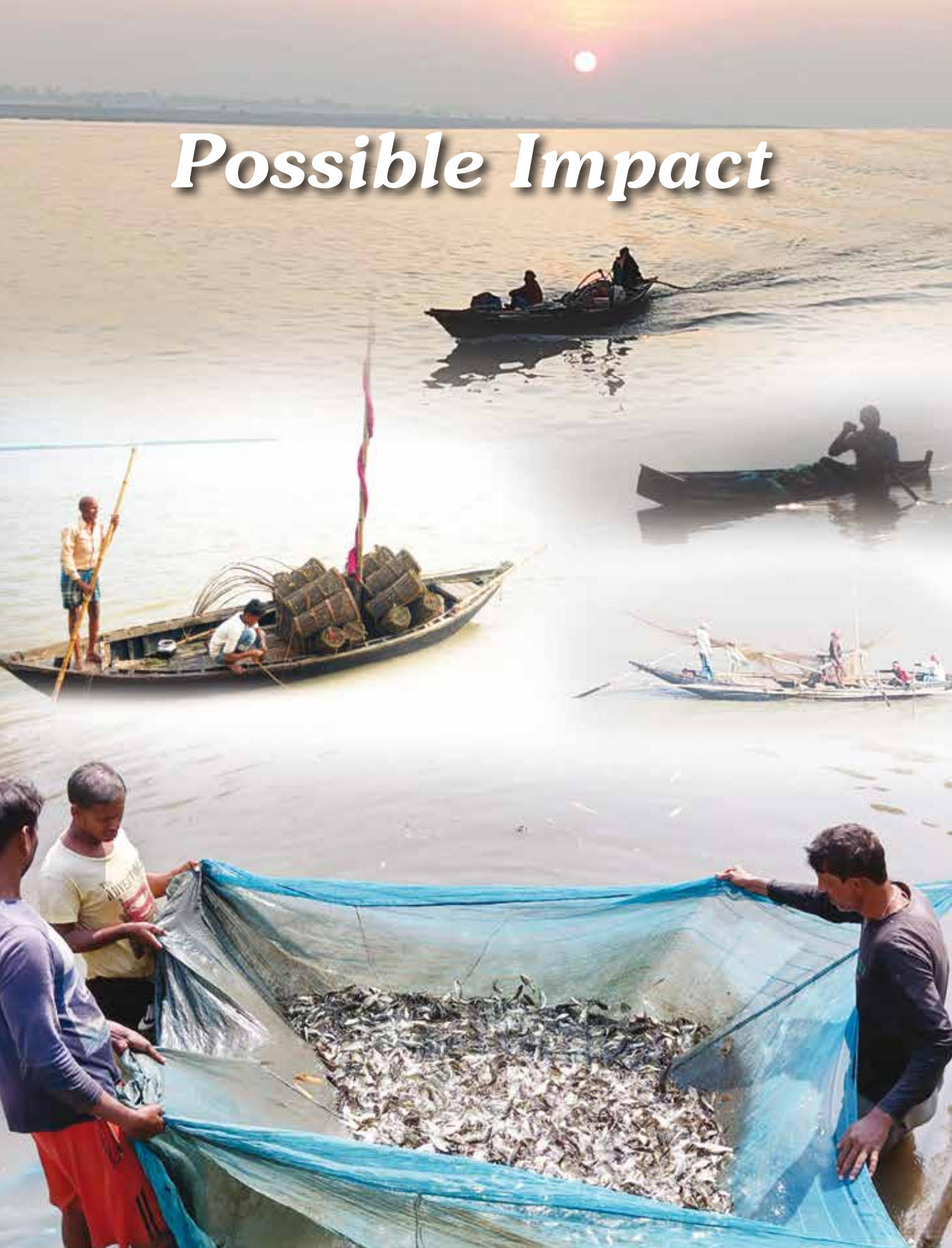
4. Riverfront encroachment

With the increasing population, the need for land is also increasing which is being encroached by the humans, leading to unfavorable environment for the fishes.

5. Increasing pollution level

With the advancement in the society, the process of industrialization is getting increased day-by-day, and waste from the major industries are carried to the river system which leads to the enhanced pollution level in the river.

Possible Impact



Possible impact on conservation

- **Conservation:**

As IMC in river Ganga is gradually declining due to environmental changes and increased anthropogenic pressure, these species are required to be conserved for maintaining the biodiversity and minimize the threats to the fishes. The ex-situ conservation through river ranching can be used to increase the fish stock. The fishes are captively breeding after collection from the river and ranched to their natural habitat. It can grow and breed in wild and the fish stock definitely rise.

- **Population enhancement:**

To restore the IMC population in different depleted stretches of river Ganga, ranching is used as an effective tool. The artificial recruitment of the fishes helps to increase the population in the river ecosystem. The released fishes will be bred in the wild and definitely increase the population of the species in the river.

- **Re-establishment of breeding population of IMC:**

The fishes are released in different depleted stretches of river and here the enhanced population of the fishes can be re-establish the breeding. If the fishes complete at least one breeding cycle in the river it will certainly produce a huge number of offsprings and by this, the conservation process of the species must be accelerate.

- **Migration pathway:**

Through the fish tagging programme the migration pathways of the fishes can be identified. The recapturing of the fishes gives the data of the migration pattern of the fishes. Not only that, the growth pattern, feeding habit, physiological development of the fishes can be known by the tagging.

- **Improvement in IMC catch and livelihood of fishers**

The lowered IMC catch in river Ganga can be increased by ranching of the fishes and the fish catch may also be higher. The increased fish catch means extra income generation for the fishers and this may help to get a better livelihood for the fishers.

- **Revival of river health:**

The increased fish population in the river can help to develop the water quality better. The fishes use the nutrients available in the river ecosystem and the lower nutrient availability can lower the algal growth which may be cause eutrophication of the river if the algal bloom occurred.

Conclusion

The Ganges River stands as the largest river in India and the fifth-longest globally, flowing through both India and Bangladesh as a transboundary river in Asia. The health of a river ecosystem is often gauged by its rich biodiversity, and the Ganga river system exemplifies this with support for over 25,000 flora and fauna species. Threats to the biodiversity of the Ganges can be categorized into five interconnected groups: over-exploitation, water pollution, flow modification, habitat destruction or degradation, and invasion by exotic species. Global environmental changes further compound these threats.

To identify the depleted river stretches, primarily a catch estimation survey along with the spawn prospecting study was conducted by ICAR-CIFRI throughout the river to assess the present scenario of the Ganga fisheries, and ex-situ conservation programme was started afterward.

The ICAR-Central Inland Fisheries Research Institute (CIFRI) in Barrackpore has partnered with the National Mission for Clean Ganga (NMCG) to carry out ex-situ conservation efforts for Indian Major Carps (IMC) such as Catla, Rohu, Mrigal, and Calbasu in stretches of the Ganga River facing depletion. To pinpoint these depleted areas, ICAR-CIFRI conducted a comprehensive catch estimation survey and spawn prospecting study along the entire river, assessing the current state of Ganga fisheries. Subsequently, an ex-situ conservation programme was initiated.

Wild brooders of IMC are sourced from the Ganga and bred in captivity in ponds located in Balagarh, West Bengal. Through artificial breeding, IMC seeds are generated, and the resulting fingerlings are nurtured in nursery ponds. These fingerlings are then released into the Ganga River through ranching programmes, with the goal of replenishing the dwindling fish stocks. These initiatives also serve to create awareness among fishermen about the importance of sustainable fish stock conservation.

Over the period of 2017 to 2020, ICAR-CIFRI has successfully executed 43 ranching programmes, releasing more than 30 lakhs of IMC fingerlings into the depleted stretches of the Ganga River. This concerted effort has significantly contributed to the restoration of prized fish species in the river.

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CIFRI
ICAR
ICAR-CIFRI Activity under NMCG Project