वार्षिक प्रतिवेदन

Annual Report

2017-18

ICAR- Central Inland Fisheries Research Institute

(Indian Council of Agricultural Research)

Barrackpore- 700120, Kolkata, West Bengal

भाकृअनुप
ICAR

ANNUAL REPORT 2017-18

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Preface

Inland open water fishery sector occupies a unique status in the national economy and provides livelihood opportunities, food and nutritional security and massive ecosystem services to the growing population in the country. India is blessed with vast inland open water resources in terms of 45,000 km of rivers, 0.3 million ha of estuaries, 0.19 million ha of backwaters and lagoons, 3.51 million ha of reservoirs, 0.354 million ha of floodplain wetlands and 0.72 million ha of upland lakes.The estimated demand of fish by 2025 in the Indian domestic market would be around 16 million tonnes (MT) against the present production of 11.41MT coming from inland (65%) and marine (35%) sectors. These resources provide employment and livelihood support to 1.24 million inland fishers including the landless. In this scenario, the projected second blue revolution of the country demands fish production from inland open water bodies as a promising option for providing high quality protein food, livelihood to the rural populace and doubling the fisher's income. However, over-exploitation of natural fish stocks, ecosystem degradation, man-made modifications for water diversion, pollution, etc., are the major threats for these aquatic resources. Further, in the event of mounting anthropogenic pressure and perceptible climatic changes, it becomes emergent to protect these resources for sustained fisheries and harness their untapped production potentials. In this backdrop, ICAR-CIFRI has considerably accomplished significant scientific and technological milestones towards generating current knowledge base through interdisciplinary research for enabling sustainability of their ecosystem services and fisheries.

The Institute executed a number of programmes and activities resulting in significant scientific and technical achievements in the year 2017-18. The commercialization of ICAR-CIFRI Model HDPE Pen and CIFRI-CAGEGROW Feed was a great success. The pathogenic Tilapia Lake virus (TiLV) was reported by the Institute for the first time in India and the TiLVrapid Diagnostic Kit was developed. Further, The CIFLIN Kit was developed for detection of formalin in fish. The design of CIFRI-GI Cage and low cost Tissue Embedding Machine was registered in Indian Patent Office. The Institute successfully implemented and considerably extended cage culture programme in the reservoirs for production of table size fish and provided technical advisory to the different state fisheries departments. The Institute will be continuing its efforts to expand enclosure culture technology alongwith species diversification at national level for increasing the productivity. The Institute is involved in various research projects for studying the impact of multiple habitat alterations on fisheries and ecology of river Ganges, Sundarbans and other open water resources; eflow estimation for a number of rivers; climate resilient pens installed and demonstrated in four floodplain wetlands covering Assam, West Bengal and Kerala towards adaptive capacity of the fisheries against climate driven changes; impact of CIFRI technologies; ecosystem modelling; nutrient profiling of fishes; disease surveillance; fish genetic stock characterization; identification of novel genes and bacteria; pollution benchmarking, metagenomics for ecosystem health assessment, herbal extracts, nanoproducts and prebiotics for fish health management and studies on immune genes pathways of Black carp (*Mylopharyngodon piceus*) etc.

New projects have been initiated by the Institute to study the ecological status, habitat fingerprinting and fisheries biodiversity of four rivers *viz.*Cauvery, Tapti, Siang and Chalier. New initiatives have also been taken to develop fisheries in four wetlands of East Champaran of Bihar and to study ecology and fish biodiversity in five wetlands of West Bengal, Assam and Uttar Pradesh, reservoir fisheries. The Institute provided advisory to Telangana and other states on cage culture with installation of more than 100 cages. Projects on Anti Microbial Resistance (AMR), ornamental fisheries, small scale fisheries (in collaboration with Worldfish under Window-3 program) have also been taken up by the Institute. During the year, the Institute conducted about 40 training programmes, benefitting more than 1000 farmers and other stakeholders from various states. The Institute

organized a number of international workshops - Culture based fisheries, Fish immunology, Bioinformatics and FAO workshop on Fish pass; important meetings and consultations of national and regional significance. Our massive drive on *Swachh Bharat Abhiyaan* and coverage under *Mera Gaon Mera Gaurav* received wide appreciation.

Recently concluded project on hilsa revealed that, the catch of hilsa is declining with drastic inter annual fluctuation, especially along the Hooghly inshore and near shore waters and showed increasing proportion of marine catch, while catch from inland areas drastically declined. Catch from Narmada, Tapti and Ukai are also progressively declining and are at all-time low. The Institute has executed activities under Tribal Sub Plan, North Eastern Hill Region components, benefitting tribal fisher community through canal fisheries development, integrated farming, distribution of inputs for fish culture, fishing implements, pen culture and wetland fisheries development in North Eastern States. The staff of the Institute attended a number of capacity building programmes, overseas trainings, workshops, brain storming sessions, international and national seminars, symposia and meetings, etc.

I am confident that our hard work and commitment to research programmes will continue to provide significant outputs and decision making tools for making effective strategies for sustainable management of the vast inland open water resources.

I have the privilege of acknowledging the constant support and guidance received from Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR. I am also grateful to Dr. J. K. Jena, Deputy Director General (Fisheries Science), Dr. S. Raizada, Assistant Director General (Inland Fisheries), Dr. Pravin Puthra, Assistant Director General (Marine Fisheries) and other staff members of the Fisheries Division of ICAR for their cooperation and help in our endeavours. All activities furnished in this report have been carried out by the scientists and other staff members of the Institute. I put on record my profound thanks and gratitude to all of them. I also take this opportunity to thank all the members of Editorial Team for their sincere efforts, dedication and commitment in timely publication of the Annual Report.

Barrackpore
Dated : 20 June, 2018

(B. K. Das)
Director

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Executive Summary

ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI) is a premier research institute which has developed state of the art research infrastructure, facilities and expertise in several areas of inland fisheries including reservoir and wetland ecology and fisheries, riverine and estuarine fisheries, aquatic environmental management, ecosystem and fish health, climate resilient inland fisheries, resource assessment modelling and fisheries socioeconomics. The Institute has accomplished significant scientific and technological progress towards generating current knowledge base for ensuring sustainability of inland open water ecology, biodiversity and fisheries.

At present, the Institute has 86 scientists, 50 technical staff, 36 administrative and 44 supporting personnel posted at Head Quarters Barrackpore and Regional Centres/Stations. During the year 2017-18, the Institute executed 15 research projects through Riverine Ecology and Fisheries, Reservoir and Wetlands Fisheries, Fisheries Resource and Environmental Management Divisions and Fisheries Socio-Economics Section. Besides those, 3 outreach activities, a number of externally funded research and consultancy projects, training and extension programmes were also executed successfully. The major activities and achievements in 2017-18 are summarized below:

Riverine and Estuarine Fisheries

During 2017-18, the habitat characterization, fisheries and socioeconomics of four important rivers of India *viz.* Cauvery, Tapti, Siang and Chaliyar were carried out. A total of 86 fish species belonging to 32 families were recorded from the River Cauvery; the highest diversity (35 species) was recorded at Shivanasamudram owing to the high habitat heterogeneity (falls, rapids, runs, riffles and pools). The shellfish species recorded from the river were *Penaeus monodon*, *P. indicus* and *Litopenaeus vannamei*. The occurrence of *L. vannamei* is recorded for the first time from the wild in India.

In the river Tapti, a total of 51 finfish species belonging to 34 genera and 15 families were recorded. All along the studied stretch highest species richness was found for the family Cyprinidae (24 species), followed by Bagridae (5 species), Channidae (4) and Nemacheilidae (3). Fish species richness was higher in Bhusawal (24 species), Nepanagar (23 species) and Burhanpur (23 species), and low in lower stretches of the river *viz.* at Sarangkheda and Kamrej (9 species at each site). *Macrobrachium tiwari* was most abundant (36%) during monsoon, followed by *M. kistnense* (30%), *Caridina* sp. (19%) and *M. lamarei lamarei* (15%) in river Tapti.

In River Siang, a total of 31 finfish species under 8 families were recorded during the study and cyprinidae was the most dominant family forming more than 70% of total individuals sampled. In River Chaliyar, a total of 66 species belonging to 32 families were recorded during the survey period. The highest fish diversity (47 species) was recorded at the estuarine station Feroke (Kozhikode District) with dominance of marine migrant fish species. Lowest diversity (3 species) was observed at the hillstream station Arappeta (Wyanad District).

Canal resources of Punjab and Sunderbans were explored for fisheries development. Fishes recorded in Srihind canal of Punjab were *Xenentodon cancilla*, *Mastacembelus armatus*, *Macrognathus puncalas*, *Channa marulius*, *Puntius* sp., *Badis badis* and small prawn and crab (*Sertoriana* sp.) where small prawn dominated the total catch. In Bishalakahi canal of Sundarbans 28 fish species were recorded during monsoon which belonged to 6 orders, 8 families and 9 species. Analysis of catch structure revealed dominance of members of family Cyprinidae (88%), followed by Polynemidae (5.75%), Ambassidae, Channidae (5.1% each), Mugilidae (4.3%) and Bagridae (2.7%). Small indigenous fishes (SIFs) were found to be the major component of fish catch in Bishalakhi canal contributing 76% of the total catch. Similarly, during monsoon a total of 345 specimens were collected from Bhetkimari canal of Sundarban which belonged to 5 orders, 5 families and 7 species. A total of 16 finfish species under 9 families were recorded. Five species (3 penaeid and 2 non penaeid spp.) of prawns were recorded contributing 10% of the total catch.

Environmental flow in Rivers Kathajodi, Siang and selected tributary of Ganga were investigated. A drastic reduction in flow from monsoon to lean season was observed in Kathajodi. During monsoon, the discharge was 160,000 cusec and fish diversity was dominated by *Gonialosa manmina* and *Labeo bata*, while, lean season discharge was only 5,000 cusec and the dominating fish species was *Puntius* sp. A total of 72 fish species belonging to 27 families were recorded from the river. About 60 % of the recorded fish diversity was represented by 7 families, *viz*., Cyprinidae (16 species), Clupeidae (6 species), Mugilidae (5 species), Engraulidae (4 species), Bagridae (4 species), Schilbeidae (4 species) and Ambassidae (4 species). The highest fish diversity (36 species) was recorded at Nuagarh (towards the estuarine mouth) with dominance of marine migrants. The fish catch at Naraj during monsoon was dominated by the gizzard shad, *Gonialosa manmina* (28%), followed by *Labeo bata* (18%) and *Cirrhinus reba* (10%). A total of 30 finfish species belonging to 8 families was recorded from River Siang. Family-wise, Cyprinidae was the most dominant comprising 70% of the total species recorded, followed by Ambassidae (6.66%) and Schilbeidae (6.66%). Station-wise, maximum number of species was recorded from Oiramghat (15 species) followed by Pasighat (13 species). A total of 12 species were recorded from Komsing, 1 species from Boleng, 5 species from Yingkiong and 2 species from Puging sampling station. Three migratory species, namely, *Schizothorax richardsonii*, *Bangana dero* and *Labeo dyocheilus* were recorded.

Impact of major tributaries and wetlands on biodiversity and ecological function of River Ganga was studied. A good number of fish species were recorded at different sites during the study *viz. at* Bhilangna confluence (*Tor putitora* and *Schizothorax richardsonii);* Nayar Confluenc (*T. putitora)*; Heval confluence (*T. putitora, S. richardsonii* and *Sperata aor*); Ghaghra confluence (*Channa marulius, C. striata, Puntius sophore, Mystus vittatus* etc.) and Karmanasha confluence (*Wallago attu*, *Labeo rohita, Catla catla* and *Clarias batrachus* etc.).

Reservoir Ecology and Fisheries

Fisheries resource assessment and refinement of enhancement protocol through participatory mode in selected reservoirs of India was carried out. The detailed study is being carried out in seven reservoirs belonging to six states for generating spatio-temporal data on 30 habitat parameters, biotic communities, fish diversity, assemblage, stocking details and fish production etc.

Habitat characteristics studies of Patratu reservoir, Jharkhand and Derjang reservoir, Odisha assessed both the reservoirs to be medium productive with most of the water quality parameters showing significant difference ($p<0.05$) between monsoon and winter season. Preliminary assessment of trophic state index values indicated oligotrophic state of the reservoirs. During the study period, the gross primary productivity varied from 300-875 $mgCm^{-3}day^{-1}$ in Patratu to 1750-2000 $mgCm^{-3}day^{-1}$ in Derjang reservoir. Based on net primary productivity (plankton based) the fish production potential was estimated to be 240 $kgha^{-1}yr^{-1}$and 1053 $kgha^{-1}yr^{-1}$ in Patratu and Derjang reservoirs respectively. The fish catch in Patratu reservoir was dominated by Indian Major Carps (IMC) (56%) with *L. rohita* as dominant species followed by *Oreochromis niloticus* (16%), other carps (7%), small indigenous fishes (3%), catfishes (2%) and miscellaneous fishes (16%). In Derjang, IMC contributed about 80% of the catch. Fish yield was estimated at 100 and 200 $kgha^{-1}yr^{-1}$ for Patratu and Derjang reservoirs respectively. In Derjang reservoir, average catch per day during winter (910kg) was comparatively higher than monsoon (342kg). The CPUE was comparatively higher during winter as compared to monsoon.

Surveys were carried out in Harangi and Kabini reservoirs in Karnataka, Mettur reservoir, Bhavanisagar and Krishnagiri reservoirs in Tamil Nadu and Nagarjunasagar reservoir in Telangana for assessment of status of ecology and fisheries. In Nagarjunasagar 28% of the catch was composed of *Salmophasia* sp. while *P. sophore* contributed around 58% of the catch in Bhavanisagar reservoir. In Harangi reservoir, *Amblypharyngodon mola* (53%) dominated while in Krishnagiri and Mettur reservoirs *Puntius vittatus* (26%) and *Pethia conchionius* (34%) dominated the catch. In Harangi *Ompak pabo* was common in all sites. *Salmostoma bacaila, S. sardinella, T. puttitora, T. khudree* were abundant in lentic zones, while *Macrognathus aral* and *Barilius gatensis* were common in lotic sites. In Krishnagiri, species abundance was common in all zones owing to smaller size. Carps abundance was higher in intermediate sites. In Nagarjunasagar, *Labeo calbasu* was abundant in lotic sites.

Collection of fish catch data from Mettur, Krishnagiri, Patratu and Tunga reservoirs was done using *Electronic Data Acquisition System (e-DAS)*. In Tunga reservoir total fish catch in 2017-18 was 29.2t. The catch was dominated by *L. rohita* (21.4%) followed by catfishes (19.8%), *C. catla* (9.3%), *C. mrigala* (6.9%) and miscellaneous fishes contributed 42.6% to the total catch.

In Jargo reservoir, Uttar Pradesh energy fixed by the primary producers accounted to 3456 $mgCm^{-3}day^{-1}$, depicting a photosynthetic efficiency of 0.18%. Considering the photosynthetic efficiency, the production potential at 1.2% of energy conversion was estimated at 127 $kgha^{-1}yr^{-1}$. Thirty-two fish species belonging to 23 genera 13 families and 7 orders were recorded from this reservoir, including two exotics viz., *Cyprinus carpio* and *O. niloticus*. Assessment of fish catch composition of Jargo reservoir revealed that the contribution of fishes other than IMC was high (42%).

Experiment was conducted to evaluate the effect of Black soldier fly (BSF), *Hermetia illucens*, on the growth performance of GIFT Tilapia (*O. niloticus*). The study showed that fishes readily accepted feeds containing the fly larvae. Fishes fed with fish meal diet and BSF incorporated diet showed significantly higher ($p \leq 0.05$) final weight and mean weight gain compared to other treatments.

Experiments for diversification of fish species for cage culture in reservoirs and wetlands are being executed in various locations in different agro climatic zones of the country using regionally important and indigenous fish species. *Pangasianodon hypophthalmus* (P) and *Barbonymus gonionotus* (G) were stocked in a polyculture system at different stocking ratios (P: G- 80:20, 60:40, 50:50, 40:60, and 20:80) at a stocking density of @45-50 $nos.m^{-3}$. After 120 days of rearing, the highest growth and survival in *P. hypophthalmus* and *B. gonionotus* were recorded in the treatment 1 (P:G::80:20).

Experiments on evaluation of growth performance of *Labeo bata* and *Ompok bimaculatus* in cages have been initiated at Maithon dam, Jharkhand. *L. bata* has been stocked in cages in three stocking densities @ $50/m^3$, $75/m^3$ and $100/m^3$ for optimization of stocking density for its grow-out culture. *O. bimaculatus* in combination with *L. bata* @ $50/m^3$ ($30/m^3$pabda + $20/m^3$bata) has been stocked in cages in duplicate to study feasibility of polyculture of these species in cages.

A preliminary 90 day field trial was conducted to evaluate growth and survival of Amur carp, *Cyprinus carpio haematopterus* in cages as an alternative fish species for cages during winter period at Chandil cage farm, Jharkhand. Fishes were stocked @ 27 $nos.m^{-3}$ (2.97±1.47 g) in HDPE cages, fed twice a day with floating pelleted feed (28% CP) at the rate 5 % of body weight. The weight gain recorded from the month of December to January was very low due to low water temperature. At the end of 90 days, 57 % survival was recorded with average weight of 13.12±1.45g.

Cage culture of Pangas was demonstrated in Pong reservoir of Himachal Pradesh. A total of 3.0 lakhs of Pangas fingerlings were stocked at the rate 63 $nos.m^{-3}$ in 48 HDPE cages ($6\times4\times4m^3$) during third week of April 2017. After 6 months of culture 45.81t of Pangas was harvested from 24 cages, with an average weight of 666g. The average fish production per cage was 1.9 t.

Ecosystem and Fish Health

The entire stretch of River Kathajodi from Naraj Barrage to Bandar was assessed during premonsoon, monsoon and postmonsoon seasons for assessment of pollution, water and sediment quality aspects and fisheries status. The river receives untreated effluents from Cuttack city which has significant influence on water and sediment quality of the river. Maximum impact was recorded in Matagajpur area with high BOD, high specific conductivity and relatively high nutrient contents. The impact was also prominent in sediment quality of the river, as observed by relatively high organic matter content and specific conductivity in Matagajpur area. A total of 71 fish species was recorded from three samplings. The Cyprinidae dominated the population (11 species), followed by Bagridae and Mugilidae (5 species each).

Residues of antimicrobial compound Triclosan (TCS) and Triclocarban (TCC), antibiotic oxytetracycline (OTC) and tetracycline were analysed in East Kolkata wetlands. Edible fishes like *Aristichthys nobilis*,

L. bata, *C. carpio* and *Cirrihina mrigala* collected from Bheri No.2 of East Kolkata wetland were found to contain OTC residues in the range 0.946 – 3.617 mgkg^{-1}. TC residue (1.19-1.68 mgkg^{-1}) was detected in *A. nobilis* and *L. bata*. Concentrations of both OTC and TC exceeded the MRL of 0.1 mgkg^{-1}. Toxicological implication of TCS exposed to test microalga was experimented in wet lab condition. The results revealed decrease in generic richness. Cell deformities in *Nitzschia* sp., *Chlorella* sp., *Navicula radiosa*, *Selenastrum* sp. were also observed under influence of TCS.

Total arsenic residues were detected in water and fish samples from floodplain wetland and aquaculture ponds located at arsenic endemic zone in Nadia District of West Bengal and ground water samples in Morigaon district of Assam. In West Bengal, total arsenic concentrations in surface water ranged between 11-26 ppb, which is above the guideline value (5ppb) for the protection of aquatic life. Fish tissues were also detected with higher concentration (32-783 ppb). Similarly, the Arsenic concentration in ground water of Gagalmari kacharigaon (51 ppb) was found higher than WHO permissible limit for drinking water (10 ppb).

Apolipoprotein (ApoA1) gene expression profile changes in fish in response to arsenic. Gene expression analysis of three *ApoA1* variants viz., *ApoA1 1*, *ApoA1 2a* and *ApoA1 2b* showed that *ApoA1 1* and *ApoA1 2a* variants were down-regulated in arsenic-exposed fishes and their expression was found to be the same as in control in the curcumin-supplemented-diet-fed fishes. Expression of *ApoA 2b* variant was only found in arsenic-exposed *L. rohita* but not in the control and curcumin-supplemented-diet-fed fishes. This study showed that *ApoA1 2b* responds well to arsenic toxicity and down-regulation of *ApoA1 2b* proves the efficacy of curcumin against arsenicosis. Further, expression of the molecules associated with first line of defence (TLRs) was up-regulated in arsenic exposed fish whereas the expression of pro-inflammatory cytokines was down-regulated in fishes fed with basal diet. In curcumin supplemented group, down-regulation of *TLR 4* and up-regulation of *IL-1β* and *IL-10* were observed, indicating the immunostabilizing ability of curcumin against arsenic toxicity.

To evaluate the effect of arsenic and ameliorative potential of curcumin under arsenic toxicity, whole transcriptome analysis of liver tissues of *L. rohita* by next-generation sequencing (NGS) under Illumina Hiseq2500 platform was carried out. Among 135,102 transcripts, 4922 transcripts were differentially expressed in arsenic-exposed group. Similarly, 4651 transcripts were differentially expressed in curcumin supplemented group. Nucleic acid binding, zinc ion binding and ATP binding functions were highly affected by arsenic exposure. Up-regulation of chemokines and other immune genes proves the efficacy of curcumin as a potential ameliorative agent.

Surveys were conducted at Patratu, Kanke, Tenughat, Getalsud and Chandil reservoirs, Jharkhand to identify fish diseases in cage culture systems. Fungal infection and septicemia were recorded in *P. hypophthalmus* reared in cages of Chandil reservoir in winter. Low water temperature and unclean cage net were identified as probable triggering factors for the disease outbreak. Isolation followed by 16S rDNA sequencing identified the bacterial pathogens as *Aeromonas veronii* and *Klebsiella pneumoniae*.

East Kolkata wetlands and Moyna wetlands in West Bengal are frequently reported with the occurrence of fish diseases. Hence, regular monitoring was carried out in selected water bodies of East Kolkata and Moyna and also in Khalsi wetland for understanding seasonal impact on disease occurrence. *Enterobacter cloacae*, *Aeromonas veronii*, *Strenetrophomonas maltophila*, *Pleisomonas shigelloides* are the main bacterial pathogens isolated from the diseased fishes of East Kolkata wetlands and Moyna wetland. The Tilapia Lake Virus (TiLV) was for the first time detected in West Bengal, India during fish disease surveillance. One-Step PCR based Tilapia Lake Virus detection kit has been developed for the fast and sensitive diagnosis of Tilapia Lake Virus.

Transcriptome study of *Edwardsiella tarda*, isolated from diseased *C. catla*, identified few genes which are significantly related to bacterial infection. This study will be helpful for understanding the pathogenic mechanism of *E. tarda* infection that would help in identifying reliable therapeutic targets against the disease. The most significantly enriched KEGG pathways included biosynthesis pathways, immune response, metabolism, degradation, infection and transport.

To understand the recognition pathway peptidoglycan recognition proteins (PGRPs) against microbial ligands, 3D models of zebrafish PGRPs (zPGRP2) was constructed and conformational and dynamic properties of the same was studied. Molecular docking study of zPGRP2 with Muramyl tripeptide, tetrapeptide, pentapeptide-DAP (MTP-DAP, MTeP-DAP, MPP-DAP)-LYS (MTP-LYS, MTrP-LYS, MPP-LYS), Tracheal Cytotoxin (TCT) through AutodockVina revealed that β1, α2, α4, β4 and loops connecting β1-α2, α2-β2, β3-β4 and α4-α5 as the key interacting domain of zPGRPs for MTP-DAP, MtrP-Dap, MTP-Lys, MTrP-Lys, MPP-Lys and TCT, respectively. The dynamic study also revealed plasticity in the binding of PGRP site with microbial ligands suggesting intrinsic capacity of fish innate immune system to rapidly evolve specificities to meet new microbial challenges.

Metagenomic DNA was isolated from soil samples of mangrove and non-mangrove ecosystem. Comparative microbial analyses showed greater abundance of *Pseudomonas*, *Alcanivorax*, *Desulfovibrio*, *Escherichia*, *Geobacter*, *Nitrosomonas*, *Paracoccus* and *Shewanella*. In non-mangrove soil major occurrences of *Dechloromonas*, *Deinococcus*, *Methylibium*, *Nitrobacter*, *Rhodoferax* were observed. A significant correlation for relative abundance of probiotics species among total percentage between mangrove versus non-mangrove samples were observed.

A total of 41 bacteria were isolated from mud volcano in pure culture under aerobic and anaerobic condition. By 16S rDNA sequencing, the isolates were identified to belong to diverse genera: *Pseudomonas*, *Halomonas*, *Acinetobacter*, *Methylobacterium*, *Clostridium*, *Bacillus*, *Brevibacillus*, *Staphylococcus*, *Kocuria*, *Curtobacterium*, *Microbacterium*, *Luteimonas*, *Lutibaculum*. Members belonging to the genera *Microbacterium* and *Acinetobacter* dominated.

The extracts of fruits of *Choerospondias axillaris* were tested for their antioxidant activity. The % antioxidant activity of the plant extracts were found to be 25% compared to 55% of the positive control (BHT) at 0.3 $mgml^{-1}$. IC_{50} of 0.158 $mgml^{-1}$ defines the extracts to be of strong antioxidant (0.1- 0.25 $mgml^{-1}$) nature. DPPH test also resulted in higher antioxidant activity by 6.9% at 0.3 $mgml^{-1}$ and depicted profound antioxidant potential of IC_{50} of 0.055 $mgml^{-1}$ and 0.025 $mgml^{-1}$, respectively.

Raw fruits of mangrove *Sonneratia apetala* were extracted with methanol which had high antioxidant content bearing LC_{50} at 0.0047 $mgml^{-1}$. Antimicrobial activity of petroleum ether, chloroform and methanol extract of fruit pulp of *S. apetala* was tested on fish pathogens *Pseudomonas putida*, *E. tarda*, *Staphylococcus aureus* and *Citrobacter freundii*. The methanol fraction showed IZD > 20 mm in all the four bacterial species; significant activity was observed for *E. tarda* (IZD = 24 mm).

Different parts (bark, fruit and leaf) of *Terminalia arjuna* were extracted with different solvents. The maximum antioxidant value was recorded with Arjuna bark extracted with ethanol solvent followed by methanol. The maximum inhibition was shown by methanolic extract of Arjuna bark (45 %). The anti-bacterial properties of these herbal extracts were studied against *Edwardsiella tarda*, *Pseudomonas* sp. and *Aeromonas hydrophila* and it was observed that *E. tarda* is more sensitive than other pathogens.

Pesticidal nano-products were developed through a sequential design of synthesis. The developed nano-products showed comparable physiochemical properties with commercial product. The size of nano-products was estimated to be 100-200 nm. The zeta potential of the developed nano-prodcuts was found to range from - 42.4 to - 53 mV. Toxicity of the developed nano-products was tested in fingerlings of *L. rohita*. It was found that all the test formulations including commercial formulation are highly toxic to fingerlings of *L. rohita*. However, some nano-products showed higher LC_{50} value as compared to commercial products. The bio-efficacy of developed nano-products was tested against an aquatic predatory back swimmer insect, *Notonecta* sp. The developed product showed lower LC_{50} value as compared to commercial product.

Resource Assessment & Modelling

Hooghly-Matlah estuary in Bay of Bengal (BOB) region is a meso-macrotidal estuarine system formed by

rivers Hooghly and Matlah and is recognized for its commercial fisheries, especially Hilsa fishery. The data used in this study was collated from the logbooks of five randomly selected fishing vessels. The distribution of CPUE was highly skewed (skewness = 5.014) varying between 0 to 120 kghr^{-1} with mean value of 6.5 kg hr^{-1}.

A modelling framework has been developed for fish species richness in river system, using GLMMs coupled with principal components scores using R software. Four river systems of western Himalayan region i.e., Beas, Ganga, Ravi and Sutlej were selected as a case study Physicochemical parameters of water of rivers has been assumed as fixed effect and river specific effect has been considered as random effect for modelling on fish species richness. Factor analysis on physicochemical parameters of water showed that five factors together explain 72.54% variation in which factor1 (35.36%) explained maximum variation. This factor is dominated by Cond(µScm^{-1}), TDS(mgl^{-1}), Alk(mgl^{-1}) and Hard(mgl^{-1}); factor 2 (10.12%) is dominated by water current (cmsec^{-1}); factor 3 (9.31%) dominated by NTR(mgl^{-1}), Factor4 (9.13%) representing DO(mgl^{-1}) and factor 5 (8.26%) dominated by Turbidity (NTU) respectively. GLMMs results showed that none of the physicochemical parameters were found to be significant excepting altitude (-0.29, $p < 0.05$) of the river system as fixed effects on fish richness. The negative effect of altitude showed that at high altitude low fish richness were observed. River impact on fish richness was found to be maximum in Ganga (2.79) and minimum in Sutlej (1.92). The estimated variance of the random effect (0.133) determines the rivers specific effect on fish richness. It also suggests the high degree of variability of fish species richness across rivers. The R^2 value of 0.53 indicated good fitting of the model.

Fisheries Socio-economics

For evaluation of impact of ICAR-CIFRI cage culture technology, data were collected from state fisheries departments and through field surveys in Chhattisgarh, Jharkhand, Odisha, Maharashtra, Manipur and Assam states. The socio-economic impact of cage culture technologies on the livelihood and employment generation of beneficiaries was assessed through difference-in-difference (DID) and the propensity score matching (PSM) methods. The interim estimate shows that at present around 14,000 cages have been installed in different reservoirs of the country. The technology yielded positive net returns across the states. The net return per cage (6x4x4 m^3) per year for Pangasius production from cages in reservoirs was estimated at 42,054 metric tonnes which is around 16% of the current reservoir production. The cage culture has generated substantial employment. All the cages in the country generated 7.46 lakh man-days of labour per year.

Tribal Sub Plan Activities

For livelihood improvement of tribal fishers/fish farmers derelict water bodies, canal and ponds of tribal in Mansadwip, Khansahebabad, Gangasagar villages of Sagar Island, South 24 Parganas district of West Bengal were selected. ICAR-CIFRI provided fish feed and fertilizers initially in 30 ponds to benefit 50 tribal families. Canals (3 nos) of Sundarbans have been brought under culture-based fishery with significant improvement in fish production and livelihood of tribal fishers. The average fish yield from these canals was 800 kg ha^{-1}. A total 1200 tribal and scheduled caste fishermen and women were benefitted from the canal fisheries development programme. Through technological intervention fish production of farmers has increased from 200 to 1000 kg ha^{-1} yr^{-1} in tribal area of Gardanmari of Burdwan district of West Bengal. In addition to that, ICAR-CIFRI has initiated fisheries development in Kalo reservoir of Odisha, Loni wetland of Madhya Pradesh for production enhancement and livelihoods developments of tribals.

NEH Activities

ICAR-CIFRI Regional Centre, Guwahati in collaboration with AFDC Ltd., Guwahati carried out fish stock enhancement in Mer beel, Morigaon, Assam. The fish yield during 2016-17 was 1465 kg ha^{-1} yr^{-1} showing that stock enhancement using stunted carp fingerlings resulted in 12.6% increase in production. The result suggests that fish production from the *beel*s can be further enhanced by stocking stunted carp fingerlings reared in pens.

A battery of CIFRI-GI cages was installed in Samaguri beel under NEH component of the Institute. Among the minor carps, *Labeo bata* is one the most preferred fish species and fetches relatively higher price in local markets of Assam. *L. bata* fingerlings were stocked in cages at five stocking densities, *viz*., 25, 50, 75, 100 and 150 fingerlings m^{-3}. After five month rearing, growth of fish in terms of specific growth rate and weight gain% was observed to be significantly higher ($p<0.05$) in the lowest stocking density group (25 nos. m^{-3}), followed by those stocked at 50 and 75 nos. m^{-3}. The lowest growth was observed in highest stocking density group (i.e., 150 nos. m^{-3}). Survival of *L. bata* in cages ranged from 85.5-94.07% in different stocking densities. Higher survival of *L. bata* even in low water temperatures of winter without any pathological conditions testified the hardy nature of the species, which can be a candidate species for cage culture in Assam even during winter season.

The Institute organized a Regional Consultation on "*Open Water Fisheries Development in NE Region*" at Guwahati on 29.04.2017. As an output of the Consultation, the policy document 'Roadmap for development of open water fisheries in North-eastern states of India' (a policy document) has been prepared and distributed to all the concerned states fisheries departments for implementation.

Outreach Activities

As a cheap and alternate protein source in fish feed, leather meal was tested. Indoor study revealed potential of leather meal for incorporation in feed for *Pangasianodon hypophthalmus.* Assessment of Cr and Pb in tissues of *P. hypophthalmus* fed with leather meal indicated their concentrations were below the maximum permitted level with relatively higher level in kidneys compared to flesh and liver.

A floating feed CIFRI-CAGEGROW has been developed under the project and was tested in a farmer's cage installed in Chandil reservoir, Jharkhand. The fish group fed CIFRI-CAGEGROW feed recorded two times faster growth rate compared to that for a commercial feed with same protein level. The feed CIFRI-CAGEGROW has been commercialized.

The comparative population structure, genetic diversity and historical demographics of *L. rohita, C. catla, C. mrigala* were characterized by analyzing partial 307bp sequences of *Cytochrome b* gene of 357 individuals collected from seven geographically isolated sites from Indian river basins (Ganga, Brahmaputra, Narmada and Teesta) and two culture zones (24 Praganas North and Midnapur). Occurrence of 35 haplotypes with haplotype diversity of 0.7333 in *L. rohita* in Brahmaputra basin showed allelic richness, while no nucleotide diversity was observed in *C. catla* of two geographically isolated locations at River Ganga and Narmada. The analysis of molecular variance revealed genetic diversity of IMC to be very low within the species, as compared to among the three species.

Gross chemical composition of *Osteobrama belangeri, O. cotio, B. gonionotus, L. gonius, L. fimbriatus* were studied. Among the fishes studied *L. gonius, L. fimbriatus, O. cotio* were found to be lean fish containing high amount of protein and low fat content and *O. cotio* was found to be rich in fat content. Amino acid, fatty acid, mineral and fat soluble vitamin composition of *O. belangeri, O. cotio, B. gonionotus, L. gonius, L. fimbriatus, Esomus danricus, Colisa fasciata* and few other species were also studied.

First record of new fish species

The Bull shark *Carcharhinus leucas* (Valenciennes, 1839) belonging to the order Carcharhiniformes, was recorded first time from the Devi estuary near Nuagarh area. Similarly, white leg shrimp *Litopenaeus vannamei* was recorded first time from the Cauvery estuarine system. *Pseudolaguvia foveolata* was also recorded from River Torsa for the first time.

Mass Awareness and Human Resource Development

During the year, a total of 15 mass awareness camps were organized on wide range of issues including fish

health management, beel fisheries management and reservoir fisheries management in different parts of the country. The technologies of ICAR-CIFRI have been showcased in exhibitions organized in 25 different places in India. Three trainings for fisheries officials, 5 trainings for students and 21 training programmes for fishers/fish farmers were organized imparting knowledge and skill to 61 officials, 150 students and 800 fish farmers/fishers. The Institute staff have also undergone capacity building trainings in their respective fields of specialization.

FAO/ICAR-CIFRI Workshop on Fish Passage Design at Cross-River Obstacles

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itkc vkj lnjcu e ekfRL;dh fodkl d ugj llkèkuk dk vè;;u fd;k x;kA itkc d Jhçgn ugj l dy 17 ueu ,d= fd, x, Fk] ftue *Xenentodon cancila*] *Mastacembelus armatus*] *Macrognathus puncalas*] *Channa marulius*] *Puntius* sp., *Badis badis* vkj NkV >Èxk vkj ddMk ¼*Sertoriana sp*½ ik; x; ftue lcl vf/kd >Èxk eNfy;k dh ipjrk FkkA lnjou d fc'ykdkgh ugj e ekulu d nkjku 28 eNyh çtkfr;k dk idMk x;kA bue lkbfçfuMk ¼88 ifr"kr½] ikfyufeMk ¼5-75 ifr"kr½] vckflMk vkj pfUMMk ¼çR;d % 5-1 ifr"kr ½] efxfyMk ¼4-3 ifr"kr½ vkj ckfxMk ¼2-7 ifr"kr½A fc'kyk[kh ugj e NkVh n"kh eRL; itkfr;k dh ipjrk n[kh xb ¼dy idM dk 76 ifr"kr½A blh rjg] ekulu d nkjku HkVdhekjh ugj l dy 345 ueu ,d= fd, x,A ue.kkdj.k d nkjku 9 ifjokjk dh dy 16 fQufQ"k itkfr;k dk nt fd;k x;kA >Èxk eNfy;k dh ikp çtkfr;k ¼3 ihfu;M rFkk 2 uku ihfu;M½ dk nt fd;k x;kA budh ipjrk dy idM dh 10 ifr"kr nt dh xbA

fjikV vof/k d nkjku dkBtkMh] fl;kx vkj xxk dh p;fur lgk;d ufn;k dh i;koj.k çokg dk vkdyu

fd;k x;kA dkBtkMh unh l tyiokg lc/kh vkdMk dk fo'y"k.k e ekulu l xh'e dky rd tyçokg e Hkkjh deh dk n[kk x;k gA ekulu d nkjku] tyiokg 160]000 D;ld Fkk vkj ble *xkfu;kyk/k eufeuk* rFkk *yfc;k ckVk* dh ipjrknt dh xb tcfd xh"e dky e 5]000 D;ld tyiokg e *ifUV;l* çtkfr;k dh vf/kdrk n[kh xbA bl unh l dy 72 eNyh çtkfr;k nt dh xb ftue lkbfçfuMk ¼16 çtkfr;k½] DyibMk ¼6 çtkfr;k½] efxfyMk ¼5 çtkfr;k½] ,xkmfyMk ¼4 çtkfr;k½] ckfxMk ¼4 çtkfr;k½] f'kychMk ¼4½ çtkfr;k½ vkj vckflMk ¼4 çtkfr;k½ FkhA Tokjune[k d egkuk {k=] uvkx< e eRL; fofoèkrk ¼36 çtkfr;k½ lcl vf/kdnt dh xÃA ekulu d nkjku cjkt e *fxtkM 'kM*] *xkfu;kyk/k eufeuk* ¼28 ifr"kr½] mld ckn *yfc;k ckVk* ¼18 ifr"kr½ vkj *fljgful jck* ¼10 ifr"kr½ ik;h x;hA fl;kx unh l dy 30 fQufQ"k çtkfr;knt dh xb ftue lkbfçfuMk lcl vf/kd& 70 ifr"kr] vckflMk& 6-66 ifr"kr vkj f'kychMk&6-66 ifr"kr ikb xbA vkjke?kkV l 15 çtkfr;k] ikIh?kkV e 13 çtkfr;k] dkÇElx l 12 çtkfr;k] ckyx l 1 çtkfr] Ç;xfdvkux l 5 çtkfr;k] iÇxx lEifyx LV'ku l 2 çtkfr;k vkj rhu çokIh çtkfr;k] *Schizothorax richardsonii, Bangana dero* ,o *Labeo dyocheilus* dh mifLFkfrnt dh xÃA

xxk unh dh to fofoèkrk vkj ikfjfLFkfrd ij çe[k lgk;d ufn;k vkj vkæHkfe d çHkko dk vè;;u fd;k x;k ,o vè;;u d nkjku fofHkUu LFkyk ij eNyh çtkfr;k dh miyC/krnt dh xÃA Hkhyxuk lxe ij ¼*Vkj ifVVkjk* vkj *flt kFkkjDl fjpMlkuh*½(u;kj lxe ¼*Vkj ifVVkjk*½(goy lxe ¼*Vkj ifVVkjk*] *flt kFkkjDl fjpMlkuh* vkj *LijV ,vkj*½(?kk?kjk lxe ¼*pUuk ek#fy;l] pUuk fLV;Vk] ifV;l lkQkj] feLVl fLoVVl* bR;kfn½ vkj dekuk'kk lxe ¼*okykxk vVV] yfc;k jkfgrk] Ih-dryk* vkj *Ih-cVkdl* bR;kfn½ dk nt fd;k x;kA

tyk'k; ikfjfLFkfrdh vkj eRL; ikyu

Hkkjr d p;fur tyk'k;k e lgHkkfxrk d vk/kkj ij eRL; ikyu l lkèku eY;kdu vkj of) çkVkd,y dk v/;;u fd;k x;kA bldk foLrr v/;;un"k d Nh jkT;k d lkr tyk'k;k e eRL; vkokl] tfod lenk;] eNyh fofoèkrk] l;ktu] LV,çdx fooj.k vkj eNyh mRiknu vkfn ij lkef;d&LFkkfud vkdMk ikIr dju d fy, fd;k tk jgk gA v/;;u e >kj[kM d lkrjkr tyk'k; vkj vkfM'kk d njtkx tyk'k; d eRL; vkokl d vè;;u budh mRiknu {kerk e/;e Lrj dk ik;k x;k g rFkk ekulu vkj xh"edky d ty ikpyk e cgr vrj n[kk x;k gA vè;;u d nkjku] irjkr e ldy çkFkfed mRikndrk 300&875 $mgCm^{-3}day^{-1}$ rFkk njtkx tyk'k; 1750&2000 $mgCm^{-3}day^{-1}$ ik;k x;kA 'k) çkFkfed mRikndrk ¼lydVu vkèkkfjr½ d vkèkkj ij eNyh mRiknu {kerk Øe'kh irjkr vkj njtkx tyk'k;k e 240 fd-xk ifr g- ifr o"k vkj 1053 fd-xk ifr g- ifr o"k vkdk x;kA irjkr tyk'k; e eNyh idM vkÃ,elh ¼56 ifr"kr½ ik;k x;kA *yfc;k jkfgrk* dh ipjrk d lkFk *vkfj;kdkfel ukbykfVdl* ¼16 ifr"kr½ vU; dki itkfr;k ¼7 ifr"kr½ NkVh Lon'kh eNfy;k ¼3 ifr"kr½ dVfQ'k ¼2 ifr"kr½ vkj fofoèk eNfy;k ¼16 ifr"kr½ ikb xbA njtkx e] vkÃ,elh dk ;kxnku 80 ifr"kr FkkA Øe'kh irk= vkj njtkx tyk'k;k eNyh mit Øe'kh 100 fd-xk ifr g- ifr o"k vkj 200 fd-xk ifr g- ifr o"k vuekfur fd;k x;k FkkA l&n;k e njtkx tyk'k; dk vklr mRiknu 910 fd-xk rFkk ekulu e 342 fd-xk- vkdk x;kA eRL; idM ifr bdkb e,ulu dh ryuk e l&n;k e vi{kk—r vfèkd ikb xbA

dukVd e gjxh vkj dchuh tyk'k;k] rfeyukM e Hkokuh lkxj vkj —".kkfxjh tyk'k;k vkj ryxkuk e ukxtulkxj tyk'k; e ikfjfLFkfrdh vkj eRL;ikyu dh fLFkfrd vkdyu d fy, lo{k.k fd, x,A ukxtulkxj e *lYekQf'k;k* ,lh 28 ifr"kr rFkk Hkokuh lkxj tyk'k; e *ifUV;l lkQkj* yxHkx 58 ifr"kr ikIr gvkA gjxh tyk'k; e ,*fEcfyQfjxkMku ekyk* 53 ifr"kr] —".kkfxjh vkj erj tyk'k;k e *ifUV;l foVkVl* 26 ifr"kr vkj *ifFk;k dfUp;kfu;l* 34 ifr"kr nt fd;k x;kA gjxh {k= e lHkh LFkyk ij *vkEid ikcnk* ik;;A —".kkfxjh e] NkV vkdkj d çtkfr;k dh cgrk;rk FkhA eè;orÊ {k=k e dki itkfr;k dh ipjrk n[kh xb rFkk ukxtulkxj e *yfc;k dYckl* çpj ek=k e ik;;A

eVj] —".kfxjh] irjkr vkj rxk tyk'k;k l eRL; idM vkdMk dk lxg byDV,fud MVk vfèkxg.k ç.kkyh ¼Ã&Mh,,l½ d }kjk fd;k x;kA Vxk tyk'k; e 2017&18 e dy eNyh idM 29-2 Vunt dh xbA eNfy;k e ,y jkfgrk ¼21-4 ifr"kr½] dVfQ'k ¼19-8 ifr"kr½] *Ih-dryk* ¼9-3 ifr"kr½ *Ih-exyk* ¼6-9 ifr"kr½ vkj fofoèk eNfy;k u 42-6 ifr"kr ikb xbA

mÙkj çn'k d tkjxk tyk'k; e] çkFkfed mRikndk }kjk Åtk 3456 $mgCm^{-3}day^{-1}$ g] tk 0-18 ifr"kr dh çdk'k l'y"k.k {kerk dk n'kkrh gA çdk'k l'y"k.k {kerk dk è;ku e j[kr g,] 1-2 ifr"kr Åtk :ikrj.k ij

mRiknu {kerk 127 fd-xk- ifr g- ifr o'k vuekfur fd;k x;kA bl tyk'k;k l 23 tujk] 13 ifjokjk vkj 7 vkMj dh 32 eRL; çtkfr;k nt dh xb] ftue nk fon"kh tl *lkbfçul dkfi;k* vkj *vkjØkfel ukbykfVdl* lfEefyr gA tkjxk tyk'k; e Hkkjrh; etj dki ¼vkÃ,elh½ d vykok eNfy;k dk ;kxnku 42 ifr"kr n[kk x;kA

fx¶V fryfi;k ¼*vkjØkfel ukbykfVdl*½ d fodkl ij Cyd lkY tj ¶ykÃ ¼ch,l,Q½ *gefV;k bylu* d çHkko dk eY;kdu fd;k x;k FkkA vè;;u l irk pyk g fd eNfy;k vkl kuh l ¶ykÃ ykok ;ä Hkk tu dk [kk yrh gA vU; vkgkj dh ryuk e eNfy;k d "kkjhfjd Hkkj e fQ"kfey ,o ch,l,Q ;Dr vkgkj l of) n[kh xbA ¼ih 0-05½

n"k d fofHkUu —f"k tyok;q {k=k d fofHkUu LFkkuk e LFkkuh; rkj ij fitjk e eRL; itkfr;k d fofo/kh dj.k ij dk; fd;k tk jgk gA *ixkfl;kukMku gkbikFkyel* ¼ih½ vkj *ckjckfuel xkfu;kukVl* ¼th½ dk cgikyu ikyu d fy; fofHkUu LV,çdx vuikr ¼ih th &80%20] 60%40] 50%50] 40%60] vkj 20%80½ e lpf;r fd;k x;kA ikyu d 120 fnuk d ckn] *ih-gkbikQFkyel* vkj *ch xkfu;kukVl* e of) vkj mÙkj thfork lcl vf/kd ¼ih th %% 80% 20½ e nt dh xÃA

>kj[kM d eFku ckèk e çitjk e *yfc;k ckVk* vkj *vkEikd fcekdyVl* d of) dk vkdyu fd;k x;kA bu fitjk e *yfc;k ckVk* ikyu d fodkl d v/;;u gr budk fofHkUu lp;u ?kuRo d vulkj j[kk x;k & 50 eNyh ifr ?ku eh0] 75 eNyh ifr ?ku eh0 vkj 100 eNyh ifr ?ku eh0A lkFk gh] bu fitjk e *vk-fcekdyVl* eNfy;k dk cgikyu d fy; Hkh i;kl fd;k tk jgk gA

pknhy tyk"k;] >kj[kM e 'khrdkyhu ekfRL;dh e çitjk e odfYid eNyh çtkfr d rkj ij vej dki] *lkbfiul dkfi;k gekVkVjl* çitjk d fodkl vkj vfrthfork d eY;kdu d fy, çkjfHkd 90 fnu dk QhYM ijh{k.k vk;kftr fd;k x;kA ,pMhihÃ çitjk e eNfy;k dk 27 eNfy;k@eh0 d rkj ij lpf;r fd;k x;kA bUg fnu e jktkuk nk ckj Hkktu fn;k x;kA ;g Hkktu ¼¶ykÇVx iy;ä QhM 28 ifr"kr lhih½ mud "kkjhfjd Hkkj dk 5 ifr"kr FkkA fnlEcj l tuojh d eghu d nkjku ty dk rkieku de gku d dkj.k eNfy;k dk out den[kk x;kA 90 fnuk d ckn eNfy;k dh mRrjthfork 57 ifr"kr rFkk vklr 'kkjhfjd Hkkj 13-12 ± 1-45 nt fd;k x;k FkkA

fgekpy çn'k d ikx tyk'k; e ixkl ikyu dk çn'ku fd;k x;kA vçy 2017 d rhlj llrkg d nkjku 48 ,pMhihÃ çitjk ¼6 x 4 x 4 ?ku ehVj½ e dy 3-0 yk[k ixkl vxfydkvk dk ¼63 vxfydkvk ifr ?kueh0½ dh nj l lpf;r fd;k x;k FkkA ikyu d 6 eghu ckn 24 çitjk l 45-81 Vu ixkl eNfy;k dk iklr fd;k x;kA ftldk vklr out 666 xk-nt fd;k x;kA çfr çitjk vklr eNyh mRiknu 1-9 Vu nt fd;k x;kA

ikfjfLFkfrd r= vkj eRL; LokLF;

ekulu io] ekulu d nkjku rFkk ekulu i"pkr ukjt cjkt l cnj rd dkBtkMh unh d ij {k= dk vkdyu çn"k.k] ikuh vkj ryNV dh x.koÙkk vkj eRL;ikyu dh fLFkfr d vkdyu d fy, fd;k x;kA bl unh e dVd 'kgj dk v"kkf/kr ty d iokfgr gku d dkj.k bl unh d ty vkj ryNV x.koÙkk çHkkfor gkrh gA eVxxtij {k= d ty dk chvkMh] of'k"V pkydrk vkj ik"kd rRok d Lrj e vf/kdrk ikb xbA ,lk iHkko unh d ryNV x.koÙkk dkcfud inkFk fof'k"V pkydrk e Hkh n[kk x;k gA rhu lEifyx e dy 71 eNyh çtkfr;k dk nt fd;k x;k ftue lkbfçfuM ox l 11 çtkfr;k vkj cfxM vkj efxfyM ox l çR;d 5 çtkfr;k dk nt fd;k x;kA

oLV dkydkrk oVy.M e ,VhfeØkfc;y dEikm.M Vkbdyklu ¼Vhlh,l½ vkj Vkbdykdkcu ¼Vhlhlh½] ,Vhck;kfVd v,DlhVVklkbfDyu ¼vkVhlh½ vkj VVklkbfDyu d vo'k"k dk fo'y"k.k fd;k x;k FkkA oLV dkydkrk oVy.M d Hkkjh u- 2 l *,df=r ,fjfDFkl ukfcfyl] yfc;k ckVk] lkbfçul dkiËvk] fljhfguk exyk* tlh eNfy;k dk vkVhlh vo'k"k dk Lrj 0-946 & 3-617 feyhxke@fdykxke ik;kx;kA *,-ukfcfyl* vkj *yfc;k ckVk* e Vhlh vo"k'k 1-19 & 1-68 feyhxke@fdykxke FkkA dN itkfr;k tl *fufRt;k* ,lih] *Dykjyk* ,lih]*ufodyk jfMlkuk] lyukLVe* ,lih e Vhlh,l vo"k'kk d dkj.k bud mRrdk e fodfr ikb xbA

vle d ekjhxko fty d Hkty d ueuk vkj if'pe cxky d ufn;k fty d vkn{k=k ,o ik[kj l ikIr ty d ueuk e vklfud d vo'k"k vo'k"k ik, x, gA if'pe cxky e lrgh ty dy vklfud lkærk 11&26 ihihch d chp ikb xb tk tyh; thou dh lj{kk d fy, fu/kkfjr Lrj ¼5 ihihch½ l Åij gA eNyh d Ård k e Hkh vklfud Lrj vf/kd ¼32&783 ihihch½ ik;k x;kA blh çdkj] xxYkekjh dpfjxko d Hkty e vklfud dh lknrk 51 ihihch ikb xb tcfd fo"o LokLF; lxBu d vulkj i;ty d vklfud dk Lrj 10 ihihch fu/kkfjr fd;k x;k x;k gA

vklfud d iHkko l eNfy;k d ,ikfyikikVhu thu ,Dli"k e ifjoru gk tkrk gA rhu *ApoA1* d çdkj] *ApoA1 1*, *ApoA1 2a* vkj *ApoA1 2b* d thu vfHk0;fä fo'y"k.k d vulkj] *ApoA1* vkj *ApoA1 2a* d ,Dli"ku vklfud iHkkfor eNfy;k e leku ik;k x;kA *ApoA 2b* d ,Dli"ku doy vklfud iHkkfor ,y jkfgrk eNfy;k e ik;k x;k ij djdfeu Hkkth eNfy;k e bldk ,Dli"ku vfu;f=r FkkA bl vè;;u l irk pyk g fd *ApoA1 2b* vklfud fo"kkärk dk fujk/k dj ldrk gA

vklfud fo"kkärk d iHkko ,o bldh fujk/k {kerk d eY;kdu d fy, Illumina Hiseq 2500 lyVQ,e d vk//kj ij *yfc;k jkfgrk* d ;—r Ård k dk fo'y"k.k fd;k x;kA blh rjg 135102 VklfØlV e l vklfud iHkkfor 4651 VklfØlV dk vyx&vyx 0;ä fd;k x;kA vklfud d iHkko l U;fDyd ,flM ckbfUMx] Çtd vk;u ckbfUMx vkj ,Vhih ckbfUMx d dk; vR;fèkd çHkkfor gkr gA dekdkbu vkj vU; çfrj{kk thu d fuleu e djdfeu ,d lHkkfor fujk/k dkjd gA

>kj[kM d irjkr] dkd] ru?kkV] xVylM vkj pknhy tyk'k;k e Çitj e ikfyr eNfy;k e jkx lde.k dk fd;k x;k FkA l&n;k e pMhy tyk'k; d Çitjk e *ixkfl;kukMku gkbikQFkel* e fo'kk.k lØe.k vkj lflVfleh;k nt fd;k x;k Fkk ft ldk dkj.k ikuh dk de rkieku vkj vifj'dr Çitj uV n[kk x;kA 16S rDNA flDoflx }kjk jkxtud thok.k] *,jkekukl ojkfu* vkj *Dycfl;yk U;ekfu* dh igpku dh xbA eNfy;k e fo—fr vkj eR; nj dk fu;f=r dju d fy, Hkktu d ekè;e l v,DlhVVk lkbfDyu dk mi;kx] efFkfyu Cy lkY;'ku e Mcdh] mipkj ;k Çitjk e $KMnO_4$ d i;kx d fy; l>ko fn;k x;kA

if'pe cxky e oLV dkydkrk oVy.M vkj ek;uk vkæHkfe e eNfy;k e jkx lde.k dh ?kVuk vf/kdrj n[kh tk jgh gA blfy,] oLV dkydkrk oVy.M vkj ek;uk d p;fur ty fudk;k rFkk [kyl h vkæHkfe eNfy;k dh fu;fer fuxjkuh dh xÄA *,VjkcDVj Dy,, lh] ,jkekukl ojkuh] LVuVkekekukl ekYVkfQyk] lyflkekukl f'kxykbMl* ioÉ dkydkrk oVy.M vkj ek;uk vkæ{k= dh jkxxLr eNfy;k e e[;jkxtud thok.k d :i e nt fd; x; gA eNyh jkxk d fuxjkuh d nkjku if'pe cxky e fryfi;k >hy ok;jl ¼VhvkÃ,yoh½ dk igyh ckj irk pykA bld fy; ou&LVi ihlhvkj vkèkkfjr fryfi;k yd ok;jl dk irk yxku ,d fdV dk fodflr fd;k x;k gA

ldfer *lh dryk* l iFkd fd; x; b-VkMk ¼*Edwardssiella tarda*½ dk VklfØiVke v/;;u fd;k x;kA bl v/;;u l *b-VkMk* d jkxtud dhVk.k dk irk yxk;k tk ldrk g rFkk bld funku d fy; mik; fd; tk ldr gA bl fn"kk e dbtth ikFko ;Fr ck;kflUFkfll ikFko] bE;u j liklU] eVkckfyTe] fMxM"ku] lde.k ,o jkx ogu bR;kfnA

fjdkfXu"ku ikFko dh igpku gr ilVhMkfXydu fjdkfXu"ku ikVhu dk ekbdkfc;y fyxkUM] tckfQ"k PGPRs (zPGRP2) 3Mh ekMy d ifji{; e r;kj fd;k x;k rFkk bldh duQe"kuy ,o Mk;ufed x.kk dk v/;;u fd;k x;kA Muramyl Tripeptide, Tetrapeptide, Pentapeptide-DAP(MTP-DAP, MTeP-DAP, MPP-DAP)-LYS (MTP-LYS, MTrP-LYS, MPP-LYS), Tracheal Cytotoxin (TCT) d lkFk zPGRP2 dh ekydyj Mkfdx v/;;u ;g crkrk g fd β1, α2, α4, β4 ,o β1-α2, α2-β2, β3-β4 vkj α4-α5 dk tkMu okyh yi dk zPGRPs d MTP-DAP, MtrP-Dap, MTP-Lys, MTrP-Lys, MPP-Lys and TCT dh e[; dMh gA

dhVuk'kd uuk&mRiknk dk l'y"k.k d vuØfed fMtkbu d ekè;e l fodflr fd;k x;kA fodflr uuk&mRiknk u okf.kfT;d mRikn d lkFk bld Hkkfrd&jlk;u fo"k"krkvk dk ryukRed v/;;u fd;k x;kA uuk&mRiknk dk vkdkj 100&200 ,u,e d chp ik;k x;kA fodflr uuk&çkMDVl dh thVk {kerk 42-4 l 53 ,eoh rd nt dh xbhA *,y jkfgrk* dh vxfydkvk e fodflr uuk mRiknk dh fo"kkärk dk ijh{k.k fd;k x;k vkj ;g ik;k x;k fd okf.kfT;d Q,ey'ku ler lHkh ijh{k.k Q,ey'ku *,y jkfgrk* d vxfydkvk d fy,

vR;fèkd fo'kkDr gA gkykfd] dN uuk&mRiknk u okf.kfT;d mRiknk dh ryuk e LC_{50} dk Lrj vf/kd n[kk x;kA fodflr uuk mRiknk dh to&çHkkodkfjrk dk ijh{k.k tyh; ijHk{kh cd Lohej dhV] *u,Vkudvk* ,lh d ifji{; efd;k x;k FkkA fodflr mRikn u okf.kfT;d mRikn dh ryuk e LC_{50} dk eku de n[kk x;kA

l|lkèku vkdyu vkj e,MçyxA

cxky ¼BOB½ {k= dh [kkMh e gxyh&ekryg egkuk ,d elk&macrotidal egku g tk gxyh unh vkj Matlah }kjk 0;kolkf;d eRL; ikyu] fo'k"k :i l fgylk eNyh ikyu gr fu£er gA bl vè;;u e i;kx fd, x, vkdMk dk ikp ;k–fPNd :i l p;fur eNyh idMu oky tgktk dh y,xcd l ,df=r fd;k x;k gA ifr bdkb eRL;;u eku lhih;Ã eku ¼skewness ¾ 5-014½ 0 l 120 fd-xk-@?kVk rFkk vklru 6-5 fd-xk-@?kVk nt fd;k x;kA

R ¼vkj½ l,¶Vo;j }kjk çe[k ?kVdk d lkFk GLMMs d lkFk eNyh çtkfr;k ipjrk d vkdyu d fy, ,d e,MçyxA <kpk fodflr fd;k x;k gA if'peh fgeky; {k= dh pkj unh ç.kkfy;k] 0;kl] xxk] jfo vkj lryt dk p;u bl v/;;u d fy; fd;k x;kA ufn;k d ty dh Hkkfrd jlk;fud ikpyk dk vk/kkj ekudj çtkfr ipjrk d fy; ekMy cuk;k x;kA ty ikpyk dk fo"y'k.k yxHkx 72-54 ifr'kr fHkUurk dk fn[kkrk gA

ekfRL;dh dk Lkkekftd&vkfFkdA

lLFkku d fitjk ikyu rduhd d iHkko d vkdyu gr fofHkUu jkT;k] NRrhlx<] vkfM"kk] egkjk'V] ef.kij ,ovlee lo{k.k fd;k x;kA fitje eNyh ikyu l eNvkjk d vk; miktu e ykHk dk v/;;u fd;k x;kA ikjfHkd vkdyu ;g crkr g fd oreku e 14000 fitjk dk n"k d fofHkUu tyk"k;k e yxk;k x;k gA bl i)gr }kjk ifr o"k ixkl ikyu e 42054 efVd Vu mRiknu gvk g tk dy tyk'k;h mRiknu dk 16 ifr'kr vkdk x;kA

tutkfr mi ;ktukA

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ifj;k tuk d rgr ,d ¶ykçVx QhM lhvkÃ,Qvkjvkà&d txk fodflr fd;k x;k g vkj pknhy tyk'k;] >kj[kM e LFkkfir ,d çi tj e ijh{k.k fd;k x;k FkkA lhvkÃ,Qvkjvkà&d txk QhM l eNyh leg u çkVhu Lrj vU; vkgkj dh ryuk e nk xuk r th l fodkl nj gvkA bl QhM dk lhvkÃ,Qvkjvkà&dxxk dk 0;kolk;hdj.k fd;k x;k gA

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Vision

Sustainable fisheries from inland open waters for environmental integrity, livelihood and nutritional security

Mission

Knowledge based management for enhanced fishery, conservation of biodiversity, integrity of ecological services and to derive social benefits from inland open waters

Mandate

- Basic and strategic research for sustainable management of inland open water resources
- Develop protocols for productivity enhancement in reservoirs and wetlands and aquatic ecosystems health management
- Act as repository of information on inland open water fisheries resources
- Human resource development through training, education and extension

Major Research Achievements

- Habitat characteristics and fisheries have been studied along 800 km stretch of River Cauvery. The upper stretch of Cauvery from Bhagamandala to Shivanasamudram is a critical habitat zone IUCN Red List fish species *viz*., *Hypselobarbus mussulah*, *H. dubius*, *Tor khudree*, *Dawkinsia arulius* and *Hypselobarbus kolus*. At Bhagamandala these species contributed to about 56% of the total fishes. In river Chaliyar 66 fish species under 50 genera, belonging to 32 families have been detected. In river Tapti 51 fish species belonging to 34 genera in 15 families, with major families: Cyprinidae, Bagridae, Channidae, Mastacembelidae have been recorded. In river Siang 31 fish species belonging to 24 genera and 8 families have been recorded: major families were Cyprinidae (70%), Scheilbidae, Ambassidae and Siluridae.

- Assessment of river hydrology, ecology and fish species diversity have been initiated in river Kathajodi, Siang and Tons/Tamas river for determination of E-flow of these rivers. Preliminary analysis indicated that a discharge of more than 20,000 cusec is required for migration of these species at Naraj barrage. Under NMCG programme the Institute has bred wild stock collected from river and ranched *Labeo rohita*, *Catla catla*, *Tor putitora* in river Ganga. Conservation and restoration of Mahseer (*Tor putitora*) through ranching programme has been initiated at Rishikesh.

- Institute has successfully demonstrated cage culture of *P. hypophthalmus* in Pong and Govindsagar reservoirs of Himachal Pradesh. The technology demonstration showed that the species can be grown to table size in cages in Himachal Pradesh. Experiment for evaluation of Amur carp as potential species for diversification has been started in Chandil reservoir, Jharkhand. Experiment for evaluation of *Puntius gonionotus* as potential species for diversification has been initiated in Salia Dam, Odisha. Pen culture technology for table fish production has been demonstrated in 4 wetlands belonging to 3 states for wider popularization and fish production enhancement from wetlands.

- Assessment of impact of reservoir and wetland stocking following CIFRI's recommended protocols revealed significant increase in fish yield in reservoirs of Jharkhand, Chhattishgarh and UP reservoirs. The study of 9 medium reservoirs of Chhattisgarh shows that the fish yield has increased by about 143 % after the adoption of culture based fisheries in the period 2010-11 to 2015-16 (combined production increased from 709.52 MT to 1012 MT).

- With technology dissemination and adoption of fish yield through stock management of wild and stocked fish in floodplain wetlands has resulted in increase of fish yield. Average fish yield rates in un-stocked beels (96 no.) has increased from 222.2 kg $ha^{-1}yr^{-1}$ in 2001-02 to 254.3 kg $ha^{-1}yr^{-1}$ in 2016-17 in Assam. In stocked beels (87 no.), average fish yield has increased from 243.89 kg ha^{-1} yr^{-1} (2001-02) to 539.12 kg $ha^{-1}yr^{-1}$ (2016-17) in Assam with a compound growth rate of 5.43% over the16 year period.

- Ecology and fisheries are assessed in Derjang reservoir of Odisha, Getalsud, Patratu, Kanke and Tilaiya reservoirs of Jharkhand, Mettur and Bhavanisagar reservoirs of Tamilnadu and Harangi and Kabini reservoirs of Karnataka. Ichthyofaunal diversity (Shannon diversity index) of four reservoirs namely Nagarjunasagar, Krishnagiri, Mettur and Harangi were 2.45, 2.039, 2.051 and 1.528, respectively. Electronic Data Acquisition System (e-DAS) was implemented for fish catch data acquisition from Tunga and Krishnagiri reservoir, Karnataka; Mettur reservoir, Tamil Nadu and Patratu reservoir, Jharkhand.

- Habitat characteristics, fish assemblage and stock dynamics are being studied in 12 wetlands including Bhomra, Mathura, Chandaniya, Bishnupur, Katiganga, Nayachara and Sahebganj of West Bengal, Samaguri in Assam, Loni wetland in UP etc.

- The Institute has identified the Tilapia Lake Virus in tilapia from North 24 Praganas district of West Bengal and reported for the first time in India. Infestation with nematode digenean, *Isoparorchis* spp. was recorded in *Mastacembelus armatus*, *Channa punctatus* and *Sperata aor* in River Tapti. Safety and withdrawal period of antibiotic oxytetracycline have been evaluated in *Pangasianodon hypophthalmus*. Drug usage pattern have been studied in 132 aquaculture farms in Assam. The study showed low amount of drug consumption per ha and no use of antibiotics.

- Exploratory survey of the river Kathajodi, below Naraj Barrage stretch indicated marked impact of the Cuttack city effluents on the water and sediment quality parameters of the river at Matagajapur stretch. As a whole, water availability in the river was recorded to be low during post-monsoon season.

- Mineral fingerprinting of major carp (*Catla catla*) from sewage fed East Kolkata Wetland (EKW) was carried out using advanced tools (ICP/AES). The carps from EKW were found to be safe as far as heavy metal and toxic elements (Co, Pb, Hg, Ni, Cr, Cd, Se and As) are concerned. Moreover, these carps were found to contain comparable quantities of macro and microelements (Ca, P, Na, K, Mg; Mn, I, Cu, Fe, Zn) important in human nutrition.

- Adoption of cage culture technology and its impact has been surveyed in 20 states. The survey estimated that 14018 cages are now installed in different reservoirs with avg. production of 3 MT/cage. Total production from cages (MT) is calculated at 42054 MT and contributes 16.30% of present reservoir production. Fish species cultured in cages are in dominance of Pangasius>Tilapia>Carps.

- The Institute has implemented pen aquaculture in 47-Morakolong beel, Morigaon district, Assam by involving over 600 fishers belonging to scheduled castes (including women). Under the NICRA project, the Institute is demonstrating pen culture technology in beels as an alternative livelihood for increasing adaptive capacity of wetland fishers. CIFRI GI cages (battery of 6 cages) were installed at Samaguri *beel*, Assam for demonstration of CIFRI cage culture technology.

- The Institute has commercialized CIFRI GI Model Cage, CIFRI CAGEGROW, and CIFRI PEN HDPE during 2017-18. The Institute has also developed CIFRI PEN HDPE, Formalin Detection Kit (CIFLIN) and CIFRI-CAGEGROW feed during the same period.

- The Institute has prepared (i) Road Map for Inland Open Water Fisheries development for the Eastern part of India (Bihar, Jharkhand, West Bengal, Odisha) and 7 North Eastern States of India, (ii) roadmap for open water fisheries; inputs have been provided to Telangana and other states for stocking in reservoirs and in situ production of fish seed through cage culture. A draft guideline on reservoir fisheries management has been prepared, (iii) policy document on 'Fisheries management modules for floodplain wetlands of India' has also been prepared.

- The institute organized 3 officers' trainings, 5 students' trainings and 21 fishers/fish farmers training programmes. In addition, 22 exhibitions, 22 awareness camps were also organized for technology dissemination.

Introduction

History

ICAR-Central Inland Fisheries Research Institute started its journey as Central Inland Fisheries Research Station from Calcutta under the Ministry of Food and Agriculture, Government of India on 17 March 1947 following the recommendation of the sub-committee of Central Government on Agriculture, Forestry and Fisheries. The Station was elevated to Central Inland Fisheries Research Institute in 1959 and shifted to Barrackpore, West Bengal in its own building. The Institute came under the umbrella of Indian Council of Agricultural Research (ICAR), New Delhi in 1967. During the last seven decades, the Institute has grown from strength to strength and established itself as a pioneer inland fisheries research institute in India and abroad. The major responsibilities of the Institute were to assess inland fishery resources and to evolve strategies to obtain optimum fish production. The plan priorities of Government of India during the late sixties and seventies were on aquaculture research and development.

The Planning Commission sanctioned five All-India Coordinated Research Projects, namely, Composite Fish Culture, Riverine Fish Seed Prospecting, Air-breathing Fish Culture, Ecology and Fisheries Management of Reservoirs and Brackish Water Fish Farming during 1971-1973. The combined success of Composite Fish Culture and Fish Seed Production projects initiated in 1974 brought blue revolution in the country and laid down a solid foundation for development of freshwater aquaculture.

Since 1980s, the Institute focused its research on inland open water fisheries of rivers, reservoirs, floodplain wetlands, estuaries, lagoons and backwaters. This resulted in development of reservoirs and floodplain wetland fisheries, database on inland open water ecology and fisheries, conservation of rivers and lagoons. The focus of the Institute has recently been inclined towards Natural Resource Management mode and mandate has been modified.

Organizational Structure

To address the mandate, the Institute is organized in the following manner: the Headquarters of the Institute is located at Barrackpore, West Bengal; the Regional Research Centers are located at Allahabad, Guwahati, Bangalore and Vadodara, with Research stations at Kochi and Kolkata. In XI Plan, the research set up of the Institute has been re-structured in to three Research Divisions, viz.,

- Riverine Ecology and Fisheries Division
- Reservoir and Wetland Fisheries Division
- Fisheries Resource and Environment Management Division

Besides these, Socio-economic research, Extension and Training activities are carried out through the 'Agricultural Economics Section' and 'Extension and Training Cell', respectively. The research activities under each of these divisions are led by Heads of Divisions appointed by ICAR. While the Regional Centers at Allahabad and Guwahati are administered by Heads of Regional Centers appointed by ICAR, other research centres are administered by Officers-in-Charges. The Institute

has cadre strength of 95 Scientists, 85 Technical Officers, 66 Administrative and 130 Supporting personnel.

Head Quarter of the Institute has a number of support services, viz. Administration Section, Audit and Accounts Section, PME Cell, Hindi Cell, AKM Unit, Library and Informatics Section, Institute Technology Management Unit, Hindi Cell, Stores Section, Vehicle Section, and Nodal Officers for MGMG programme, TSP programme, RFD and HRD executing different functions of the Institute.

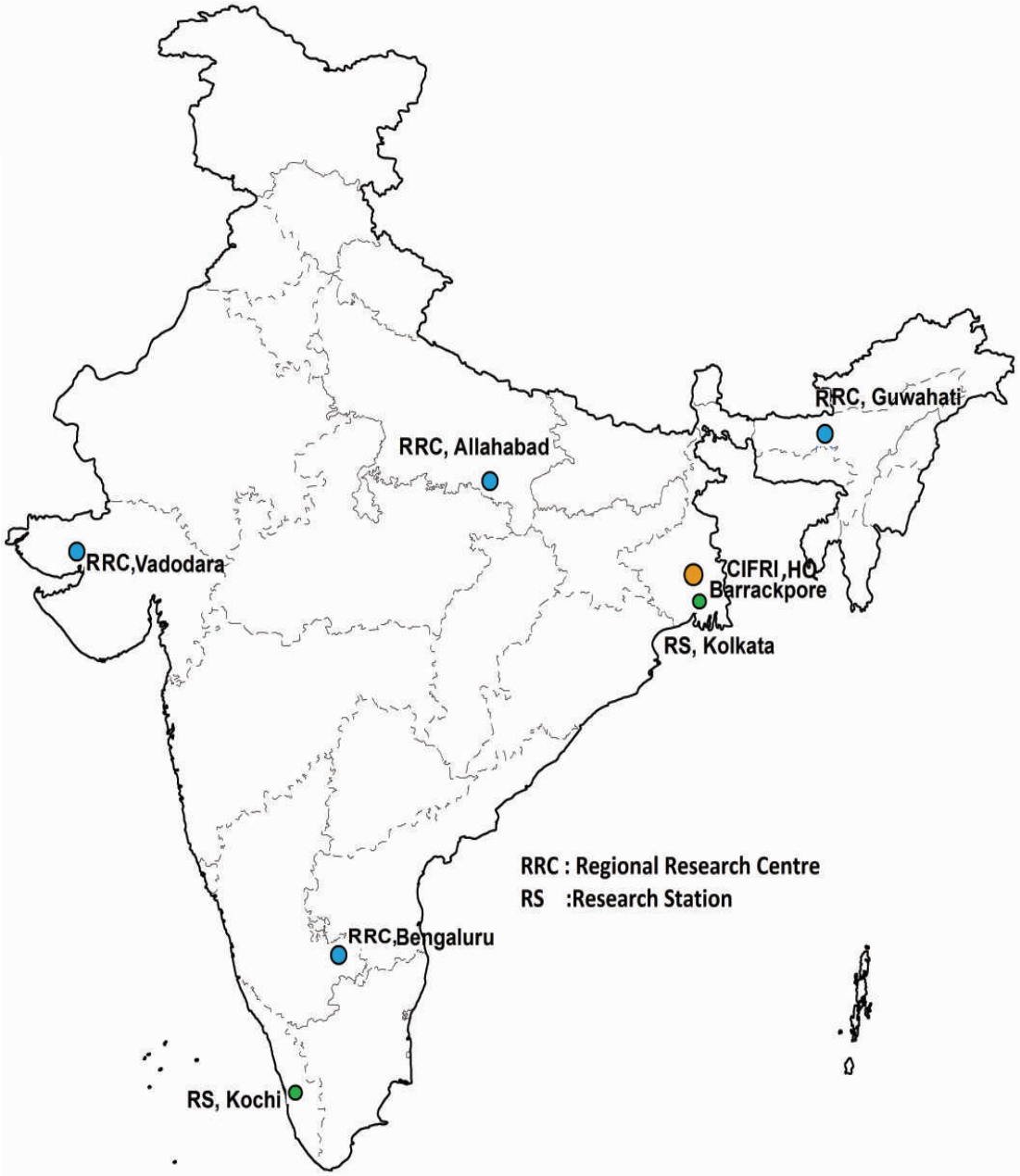
The Director leads the Institute and is responsible for overall research, administrative and financial management with support and guidelines from concerned Sections, Institute Management Committee, the Institute Research Committee and the Research Advisory Committee. The Institute is ISO 9001: 2015 certified.

Ornamental Fish Hatchery Unit

Organogram of ICAR-CIFRI

- **Director**
  - Research Advisory Committee
  - Institute Management Committee
  - **Research Division**
    - Riverine Ecology & Fisheries
    - Fisheries Resource & Environmental Management
    - Reservoir & Wetland Fisheries
  - **Regional Research Centre**
    - Allahabad
    - Guwahati
    - Bangalore
    - Vadodara
    - **Research Station**
      - Kolkata
      - Kochi
  - **Administration**
    - General
    - Stores & Vehicle
    - Works & Utility
  - **Finance**
    - Audit & Accounts
    - ICAR Pension Cell
  - **Sections/Cells/ Units**
    - Agricultural Economics Section
    - Library & Informatics Section
    - Extension & Training Cell
    - PME Cell
    - IT & AKM Unit
    - Hindi Cell
    - ITMU

Location of ICAR-CIFRI Headquarters, Regional Research Centres and Research Stations



Budget Details

Budget details for the Year 2017 – 18 (` in Lakh)

Head of Account	Budget (RE)	Expenditure
	Institute	Institute
Pay and Allowance including OTA*	8781.60	8781.07
TA	57.00	57.00
Other Charges including Equipment, Library Books, IT and HRD	708.00	707.54
Works	294.75	295.12
Grand Total	**9841.35**	**9840.73**

*includes Pension also

The Budget & Expenditure under Non Plan and Plan for the Financial Year 2017 – 18 (` in Lakh)

Budget Head	Institute	
	Budget	Expenditure
Revenue	**3008.60**	**3008.00**
Estt. Charges	2350.00	2349.91
OTA	0.60	0.16
TA	57.00	57.00
Other Charges		
Office Buildings	36.67	36.67
Residential Buildings	19.73	19.72
Minor Works	3.09	3.09
Misc expenses including HRD	502.51	502.46
TSP general	14.00	13.99
NEH General	25.00	25.00
Capital	**401.75**	**401.73**
Equipment*	59.62	59.62
Information Technology	15.00	15.00
Library Books	5.00	5.00
Vessel		
Furniture & Fixture	20.00	20.00
Works	290.16	290.16
Minor Works	4.97	4.96
TSP Capital	5.00	4.99
NEH Capital	2.00	2.00
Total	**3410.35**	**3409.73**
Pension	6431.00	6431.00
Total	**9841.35**	**9840.73**
Loans & Advances	15.00	11.00

*Plan Equipment includes 'Other Equipment' of ` 5.00 lac

Cont.....

Other projects

Budget Head	Budget			
	Receipts (including opening balance)		Expenditure	Refund
NICRA	0.33	48.00	42.55	0.33
CABIN	0.02	13.22	13.06	-
NASF	12.36	20.83	21.84	11.18
ITMU	0.01	6.36	4.04	-
SIT-TXMU	-	-	-	-
Fish Health	0.98	12.50	12.29	0.98
Deposit Schemes (Externally Funded)	155.44	190.99	183.50	0.00
Consultancies	138.85	220.37	156.73	

Revenue receipts

Head	ICAR	Institute	Target	Achievement
Income from Sales / Services	12.08	73.60	-	12.08
Fee / Subscription	00.00	-	-	0.00
Income from Royalty, Publication etc.	00.00	-	-	0.00
Other Income	20.77	-	-	23.28
STD Interest	15.35	-	-	15.35
Sale of Assets	02.52	-	-	-
Recoveries on Loans and Advances	10.75	-	-	10.75
CPWD / Grants Refund	25.67	-	-	25.67

UNITED REGISTRAR OF SYSTEMS · CERTIFICATION · URS

Certificate of Registration

This certificate has been awarded to

ICAR- Central Inland Fisheries Research Institute

26, Barrackpore, Kolkata, West Bengal, 700120, India

in recognition of the organization's Quality Management System which complies with

ISO 9001:2015

The scope of activities covered by this certificate is defined below

Basic and Strategic Research in Inland Open Water Fisheries

Certificate Number:	Date of Issue: (Original)	Date of Issue:
8637QA1001NB/En	30 May 2018	30 May 2018
Issue No:	**Expiry Date:**	
1	29 May 2021	

Issued by: *On behalf of the Schemes Manager*

UNITED REGISTRAR OF SYSTEMS · URS · ISO 9001

NABCB QM016

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT · IAF

Riverine Ecology and Fisheries

Project Title : Habitat characterization, fisheries and socioeconomics of rivers Cauvery, Tapti, Siang and Chaliyar

Project No.: REF/17-20/07

Project Staff : V. R. Suresh, B. K. Bhattacharya, S. K. Das, Feroz Khan, R. K. Manna, C. M. Roshith, T. T. Paul, Manas H. M. (transferred), K. Kumari, R. Baitha, N. R. Nayak, S. P Kamble., T. N. Chanu, W. Anand Meetei, Sabina Mol S., Vaishak G., A. Saha, S. K. Koushlesh, S. Borah, N. S. Singh, S.Sharma, P. Gogoi, S. K. Sahu, A. Roy, R. C. Mandi, C. N. Mukherjee, A. Sengupta, D. Saha, A. R. Chowdhury, S. Mandal, K. K. Sharma, A. Kakati, M. E. Vijaykumar, S. Manoharan. U. Unnithan, R. K. Sah and J. K. Solanki

Major river systems in India are the Indus, Brahmaputra, Ganga, Narmada, Tapti, Godavari, Krishna, Cauvery and Mahanadi. All these rivers are undergoing various forms of ecosystem degradation, change or loss of habitats of prized fishes, resulting in catch and diversity decline, which in turn adversely affect the livelihoods of riparian population. An understanding on how river habitats and their surrounding environment shape the structure of fish assemblages is valuable in restoration, and management and conservation of fish populations. The project targeted studies on rivers Cauvery, Tapti, Siang and Chaliyar, distributed along the southern, western and north eastern region of India.

RIVER CAUVERY

Habitat characterization

The stretches studied were the upper stretch (Bhagamandala to Hogenakkal), the middle stretch (Bhavani) and the lower stretch (Kollidam, Poompuhar and Pazhaiyar). Some of the major physical habitat parameters recorded are presented.

Physico-chemical parameters of water and sediment

Water abstraction as well as obstruction at weirs, barrages and dam made the river partially lentic with sluggish flow at some stretches and paved way for luxuriant growth of aquatic macrophytes. Higher dissolved oxygen (8.16 to 10.42 mg l^{-1}) at T. Narsipura and Shivanasamudram are result of dense submerged macrophytes. Discharge by nearby aquaculture farm might have a role in significantly low dissolved oxygen (4.56 ± 0.47 mg l^{-1}) at Poompuhar.

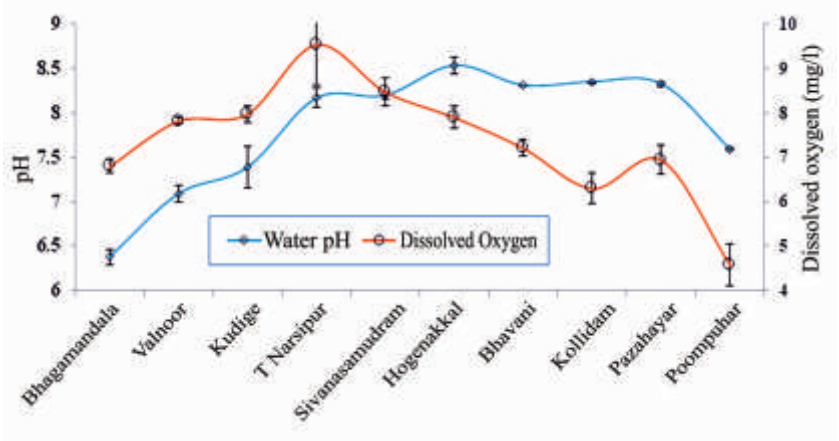


Fig.1.Water pH and dissolved oxygen in river Cauvery

Table 1 : Physical habitat characters of river Cauvery

No	Physical habitat parameters	Bhaga-mandala	Valnur	Kudige	T. Narasipura	Shivana-samudram	Hogenakkal	Bhavani	Kollidam	Pazhaiyar	Poompuhar
1	Right bank slope (□)	60	45	56	8	22				3	3
2	Left bank slope (m)	60	45	28	6	26				2	2.5
3	Bank full width (m)	21	65	1.	430	450		589	1245		
4	Wetted width (m)	15-17	55-57	9.5	930	410		315	368	750	80
5	Thalweg depth (m)	1.4-1.7	2.5-2.8	3.6	4.2	3.9 4	5.5-6.8	4.4			
6	Mean depth (m)	0.75-0.91	0.6-0.75	2.2	2.3-2.4	1.2-1.8	4.1- 4.5	2.1-2.3	1.7		
7	Depth averaged velocity (m/s)	0.4	0.26-1.5	0.4 – 3	0.4 - 1.15	0.15 0.15	0.4-1.1	0.01- 0.05			
8	Canopy cover on stream (%)	64	85	65	70	55	30	10	15	20	5
9	Riparian vegetation cover (%)	45-50	80-85	90	50-60	50-60	30-35	30-35	25	45	5
10	Barren land cover (%)	15	0	10	30 40	30	55 65	25 30	30	25	10
11	Agricultural land/ farm (%)	35 50	15 20	0	10 20	10 20	5 10	35 45	45	30	85
12	Littoral vegetation (%)	85	90		35	55	15	20	20	25	
13	In stream vegetation (%)	5	20		65	45	10	30	15	10	
14	In stream rock cover (%)	20	55		10	15	25	10	10		
15	% in stream cover and refuge	25	75		75	60	35	40	25		
16	Pool (%)	10-30	10-25	15	60-70	15-30	10	30	35	0	0
17	Run (%)	30-95	30-70	40	30-40	35-40	35	30	65	100	100
18	Rapids/ Riffles (%)	0	5 10	15	0	25 30	30	0	0	0	0
19	Sand (%)	20	5	15	45	15	5	50	80	95	100
20	Gravel (%)	30	30	25	15	10	5	10	5	5	
21	Pebble (%)	25	25	20	15	25	20	0	0		
22	Cobble (%)	10	20	25	10	20	25	20	5		
23	Boulder (%)	15	20	15	15	30	45	20	20		

Steady increase in water temperature was recorded from upstream to downstream with significantly higher temperature in three downstream stations, viz. Kollidam, Pazhayar and Poompuhar. Total alkalinity, increased from 42 mgl^{-1}at Kudige to 184 mgl^{-1}at T. Narsipura, a possible impact of local pollution load from nearby cities and towns, more vivid in low water depth (2.13±0.25 m) with low flow.

Specific conductivity and total hardness had higher values in the three estuarine stations. Sharp increase in these parameters were recorded from Kudige to T. Narsipura.

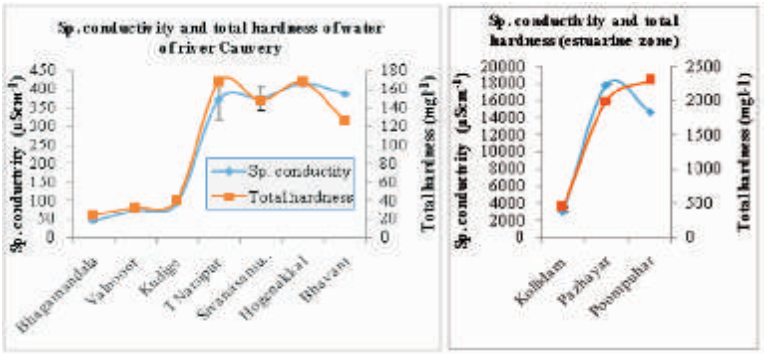


Fig.2.Specific conductivity and total hardness of water of river Cauvery

Bottom soil had 97 to 99% sand; slightly lower values were recorded at Valnoor (89% sand) and T Narsipura (95% sand). Soil organic carbon was mostly less than 1% except at T Narsipura (1.12%). Soil pH was acidic in uppermost two stations (Bhagamandala and Valnoor), neutral to alkaline at rest of the stations.

Soil available P varied in a narrow range of 5.2 to 6.4 mg per 100 g in river Cauvery. Soil sp. conductivity (μScm^{-1}) was low (26.3 to 77.0) at hilly stretch of Bhagamandala to Kudige, moderate (133.2 to 263.0) from T Narsipura to Bhavani, increased sharply (1534 to 2790) in estuarine stretch caused by saline water intrusion.

Diversity and abundance of fish

A total of 86 fish species belonging to 32 families were recorded. The highest diversity (35 species) was recorded at Shivanasamudram owing to the high habitat heterogeneity (falls, rapids, runs, riffles and pools). Lowest diversity was recorded from Kudige as this site represented a narrow hillstream with low habitat heterogeneity. But, the average number of species recorded per station was highest for the lower estuarine sector due to the dominance of marine migrants.

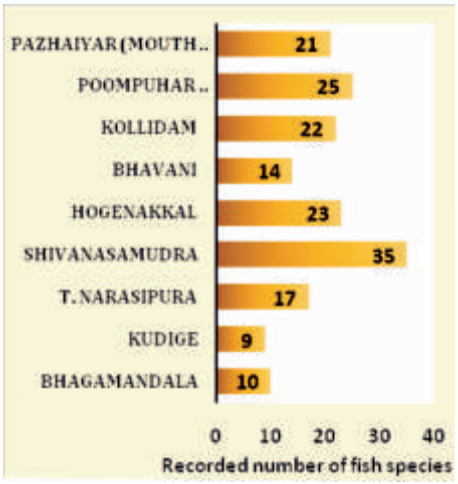


Fig.3. Number of fish species recorded at different stretches of river Cauvery

Shellfish diversity

There is no established commercial fishery of shell fishes in river Cauvery. The species recorded are *Penaeus monodon*, *P. indicus* and *Litopenaeus vannamei*. The occurrence of *L. vannamei* is reported for the first time from the wild along the lower estuary stretch of the river. The introduction of the species into the wild may have happened accidentally from the nearby aquaculture farms where culture of the species is carried out.

Diversity and abundance of macrobenthos

A total of 45 species namely gastropods (12 families, 16 species), bivalves (7 families, 12 species), insects (4 species), Polychaetes (3 species), Oligochaetes (2 species), crustacean (4 species), Isopods (one), Amphipods (2 species) and Barnacles (one species) were recorded during monsoon and post-monsoon sampling. Bellamidae, a gastropod family, was most abundant (146.2 nos. m^{-2}) during monsoon while the clam family Corbiculidae dominated during post-monsoon (104.3 nos. m^{-2}).

Diversity and abundance of plankton

A total of 38 genera of phytoplankton belonging to four families were identified. Phytoplankton belonging to 14 genera were recorded during monsoon whereas 35 genera during post monsoon season. Bacillariophyceae was found to be the most diverse family in both the seasons. The quantitative abundance varied from 30-900 $cells l^{-1}$ in monsoon and 4-1800 $cells l^{-1}$ in winter. During post monsoon season, Bacillariophyceae dominated the middle and lower stretches by 73%and 70% respectively, followed by Chlorophyceae (18 and 11% respectively). In the upper stretch, Bacillariophyceae dominated the phytoplankton diversity by 61%, followed by Cyanophyceae (27%). Among Bacillariophyceae, 32% was *Navicula*, 21% *Nitzschia* and 14% *Skeletonema*. The plankton abundance was found to be very low in the upper stretch. During monsoon, it was observed that phytoplankton belonging to the family Cyanophyceae dominated at Bhagamandala (900 nos.l^{-1}) and Valnoor (600 nos.l^{-1}), and Bacillariophyceae (1200 nos.l^{-1}) dominated at Poompuhar, followed by Chlorophyceae (330 cells l^{-1}).

Fishing crafts and gear

The major fishing craft used in the freshwater stretch of the river is "*Coracle*", both fibre as well as bamboo made. Towards the brackishwater stretch, fibre boats of about 7 m length were used for fishing.

Fish catch and effort

Initial surveys revealed presence of 86 species belonging to 32 families, mostly belonging to Cyprinidae family. Thirty five species were recorded from Shivanasamudram having higher habitat heterogeneity (falls, rapids, runs, riffles and pools), 9 species at Kudige (narrow hill stream with low habitat diversity). Major families were Cyprinidae (31 species), Mugilidae (6 species) and Leiognathidae (5 species). Three exotic species (*Oreochromis mossambicus*, *O. niloticus* and *Clarias gariepinus*). *O. mossambicus* was found established throughout the river. Relative abundance (% of total catch) of exotics were *O. mossambicus* (69.14 %), *C. gariepinus* (4.94 %) and *O. niloticus* (3.46 %). In T. Narasipura exotics constituted 77.54 % of the total fish catch from the river.

Preliminary estimates determined the fish catch as 42-170 kgday^{-1} across the stations, with the highest catch at Kollidam (170 kgday^{-1}) and lowest at Bhavani (42 kgday^{-1}). The corresponding fish yield was estimated at 5.4-14 kgkm^{-1}day^{-1}.

Table 2 : Preliminary estimates on fish catch and yield at selected landing centres of Cauvery

Landing centre	Fish catch (kgday^{-1})	Fish yield (kgkm^{-1})
T. Narasipura	65	6.2
Shivanasamudram	55	9.3
Hogenakkal	62	8.3
Bhavani	42	5.4
Kollidam	170	14

Socio-economic status of fishers

Data were collected from fishermen households, labourers hired by fishermen (direct dependents) and middleman-traders (indirect dependents). In order to understand livelihoods, both men and women were interviewed. Important indigenous fishermen castes found in Cauvery River stretches are *Setti/Sibnapadayar* and *Varurathuragakulam*. An attempt was made to document the number of fishermen population dependent on the River Cauvery for their livelihoods. Data were collected from the Fishermen Cooperative Societies as well as from village panchayats.

Average income of fishers exclusively from fishing in river Cauvery was ? 9000/month. Fishers have 56% dependence on river Cauvery for their livelihoods. Other than fishing, fishers were also involved in agriculture and livestock rearing activities (25%) and as labourer (19%) for earning their livelihoods.

RIVER TAPTI

Ten stations distributed along river Tapti were selected for the study. The upper stretch comprised five stations (Multai, Betul, Dedtalai), middle stretch (Nepanagar, Burhanpur, Bhusawal) and lower stretch comprising four stations (Savkheda, Sarangkheda, Singal Khanch, Surat).

Physico-chemical parameters of water and sediment

Mean water temperature in Tapti River was recorded at 29°C during monsoon with maximum temperature of 31°C recorded at Kamrej (Gujarat) and minimum temperature of 26°C observed at the uppermost station (Multai). Higher transparency was observed during post-monsoon in all the stations.

Dissolved oxygen was above 6 mg l^{-1} and congenial for fish. Water pH ranged between 7.6 to 8.7. Total alkalinity was highest in middle stretch at Burhanpur station (202.3 mg l^{-1}) and in lower stretch at Kamrej station (250 mg l^{-1}) during monsoon and post- monsoon season respectively; thus water was "hard" with

high buffering capacity. Nitrate level at middle stretch (Bhusawal, Burhanpur and Nepanagar) were high (0.6 mg l^{-1}) possibly due to mixing of extraneous nitrogen-rich material like sewage.

Sediment pH was neutral to slightly alkaline during monsoon season. Available phosphorus content in sediment during monsoon season was recorded highest in upper stretch at Betul (34.50 mg 100 g^{-1}), followed by Burhanpur (33.60 mg 100 g^{-1} soil). There was very high organic carbon content at Burhanpur (Fig.4) which might be due to accumulation of high organic waste discharge from Burhanpur city. Entry of pollutant ions might be a reason behind increasing specific conductivity in samples from upper and middle stretches (Fig.5).

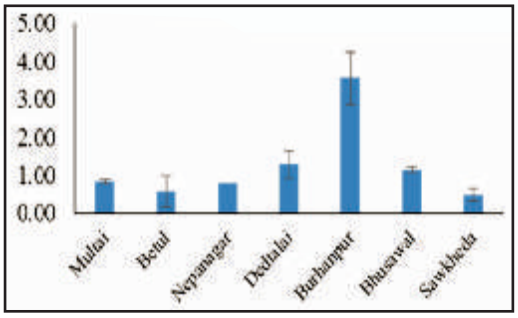


Fig.4. Organic carbon content (%) in sediment of Tapti River

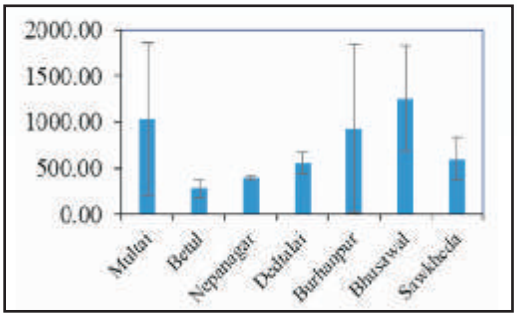


Fig.5. Specific conductivity (µS cm^{-1}) in sediment of Tapti River

Diversity and abundance of fish

A total of 51 finfish species belonging to 34 genera in 15 families were recorded during 2017-18. All along the studied stretch highest species richness was found for the family Cyprinidae (24 species), followed by Bagridae (5 species), Channidae (4) and Nemacheilidae (3). Fish species richness was observed higher in Bhusawal (24 species), Nepanagar (23 species) and Burhanpur (23 species), however it was low at lower stretches of the river viz. at Sarangkheda and Kamrej (9 species each). The survey also recorded occurrence of *Oreochromis mossambicus* and *O. niloticus* only in riverine stretch at Multai (upper stretch) and Bhusawal (middle stretch) respectively. The relative abundance of *O. mossambicus* and *O. niloticus* were 67 % and 8% respectively at Multai and Bhusawal.

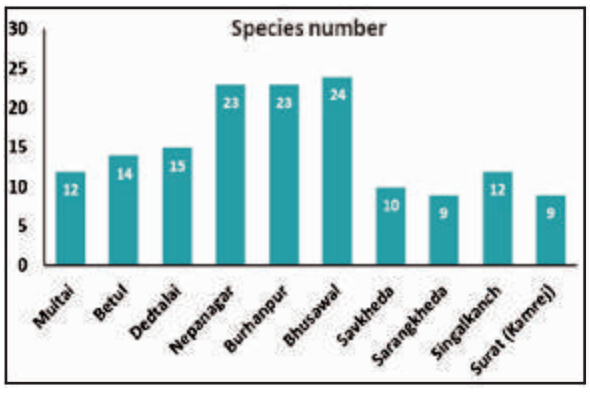


Fig.6. Station-wise species richness at river Tapti

Diversity of Shellfish

Four species of freshwater prawns belonging to two genera and two families were recorded. *Macrobrachium tiwari* was most abundant (36%) during monsoon, followed by *M. kistnense* (30%), *Caridina* sp. (19%) and *M. lamarei lamarei* (15%); however, *Macrobrachium lamarei lamarei* was the

Table 3 : Physical habitat characters of river Tapti

No.	Physical habitat	Multai	Betul	Dedtalai	Nepanagar	Burhanpur	Bhusawal	Savkheda	Sarangkheda	Singalkanch
1	Right bank slope (%)	14.47	27.6	32.85	19.23	30.68	9.88	31.01		
2	Left bank slope (%)	13.5	32.74	37	24.065	11.98	15.85	27.49		
3	Bank full width (m)	24.5	101.5	202	227	248	432	223.4	117.67	450
4	Wetted width (m)	3.5 – 9.5	25-29.5	117.5	165	95	245	181.5	109.33	287
5	Thalweg depth (m)	0.3	1.07	1.5	2.7	2.06	3	0.99		
6	Mean depth (m)	0.1-0.35	0.19-0.5	0.4-0.9	1- 1.5	0.25-4.1	0.20-1.04	0.2- 0.474		
7	Depth averaged velocity (m/s)	0.4	0.26-1.5	0.04 0.3	0.4 - 1.15	0.1-0.15	0.4-1.1	0.01- 0.05		
8	Canopy cover on stream (%)	20-25	5	5	0	0	0	0	0	40
9	Riparian vegetation cover (%)	60-75	65-75	65-70	35-50	35-40	25-30	80-85	67	60
10	Average barren land cover (%)	25-40	20-25	30-35	50 -55	55-60	70-75	15-20	33	
11	Agricultural land/farms (%)	0.	5	10	0	5	5	50		10
12	Littoral vegetation (%)	2-5	5	45	10	10	20	15	5	
13	Instream vegetation (%)	3-10	2	25	5	5	5	10		
14	Instream rock cover (%)	25-35	40		30	5	10			
15	Instream 'cover and refuge'	30-50	42	25	35	10	15	10		
16	Pool area (%)	50-100	20-25	15-100	20	90	65-85	20-95		
17	Run area (%)	0.-50	50-60	0-85	60-65	10	10-25	5-80		
18	Rapid/ Riffles area (%)	0	20-25	0	15-20	0	5-10	0		
19	Sand area (%)	5	2	10	2	10	0	2.5	2	
20	Gravel area (%)	5	3	15	2	5	0	75	70	
21	Pebble area (%)	15	20	45	6	40	10	22.5	3	
22	Cobble area (%)	35	45	40	60	35	30	2.5	5	
23	Boulder area (%)	40	30	0	30	10	60	0	20	

only prawn species recorded from the middle stretch (Bhusawal and Savkheda) during post monsoon. Only one species of crab, *Barytelphusa cunicularis*, belonging to family Gecarcunidae was recorded.

Diversity of macrobenthos

Abundance of benthos in Tapti River during monsoon and post monsoon season ranged from 407 to 7391 and 11 to 396 um^{-2} respectively (Fig.7). Maximum diversity (Simpson's index) was at Singalkanch (lower stretch) during monsoon (0.817) and at Multai (upper stretch) during post monsoon (0.787). Biological Quality of River using Invertebrates (BMWP) value at Sarangkheda stretch in Maharashtra was 44 implying moderate impact to pollution; remaining stations fell under category of poor and very poor during monsoon. Multai in Madhya Pradesh scored 41 in BMWP during post monsoon season indicative of moderate impact while the rest were poor to very poor. Dedtalai, Burhanpur, Bhusawal and Savkheda, whose BMWP score were less than 40, fall under the category of poor indicating the stretches were polluted or impacted. Multai, Sarangkheda and Singalkanch stretches were moderately impacted indicated by score ranging between 41 and 70.

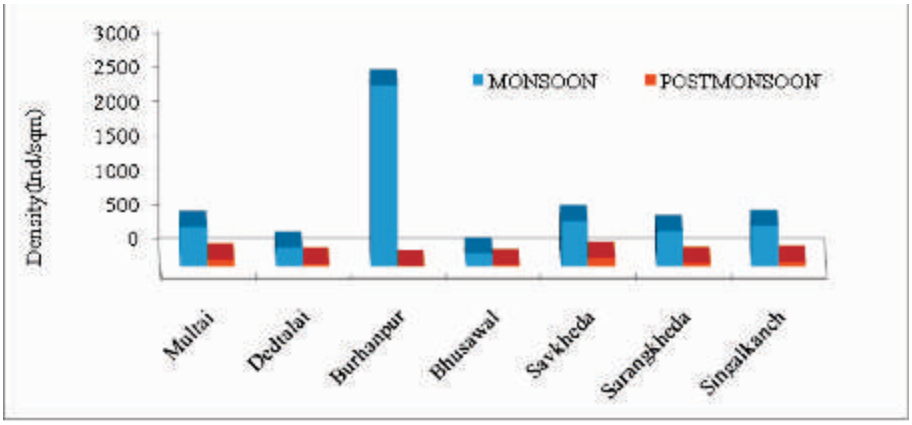


Fig.7. Macrobenthos density in river Tapti in monsoon and post-monsoon season

Diversity and abundance of plankton

The study identified a total of 119 species of phytoplankton belonging to 98 genera from ten sampling stations. Out of 11 algal groups Cyanophyceae was the most dominant in terms of abundance (0.180 x 10^3 to 21.17 X 10^3 cells l^{-1}), while Bacillariophyceae in diversity (42 species). The quantitative abundance of

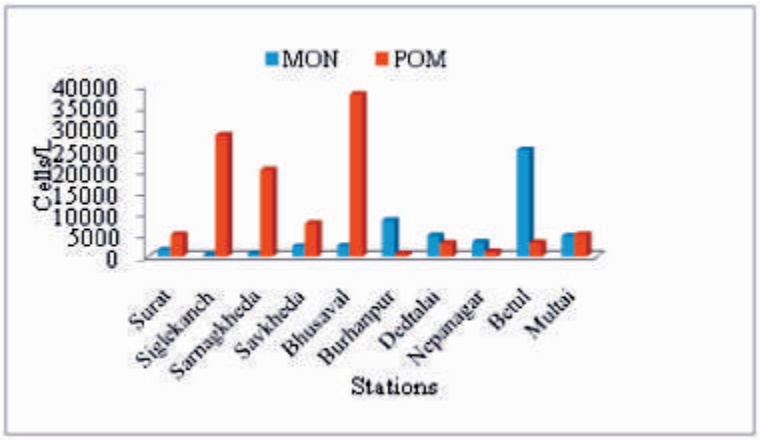


Fig.8. Abundance of phytoplankton in different stretches of river Tapti

phytoplankton ranged from 0.411 x 10^3 to 38.11 X 10^3 cells l^{-1}, being highest at Bhusaval during post-monsoon and lowest at Singlekanch during monsoon season. The station-wise abundance of phytoplankton is shown in Fig.8.

Twenty nine species of zooplankton comprising 16 species of rotifera, 7 species of cladocera and 3 species each in calanoida and cyclopoida were recorded. Zooplankton abundance was highest at Burhanpur and lowest at station Surat (Fig.9). The quantitative abundance of zooplankton was range from 71 to 3,533 no.l^{-1} during the study period.

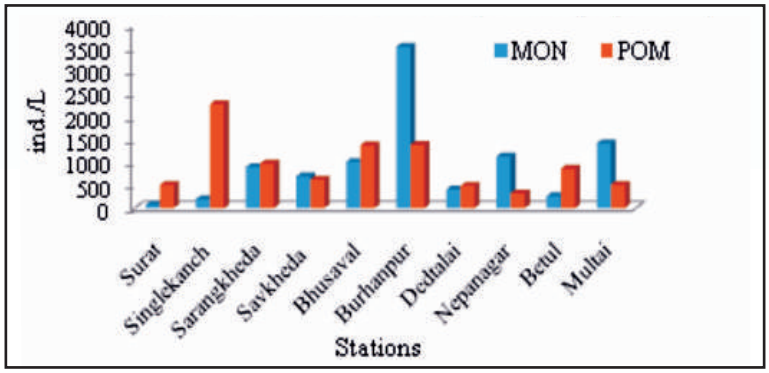


Fig.9. Abundance of zooplankton in different stretches of river Tapti

Fish and shellfish parasites

There are meagre information on parasites in fishes in rivers. Present study revealed low to moderate levels of parasitic infection in fishes in river Tapti. The stations at which fishes were found positive for parasitic load were Dedtalai and Nepanagar in middle stretch. About 1,332 fish specimen belonging to 13 families were screened for 'Blackspot' and 'diplostomiasis' disease. The 'Blackspot' (Fig. 10 a and b) and 'diplostomiasis' (Fig. 10 c and d) were recorded from *Parambasis ranga* at Dedtalai and *Sperata*

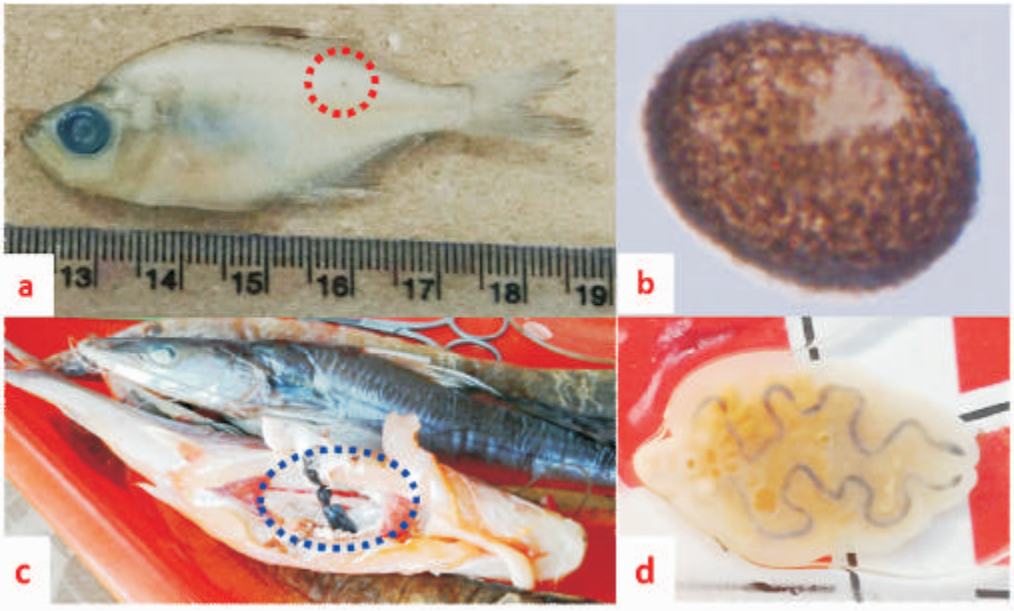


Fig.10. Clinical manifestation of parasite: a) 'Blackspot' in *P. ranga*, b) Metacercarial cyst of *Posthodiplostomum* sp., c) Diplostomiasis in *S. seenghala*, d) *Isoparorchis* sp. from swim bladder

seenghala at Nepanagar respectively. The *Posthodiplostomum* sp. and *Isoparorchis* sp. are the causative agent for 'Blackspot' and 'Diplostomiasis' disease in *P. ranga* at Dedtalai and *S. seenghala* at Nepanagar respectively. The prevalence, mean intensity (MI) and mean abundance (MA) for *Posthodiplostomum* sp. were 1.8%, 1.4 and 0.97 in *P. ranga.* While, the *Isoparorchis* sp. have prevalence (0.07), MI (2) and MA (0.05).

Fishing crafts and gears

'Gill net' was found to be the most commonly used fishing gear along Tapti River course in both the seasons, comprising about 54.67% (in monsoon) and 58.70 % (in post monsoon) of total gears used (Fig 11). The mesh size of gill net was found in the range of 10-120 mm, however small mesh size gill nets (10-30 mm) operated during monsoon season and >60 mm mesh size nets were found in post monsoon.

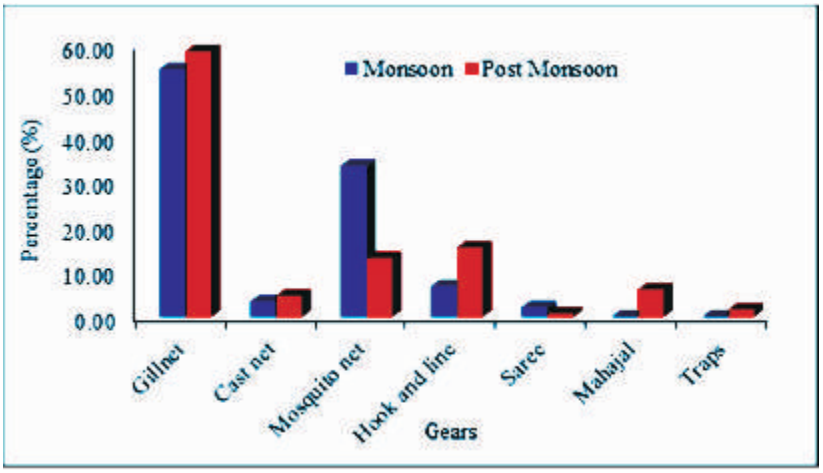


Fig.11. Use of different fishing gears in River Tapti

Fish catch and effort

The fish catch composition revealed dominance of Cyprinidae family (48%), followed by Bagridae (19%), Channidae (14 %) and Mastacembelidae (8%). Preliminary study indicated Nepanagar, Burhanpur and Bhusawal as the major fish assembly centres along the banks of river Tapti during October to November, 2017. Fish catch was highest at Burhanpur (25 km riverine stretch) amounting to 106.7 to 135 kgday^{-1} during October to November 2017, while it was only 51.33-68.0 kgday^{-1}at Nepanagar (20 Km riverine stretch). The initial findings suggested non-existence of commercial shellfish fishery. The harvested and marketed component of fish productivity during October to November, 2017 from Burhanpur and Nepanagar was estimated to range from 4.27-5.4 kgkm^{-1}day^{-1} and 2.56-3.4 kgkm^{-1}day^{-1}respectively. However, the mean values for this was estimated at 4.83 kgkm^{-1}day^{-1} for Burhanpur and 2.98 kgkm^{-1}day^{-1} for Nepanagar. Fish catch in the lower stretch were estimated at 35 kg day^{-1} at Sarangkheda, 38 kgday^{-1} at Singalkanch and 5 kgday^{-1} at Kamrej. As per the information from stakeholders the commissioning of barrage near the river mouth at Surat leads has led to less catch. The absence of tidal water also affects the catch of estuarine and marine fishes in the stretch. Gear-wise estimate of CPUE was obtained at each station (Table 4).

Table 4: Estimated catch per unit effort (CPUE)

Station	Gear	Average CPUE (kg/operation)
Singalkanch	Gill net	3.5
Sarangkheda	Hook and Line	4
	Gill net	7
	Mahajal	10
Kamrej	Hook and Line	3
	Gill net	8

Socio-economic status of fishers

Fishermen mainly belonged to caste Dheemar, Bhoi, Jhinga Bhoi, Machhindra and Bhoi**.** Average income of the fishers from riverine fisheries in this river was ? 6500 month^{-1}. Fishers depend on the river for 6.5 man months for their livelihoods. Other livelihood options of the fishers of RiverTapti are mainly petty business, labourer at stone mines and agricultural labourer.

RIVER SIANG

Characterization of different habitats

Six stations distributed along river Siang were selected for the study. The upper stretch comprised two stations (Puging, Yingkiong), middle stretch (Boleng, Komsing) and lower stretch comprising two stations (Pasighat, Oiramghat).

Physico-chemical parameters of water and sediment

Water was highly turbid at the time of study as transparency was as low as 2 cm and to a maximum of 30 cm in all the selected sites which was also supported by total dissolved solids as high as 265 mgl^{-1} and specific conductivity as high as 415 mScm^{-1} during the study which could lead to less light penetration into the river water thereby affecting the lives of many aquatic communities.

Diversity and abundance of fish

A total of 31 finfish species under 8 families were recorded during the study and cyprinidae was the most dominant family forming more than 70% of total individuals sampled. Highest species diversity was recorded from Komsing (middle stretch) during post-monsoon whereas it was in Oiramghat (lower stretch) during monsoon. Overall highest species diversity was recorded from Oiramghat (Fig. 12).

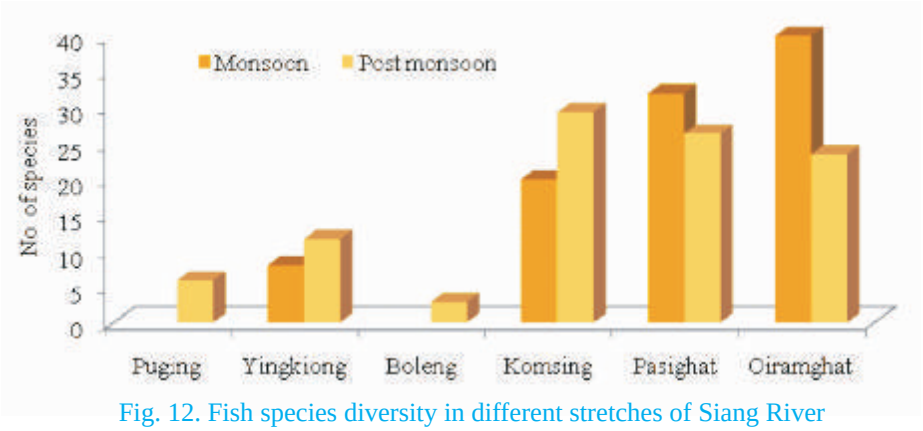


Fig. 12. Fish species diversity in different stretches of Siang River

Diversity and abundance of plankton

A total of 33 species of phytoplankton belonging to 24 genera were recorded. Bacillariophyceae (203±333) and Cyanophyceae (71±43) were most abundant. Twenty four species of diatoms, dominated by Pennales were recorded. *Synedra ulna*, *Nitzschia palea*, *Fragilaria* sp., *Navicula* sp. *Cymbella* sp., *Gyrosigma* sp. *Diploneis* sp. and *Gomphonema* sp. were dominant diatom taxa during the study period. The group-wise abundance of phytoplankton is shown in Fig. 13. Major zooplankton were copepod nauplius (52%), other copepods (29%) and insect larvae (18%). The quantitative abundance of zooplankton was 15-134 ind.L^{-1}, highest at station Yingkiong (Fig.14). The occurrence of lower density of plankton may be due to sudden change of water quality, which was extremely turbid (water transparency< 4.0 cm) during the study.

Table 5: Physical habitat parameters of river Siang

No.	Physical habitat	Puging	Yingkiong	Boleng	Komsing	Pasighat	Oiramghat
1	Right bank slope (%)	14.47	27.6	32.85	19.23	30.68	9.88
2	Left bank slope (%)	13.5	32.74	37	24.065	11.98	15.85
3	Bank full width (m)	24.5	101.5	202	227	248	432
4	Wetted width (m)	3.5 – 9.5	25-29.5	117.5	165	95	245
5	Thalweg depth (m)	0.3	1.07	1.5	2.7	2.06	3
6	Mean depth (m)	0.1-0.35	0.19-0.5	0.4-0.9	1- 1.5	0.25-4.1	0.20-1.04
7	Depth averaged velocity (m/s)	0.4	0.26-1.5	0.04 – 0.3	0.4 - 1.15	0.1-0.15	0.4-1.1
8	Canopy cover on stream (%)	20-25	5	5	0	0	0
9	Riparian vegetation cover (%)	60-75	65-75	65-70	35-50	35-40	25-30
10	Average barren land cover (%)	25-40	20-25	30-35	50 -55	55-60	70-75
11	Agricultural land/farms (%)	0.	5	10	0	5	5
12	Littoral vegetation (%)	2-5	5	45	10	10	20
13	Instream vegetation (%)	3-10	2	25	5	5	5
14	Instream rock cover (%)	25-35	40		30	5	10
15	Instream 'cover and refuge'	30-50	42	25	35	10	15
16	Pool area (%)	50-100	20-25	15-100	20	90	65-85
17	Run area (%)	0.-50	50-60	0-85	60-65	10	10-25
18	Rapid/ Riffles area (%)	0	20-25	0	15-20	0	5-10
19	Sand area (%)	5	2	10	2	10	0
20	Gravel area (%)	5	3	15	2	5	0
21	Pebble area (%)	15	20	45	6	40	10
22	Cobble area (%)	35	45	40	60	35	30
23	Boulder area (%)	40	30	0	30	10	60

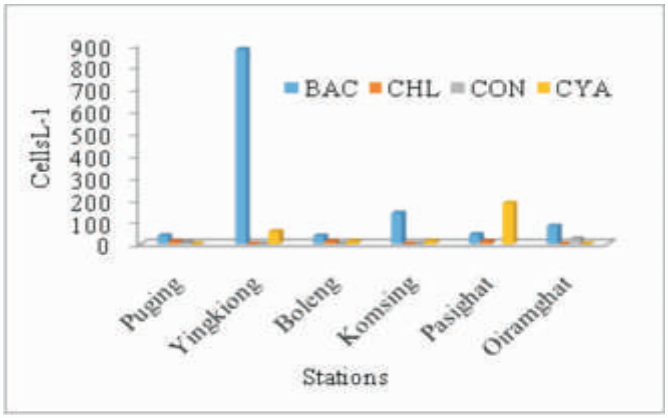


Fig. 13. Group-wise abundance of phytoplankton

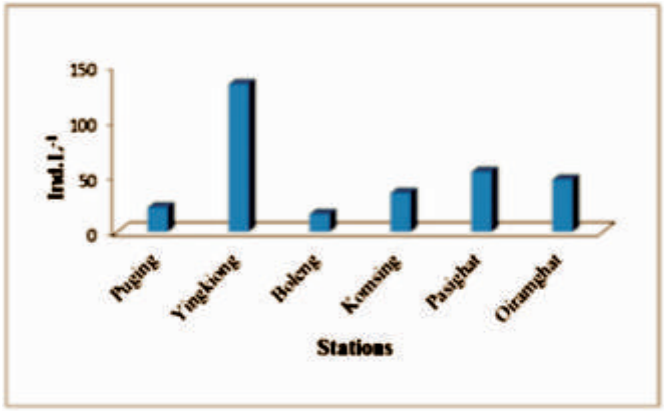


Fig. 14. Station-wise abundance of zooplankton

Table 6: Gear-wise CPUE operated in Siang River

Station	Gear		CPUE	Craft
	Type	Local name		
Puging	Gill net	---	0.5-0.75 Kggear^{-1}day	Bamboo raft
Yingkiong	Trap	*Porang*	0.5-1.0 Kggear^{-1}day	Do
	Cast net	---	0.25-0.5 Kggear^{-1}h^{-1}	
Boleng	Cast net	---	0.2 Kggear^{-1}h^{-1}	Do
Komsing	Gill net	---	1.0-1.2 Kggear^{-1}day	Do
Pasighat	Lift net	---	0.4-0.5 Kggear^{-1}h^{-1}	Bamboo raft and Plank-built boat
	Cast net	---	0.3-0.5 kg/gear/hour	
Oiramghat	Trap	*Dingora*	1.0-1.5 Kggear^{-1}day	Plank-built boat
		Dritok	1.0-1.5 Kggear^{-1}day	
	Cast net	---	0.3-0.5 Kggear^{-1}h^{-1}	
	Gill net	---	1.0-1.5 Kggear^{-1}day	

Fish catch and effort

There were no designated landing centres in upper and middle stretch of this river. A single landing centre was recorded at Oiramghat, Assam along lower stretch. Subsistence fishing is carried out in the whole stretch of the river in Arunachal Pradesh.The catch per unit effort of all fishing gear operated in the river is presented in Table 6. Catch per unit effort for cast net was low to moderate (0.2 to 0.5 kg gear^{-1} hr^{-1}) at all stations whereas gill net catch per unit effort were found to be ranging from 0.5 to 1.5 kg gear^{-1}day^{-1}.

RIVER CHALIYAR

Characterization of different habitats

Six stations located along the river Siang were selected for the study. The upper stretch comprised three stations (Cholamala, Arrapetta, Nilambur), middle stretch with two stations (Mambad, Edavanna) and lower stretch comprising three stations (Areekode, Azhinjilam, Feroke). The major habitat parameters recorded from these stretches are shown in Table 7.

Physico-chemical parameters of water and sediment

The physicochemical properties of Chaliyar River are within the acceptable limits with a few excessive values (Table 7-9). In upper and upper-middle stretches the bottom was almost rocky in nature.Overall, the pH values were higher in the post-monsoon season than the monsoon season. The influence of saline water intrusion increasing the alkalinity (Azhinjilam and Feroke) in the estuarine region and during post-monsoon, it increased due to evaporation and reduced run-off of fresh water. Conductivity was higher at estuarine stations.Water hardness, was higher in post-monsoon in Azhinjilam and Feroke stretches. Total nutrient concentrations were higher in the upper stretches, and both N and P were high indicating influence of run-off and other anthropogenic activities and particularly from the upper stretches where coffee plantation is high and may be due to high fertilizer run-off particularly at monsoon period. Except the estuarine stretches (alkaline), sediment pH was generally in acidic to neutral range.

Diversity and abundance of fishes

A total of 66 species belonging to 32 families were recorded from the river during the survey period (Fig. 20). The highest fish diversity (47 species) was recorded at the estuarine station Feroke (Kozhikode District) with dominance of marine migrant fish species. Lowest diversity (3 species) was observed at the hillstream station Arappeta (in Wyanad District).

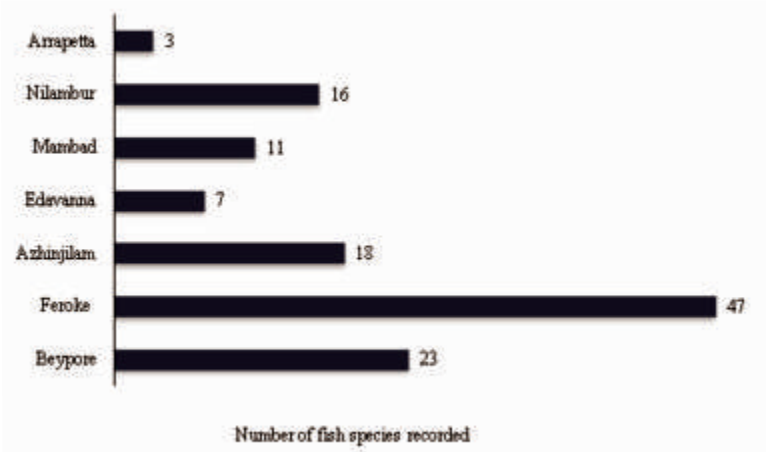


Fig. 15. Fish diversity recorded in river Chaliyar

Table 7: Physical habitat parameters of river Chaliyar

No.	Physical habitat parameters	Cholamala	Arrapetta	Nilambur	Mambad	Edavanna	Areekode	Azhinjillam	Feroke
1	Bank full width (m)	16	22	169.1	141.1	150	75	91	
2	Wetted width (m)	13	18						
3	Thalweg depth (m)	0.8	1.5	8.5-10.5	1.6	1.12	2.9	8	21
4	Mean depth (m)	0.3	.45	1.4	0.98	0.6			1.6
5	Depth averaged velocity (m/s)	0.26-1.5	0.04 0.3	0.4 - 1.15	0.1-0.15	0.4-1.1	0.01- 0.05	0.4	
6	Canopy cover on stream (%)	85	75	92	56.5			5	52
7	Riparian vegetation cover (%)	95	95	65	50	20	45	30	45
8	Average barren land cover (%)	5	5	10	35	20	10	5	40
9	Agricultural land/farms (%)	0	0	20	15	60	45	65	20
10	Littoral vegetation (%)	55	50	10	15	20	25	5	
11	Instream vegetation (%)	25	30	5	45	20	15	5	
12	Instream rock cover (%)	25	45	60	7.5	15	5	5	
13	Instream 'cover and refuge'	50	75	20	5	35	20	10	
14	Pool area (%)	10	15	5-10	20	30	30	35	35
15	Run area (%)	70	75	15-50	45	60	60	65	65
16	Rapid/ Riffles area (%)	0	0	10-80	0	0	0	0	
17	Sand area (%)	5	10	5	30	85	20	70	45
18	Gravel area (%)	20	25	15	15	10	35	20	35
19	Pebble area (%)	5	5	10	35	5	15	10	
20	Cobble area (%)	40	40	15	20	0	25	0	20
21	Boulder area (%)	30	20	70	0	0	5	0	

Diversity of Shellfishes

Targeted fishing for prawn is not widely practiced along the Chaliyar river stretch. But in Feroke, prawns were captured using cast nets and was composed of *Fenneropenaeus indicus*, *Metapenaeus affinis* and *M. dobsonii*. Crabs were exclusively fished using traps at Feroke and composed of *Scylla serrata* and *S. tranqueberica.*

Diversity of macrobenthos

A total of 26 species of macrobenthic fauna comprising of gastropods (5 families, 9 species), bivalves (2 families, 5 species), insects (4 species), polychaetes (1 species), oligochaetes (1 species), crustacean (4 species), fish larvae (one species), diptera (two species) and Tubifex (one species) were recorded.Along the stretch, the variation among the stations in two seasons was not in uniform trend as it depends on various factors like percentage of vegetation, altitude, flow, channel width and salinity.

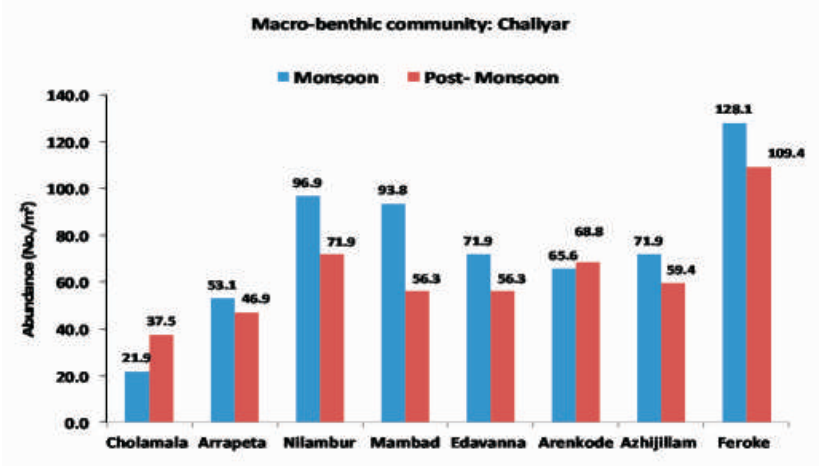


Fig. 16. Abundance of macrobenthic fauna in river Cauvery

Diversity and abundance of plankton

Total plankton diversity (no.l^{-1}) was estimated at **100-1300,** of which 98% was contributed by phytoplankton. A total of 28 genera of phytoplankton were recorded belonging to 5 groups from the selected sampling stations of the river. The quantitative abundance of phytoplankton ranged from 25 to 800 no.l^{-1}, highest at station Edavanna and lowest at Arapetta in monsoon, whereas during post monsoon season, the quantitative abundance of phytoplankton ranged from 50 to 900 no.l^{-1}, highest at Nilambur station and lowest at Cholamala. Only a group of zooplankton (Copepoda) was recorded during post monsoon. Zooplankton abundance was noted only at Edavanna (50 no.l^{-1}) and Mambad (50 no.l^{-1}) during post monsoon. The quantitative abundance of zooplankton ranged from 50 to 250 no.l^{-1}.

Socio-economic status of fishers

Average income of the fishers is ? 8000/month from the riverine fisheries. Fishers are dependent on riverine fishery for an average of 6.9 man months (57.5%), in business (26.5%) and as labourers (16%) for earning their livelihoods.

Table 8 : Water quality attributes of river Chaliyar

Water Quality	Season	Cholamala	Arrepatta	Nilambur	Mambad	Edavana	Areecode	Azhinjilam	Feroke
pH	Monsoon	7.00±0.04	7.20±0.03	6.4±0.02	6.48±0.00	6.6±0.04	7.0±0.04	6.9±0.036	7.0±0.017
	Post-monsoon	6.75±0.04	6.84±0.06	7.36±0.13	7.42±0.05	7.5±0.06	6.72±0.05	7.45±0.04	7.62±0.05
Dissolved oxygen (ppm)	Monsoon	7.33±0.03	7.97±0.07	5.6±0.09	4.8±0.10	3.6±0.33	7.6±0.19	7.8±0.09	6.96±0.04
	Post-monsoon	8.45±0.34	8.67±0.49	8.41±0.13	7.98 ±0.12	7.76±0.23	7.62±0.05	7.13±0.08	7.62±0.05
Electrical conductivity	Monsoon	109.4±3.20	41.7±3.41	120±6.24	124.7±4.24	131.3±4.42	53.1±4.65	120.7±3.38	6147±82.46
	Post-monsoon	77.3±2.3	85.4±4.0	76.6±2.3	76.8±3.00	79.2±1.7	76.7±3.0	21748±1833	34033±2432
Alkalinity (ppm)	Monsoon	38.0 ±2.01	18.0±1.30	23.2±0.16	24.0 ±0.58	24.0±0.51	16.0±1.54	20.2±1.15	20.0±0.74
	Post-monsoon	28±1.0	28±1.22	30.4 ±0.8	29.5 ±0.70	30.4±0.4	29.6±0.4	51.4±0.2	89.8±0.6
Total hardness (ppm)	Monsoon	24.03+2.00	20 +1.80	8±0.38	4±0.25	8±0.31	28+1.90	12+0.33	26.01±1.73
	Post-monsoon	25±3.00	30±3.35	30±4.56	30 ±3.03	32±1.49	18±2.10	2420±270.8	3860±216.1
Ca hardness (ppm)	Monsoon	8.02±0.04	6.41±0.56	1.61±0.35	3.21±0.21	3.20±0.46	4.80±0.22	6.42±0.14	10.43±0.57
	Post-monsoon	11.2±0.82	8.0±1.19	8.0±0.15	3.2±0.29	8.0±0.45	60.9±2.71	192.4±5.50	676.6±8.84
Chloride (ppm)	Monsoon	49.99±2.07	52.00±1.78	17.00±0.1	19.01±0.96	16.00±1.14	25.99±1.8	32.00±2.15	376±14.73
	Post-monsoon	11.0±1.26	13.0±1.73	18.0±0.61	9.0±1.00	13.0±1.32	12.0±1.13	7659±285.1	14319.6±
Nitrate nitrogen (ppm)	Monsoon	42.1±2.16	20.3±1.90	15.5± 1.06	26.4±1.52	9.5±1.21	8.9±0.60	49.8±4.57	7.5±0.80
	Post-monsoon	21.5±0.74	49.3±1.86	2.9±0.26	23.2±1.28	5.7±0.33	6.0±0.12	11.7±0.91	14.3±1.06
Available phosphorous(ppb)	Monsoon	68±3.20	50.2±2.72	10±1.28	10±1.14	10±1.73	59.1±3.51	65.9±1.71	78.6±8.94
	Post-monsoon	10.2±1.04	10.6±1.46	10.2±2.05	11.5±1.26	15.3±2.16	9.8±1.15	9.8±1.35	188.9±8.08
Avaiable Silicate (ppm)	Monsoon	16.8±1.65	10.6±1.46	0.6±0.04	0.6±0.01	1.0±0.01	12.4±1.11	10.7±2.49	8.9±0.91
	Post-monsoon	12.0±1.08	12.9±0.23	12.6±0.51	13.0±0.23	12.5±1.25	13.0±1.15	5.2±0.65	7.6±1.16

Table 9: Sediment quality parameters of river Chaliyar

Sediment quality	Seasons	Cholamala	Arrepatta	Nilambur	Mambad	Edavana	Areecode	Azhinjilam	Feroke
pH	Monsoon	6.39 0.10	6.68±0.06	6.72±0.07	6.59±0.10	6.67±0.06	5.82±0.09	6.98 0.10	8.09 0.21
	Post-monsoon	6.2±0.12	6.6±0.11	6.6±0.06	6.7±0.03	6.4±0.28	6.4±0.05	7.3±0.23	8.2±0.50
Soil OC (%)	Monsoon	0.46±0.01	1.11±0.08	0.13±0.00	0.31±0.01	0.49±0.02	0.93±0.03	0.04±0.01	0.52±0.02
	Post-monsoon	0.32±0.02	0.3±0.05	0.24±0.02	0.5±0.05	1.13±0.10	0.47±0.05	1.41±0.10	1.49±0.04
Available-N (mg/100gm of sediment)	Monsoon	9.48±0.64	6.69±0.30	10.59±0.79	12.27±1.80	18.96±1.06	13.38±0.99	18.96±1.19	18±0.64
	Post-monsoon	14.27±0.32	10.87±1.04	8.92±0.52	11.15±0.83	16.73±0.76	11.15±1.00	11.71±0.73	14.27±0.32
Available P (mg/100gm of sediment)	Monsoon	1.06±0.15	1.16±0.08	0.80±0.11	0.81±0.02	0.80±0.11	1.03±0.14	0.90±0.03	3.86±0.19
	Post monsoon	0.86±0.04	0.54±0.06	0.37±0.02	0.41±0.05	0.35±0.09	0.76±0.01	0.64±0.05	2.47±0.17

Project Title: Exploration of canal resources of Punjab and Sunderbans for fisheries development

Project No: REF/17-20/08

Project Staff : Archana Sinha, Aparna Roy, Pranab Gogoi, Manas H. M (transferred), Mitesh H. Rameteke, Tasso Tayung, S. K. Das

Canals are the second most important source of irrigation (26%) covering 17.0 million ha in India (Agricultural Census 2010- 2011) and are able to support various levels of fisheries. The present study focussed on selected canals in Punjab and in Sundarbans, West Bengal with the objective to generate basic data on fisheries and examine their fisheries potential. The Sirhind canal system in Punjab takes water from river Sutlej and is spread over a length of 3,215 km. The Indian Sundarbans cover an area of 907.33 ha, with the highest resource in Gosaba island (427.34 ha). Naturally, fishes enter these canals from the source waters and some fish species may form natural populations in the canals.

Canals of Sundarbans

A Preliminary survey of Irrigation canals in Sagar Island was conducted for fisheries development and "Bishalakhi canal" in Krishnanagar village was selected as study area. This irrigation canal feeds water to paddy and horticulture crops in the region. The canal was constructed in 1970 and maintained by villagers. The canal's sluice gate is situated at a distance of 150 m from Hooghly river and canal has a length of 1.5 km. Around 100 families are dependent on agriculture and additionally 200 families on fisheries (Hoogly estuary and in Bay of Bengal. Of these, around 100 families depended on subsistence fishery on the canal. Rain water is the main source of fresh water in the canal. Traps of various sizes, cast nets and seine nets are mostly used in the canal to catch fish, which enter during high tide form estuary.

Bhetkimari and Bishalakhi canal

Three sampling stations were identified in each canal. Seasonal samplings were done to collect sediment, water, plankton, macro-zoo benthos, finfish and shellfish from the canal followed by field and laboratory analysis of samples.

Water quality of canals of Sundarbans

Salinity variation was wide in Sundarbans canals in different seasons with high salinity during pre-monsoon season (18-21 ppt). The pH of surface water enhanced to more than pH 8 in Bhetkimari canal during summer. D.O. (5.8-6.3 mg l^{-1}) was favorable for good production in both the canal.Total alkalinity in both the canals remained about 100 ppm in monsoon and post monsoon season. Overall, both the canals have good "buffering" capacity. Higher specific conductivity (>25 $mScm^{-1}$) was observed in both the canals during pre-monsoonperiod.

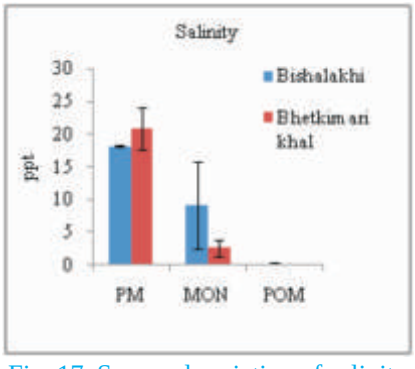


Fig. 17. Seasonal variation of salinity

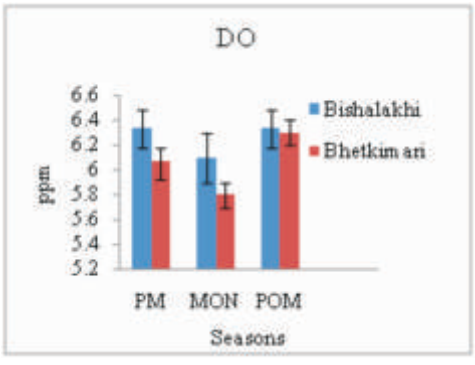


Fig. 18. Seasonal fluctuations of DO

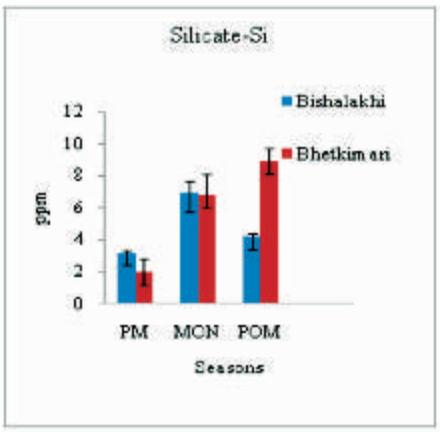


Fig. 19. Seasonal variation of Silicate-Si

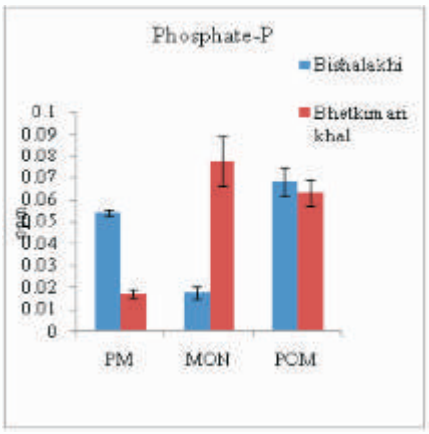


Fig. 20. Seasonal variation of Phosphate-P

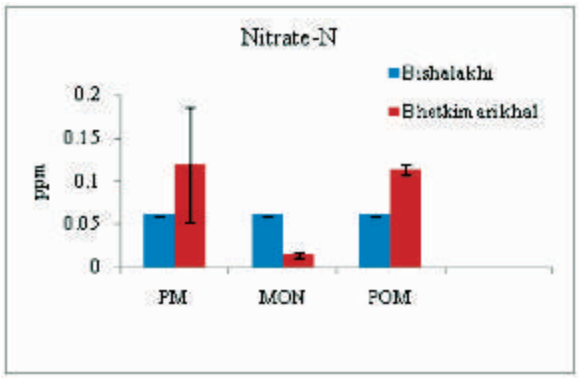


Fig. 21. Seasonal variations of Nitrate-N in Sunderban canals

There were not much variations in nitrate level at Sagar Island. However, in Bhetkimari canal, nitrate concentration was significantly diluted in monsoon season (from 0.1 ppm to 0.01 ppm). Silicate was in conformity with other quality parameters; pre-monsoon content was very less. Phosphate-P in Bhetkimari canal increased significantly during monsoon.

Sediment was “sandy loam” in texture. Organic carbon content in soil was low to medium. In both the canals, accumulation of good quantity of available nitrogen and phosphorus were found, especially available phosphorus.

Fish diversity of Bishalakahi canal

During monsoon 28 specimens were collected which belonged to 6 orders, 8 families and 9 species. A total of 18 (SIF 12 nos. and Non SIFs 6 nos.) fin-fish species under 10 families were recorded during post monsoon sampling. Two species (one penaeid and one non-penaeid) of prawns contributed 8.6 % of the total catch.

Analysis of catch structure revealed dominance of members of family Cyprinidae (88%), followed by Polynemidae (5.75%), Ambassidae and Channidae (5.1% each), Mugilidae (4.3%) and Bagridae (2.7%). SIFs were found to be the major component of fish catch of Bishalakhi canal contributing 76% of the total catch.

Survey identified a number of gears to be in operation in Bishalakhi canal. These were Seine net (mesh size 0.5 cm), Cast net (mesh size 0.5 cm) and Traps (Bamboo made).

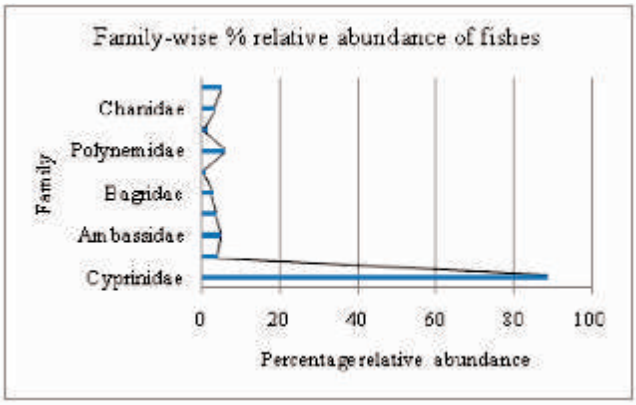


Fig. 22. Relative abundance (%) of fishes in Bishalakhi canal

Fig. 23. Fish catch from Bishalakhi canal during post monsoon

Fish diversity of Bhetkimari canal

During monsoon sampling a total of 345 specimens were collected which belonged to 5 orders, 5 families and 7 species. A total of 16 (SIF 13 no. and Non SIFs 3 nos.) fin-fish species under 9 families were

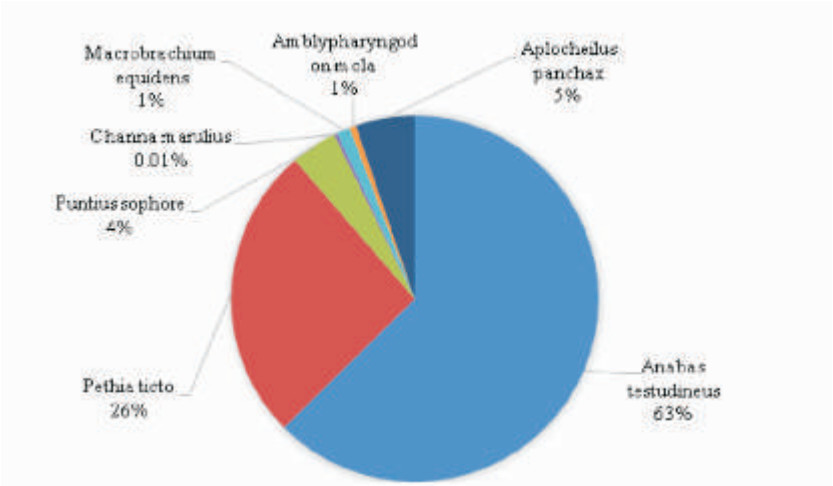


Fig. 24. Fish diversity in monsoon season

recorded during sampling.Five species (penaeid 3 nos. and non penaeid 2 nos.) of prawns were recorded contributing 10% of the total catch. No exotic fish species were recorded. Fish diversity was highest during monsoon (13 species) season.

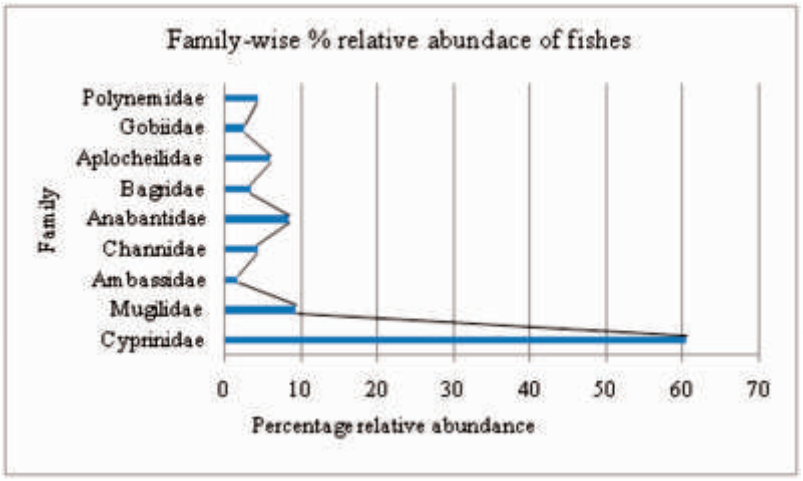


Fig. 25. Family wise % relative abundance of fishes

Analysis of fish catch structure revealed the dominance of Cyprinidae (60.5%), followed by Mugilidae (9.2%), Anabantidae (8.4%), Aplochelidae (5.6%), Polynemidae (4.2%) and Bagridae (3.3%).In Bhetkimari canal also SIFs were found to be the major component of fish catch contributing 83% of the total catch.Gears in operation in Bhetkimari canal were Bag net and seine net.

Plankton community in canals of Sundarbans

Plankton populations exhibited the significant variations in abundance in different seasons. A total of 77 species belonged to 66 genera were recorded from the Bhetkimari canal, Madanganj during sampling. Cyanophyceae was teh most dominant component (36%), followed by Bacillariophyceae (30%) and Chlorophyceae (22%). In phytoplankton assemblage, diatoms were the most diverse group (25 species) in this canal. *Fragilaria* sp., *Synedra ulna*, *S. acus*,*Cymbella* sp., *Navicula rhinocephala*, *N. gracilis*, *N. angusta*, *Nitzschia palea*, *N. sigmoidea*, *N. intermedia*, *Gyrosigma acuminate*, *Tabelleria* sp., *Asterionella* sp., *Gomphonema angustum*, *G. truncatum* and *Amphora* sp. were the prominent diatom taxa. Cyanophyceae (2,143±818 cellsl^{-1}) and Chlorophyceae (1,510±851 cellsl^{-1}) emerged as major groups during monsoon season while Bacillariophyceae attained peak (1,995±1,429 cellsl^{-1}) during post-monsoon season. Nine groups of zooplankton were observed from the Bhetkimari canal with the highest seasonal abundance during post-monsoon (547±138 ind.l^{-1}) and lowest abundance in pre-monsoon season (320±103 ind.l^{-1}).

In Bishalakhi canal, phytoplankton was the mainstay where blue green algae, green algae and diatoms dominated. A total 62 species of phytoplankton belong to 54 genera were recorded during the study period. Among nine algal groups, Cyanophyceae dominated in terms of abundance and Bacillariophyceae in diversity. Quantitative spectrum of phytoplankton Cyanophyceae (1363±396 cellsl^{-1}), Bacillariophyceae (630±336 cellsl^{-1}) and Chlorophyceae (499±330 cellsl^{-1}) shared the key abundance in the sampling stations. Compositions of phytoplankton represented as Cyanophyceae > Bacillariophyceae > Chlorophyceae > Euglenophyceae > Coscinodiscophyceae > Conjugatophyceae > Mediophyceae > Xanthophyceae > Trebouxiophyceae. Seven groups of zooplankton were recorded where crustacean nauplius (56.5%) dominated. The other group of zooplankton of this canal was mostly shared by Copepoda (27%), Eggs (9.5%), Rotifera (3%), Protozoa (2%), Cladocera (1%) and Nematoda (1%). The quantitative abundance of zooplankton ranges from 221 to 829 ind.l^{-1}.

A total of 36 periphytic genera belonging to four groups (Bacillariophyceae > Cyanophyceae >

Coscinodiscophyceae > Nematoda) were recorded from the Bhetkimari canal. Algal group Bacillariophyceae was the most diverse, represented by 23 species and contributing 88% to the total periphytic community. Concurrently, algal group, Cyanophyceae also emerged as conspicuous component (11%) in Bishalakhi canal, showed increasing trend during post-monsoon season. Six groups (44 genera) of periphyton were recorded from the Bishalakhi canal. These populations were the most prominent during post-monsoon compared to monsoon season. Diatoms invariably constituted the bulk of the population (66%), followed by Cyanophyceae (25%), Chlorophyceae (6.5%), Conjugatophyceae (1.5%), Xanthophyceae (0.6%) and Nematoda (0.4%). A total of 29 species of diatoms were recorded from the sampling stations.

Benthos samples were collected seasonally from the selected canals of Sundarban. Analyses revealed a total of seven and five species in Bhetkimari and Bishalakhi canal respectively. *Pila varians, Bellamya bengalensis, Pila globossa, Meiniplotica scabra, Tarebia granifera, Thiara lineata*were found to be very common irrespective of seasons in both the canals. Quantitatively, macro-benthic community ranges from 350-414 nos./m^2 in Bhetkimari and 159 – 955 nos./ m^2 in Bishalakhi canal respectively.

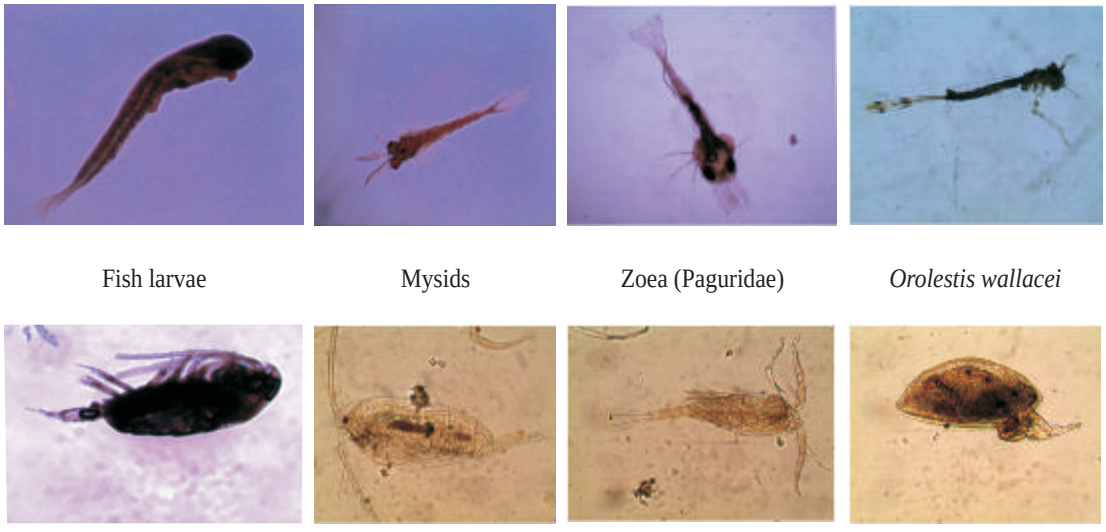
Socio-economics of Bhetkimari canal

Assessment of fisher population in Bhetkimari canal in Sundarbans depicts that considerable number of population of two villages namely Dwariknagar and Madanganj is dependent on that canal for their livelihood.Canal fishers are dependent on canal for income as well as for their own fish consumption. Income from the canal is seasonal (June to November) and average income is ? 3,200/month. Canal fishery contributes to 15% of the total house hold income of the respondents. Two Stakeholder meetings were organized in Madanganj and Bishalakhi canal area. The villagers as well as the Panchyat Members including Panchyat Pradhan consented for implementing scientific intervention in the canals.

Sirhind canal, Punjab

The Sirhind Canal system is about 150 years old and has an authorized capacity of 12,620 Cs with a cultivable command area of 13.59 lac ha. The canal and its distribution network are spread over a length of 6115 km.

Zooplankton

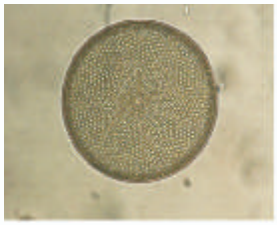


Fish larvae | Mysids | Zoea (Paguridae) | *Orolestis wallacei*

Bestiolina similis | *Helediaptomus* sp. | *Oithona* sp. | Ostracoda

Fig. 26. Few Zooplanktons in Sunderban canals

Phytoplankton



Coscinodiscus centralis

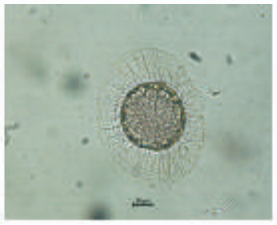
Nitzschia sigmoidea

Chaetoceros loranzianus

Diploneis stromei

Thalassiosira punctigera

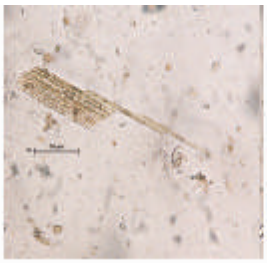
Ditylum brightwelli



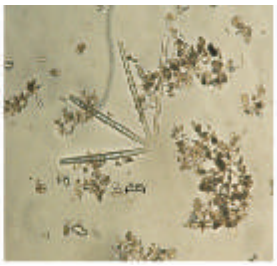
Planktionella sol

Odontella mobiliensis

Gyrosigma acuminata

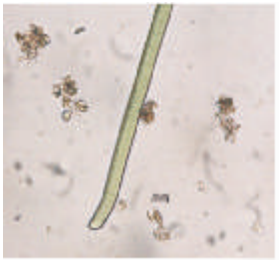


Bacillaria paradoxa



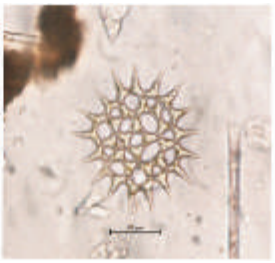
Thalasionema nitzschiodes

Anabaena sp.

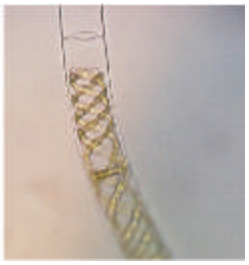


Oscillatoria princeps

Lyngbya sp.



Pediatrum duplex



Spirogyra hyalina

Fig. 27. Few phytoplanktons in Sunderban canals

Fish diversity in Srihind canal

A total of 17 specimens were collected which belonged to 4 orders, 5 families and 9 species. Fishes recorded in the Sirhind canal are *Xenentodon cancila*, *Mastacembelus armatus*, *Macrognathus puncalas*, *Channa marulius*, *Puntius* sp. *Badis badis* and small prawn and crab (*Sertoriana* sp.) where small prawn dominated in the total catch. Seine net was documented as used.

Prawn and Crab catch from Sirhind canal, Punjab

Water and sediment qualities of Sirhind canal

Salinity of water of Sirhind Canal (av. 108 mg l^{-1} in monsoon and 56 mg l^{-1} in post monsoon) shows that it is in freshwater zone in both monsoon and post-monsoon seasons. Water alkalinity was 78-90 mg l^{-1} with very less seasonal variation. D.O. was more than 8 mg l^{-1} owing to high water flow velocity. Both nitrate and phosphate contents of the canal water were high; nitrate reached nearly 0.4 mg l^{-1} in post-monsoon. Phosphate was higher in monsoon (0.13 mg l^{-1}) as compared to post-monsoon (0.06 mg l^{-1}) due to probable run-off from agricultural fields. Soil organic carbon content found to be medium productive; the sediment was mostly sandy (80-84% of sand, 9-12% clay and 6-11% silt) in different sites of this canal and may permit some percolation loss of canal water.

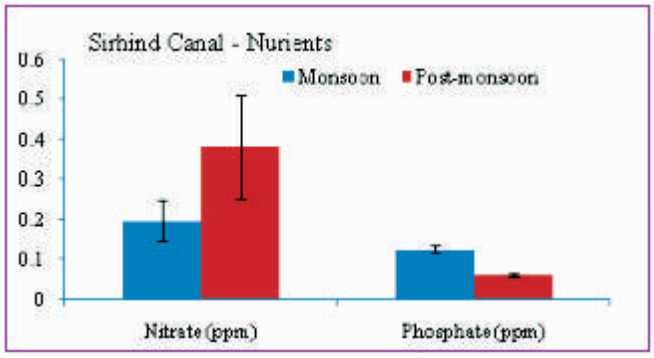


Fig. 28. Seasonal variations of water nitrate and phosphate levels in Sirhind canal

Fish species diversity of Sirhind canal

Fish specimens collected belonged to 4 orders, 5 families and 9 species with greater dominance of *Pethia* and *Xenontodon*.

Table 10: Fish Diversity indices in selected canals

Indices/Canal	Margalef's richness d	Pielou's Evenness J'	Shannon H' (loge)	Simpson 1-λ'
Bhetkimari	1.027	0.527	1.026	2.152
Bishalakhi	2.401	0.859	1.888	5.091
Sirhind (Punjab)	1.412	0.829	1.335	3.176

Plankton community structure of Sirhind canal

Plankton samples were collected in monsoon and post-monsoon season from Sirhind canal. A total of 48 species belonged to 46 genera were recorded during the study period. Bacillariophyceae dominated in

terms of abundance (639±493 cellsl^{-1}) and diversity (25 species). Cyanophyceae were recorded to be of very low abundance (191 ±105 l^{-1}) in both the seasons. Abundance of phytoplankton was higher in post-monsoon as compared to monsoon season. Lower population of zooplankton was observed in Sirhind canal as compared to Sundarban canals. Seven groups of zooplankton were recorded where crustacean nauplius dominated (33%) among the zooplanktons. Crustacean nauplius > Copepoda > Cladocera > Rotifera > Insect larvae > Branchuran larvae registered the stated order of the quantitative abundance. The quantitative abundance of zooplankton ranged from 66-466 ind.l^{-1}.

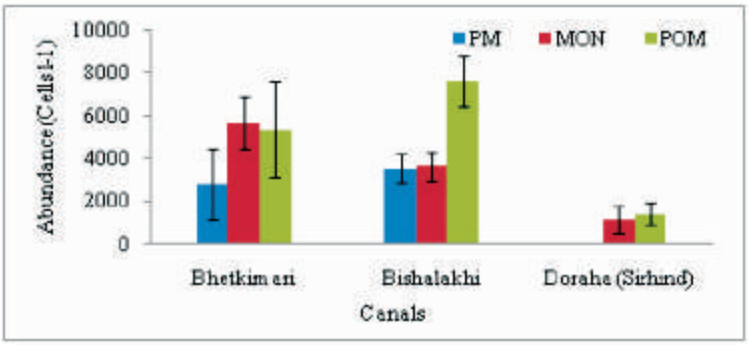


Fig. 29. Phytoplankton abundance in canals

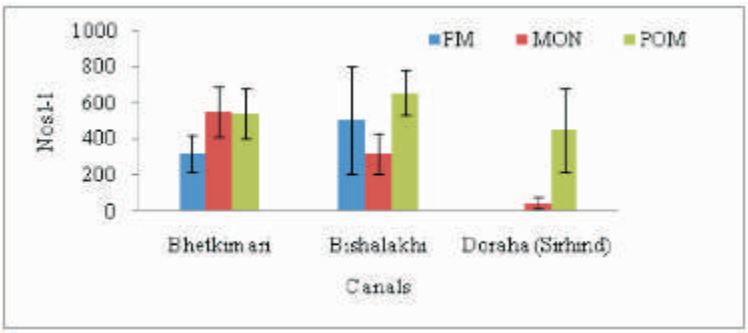


Fig. 30. Zooplankton abundance in canals

Periphyton of Sirhind canal

The periphytic assemblage of the Doraha stretch (Sirhind canal) was much lower compared to Bhetkimari and Bishlakhi canal of Sunderbans. Twenty genera of periphyton were recorded from Doraha stretch. The quantitative spectrum of periphyton was observed highest at Bishalakhi canal (43,157 ±25,752 no.cm^{-2}) followed by Bhetkimari (28579±18561) and Doraha stretch (6,858 ±4,344 no.cm^{-2}).

Project Title: Investigation on environmental flows in rivers Kathajodi, Siang and selected tributary of Ganga

Project No: REF/17-20/09

Project Staff : A. K.Sahoo, B. K. Bhattacharjya, S. K. Das, Roshith C. M., R. K. Raman, D.N. Jha, S.C.S. Das, A. K. Yadav, Simanku Borah, S. K. Koushlesh, Pranab Gogoi and Shravan Sharma

Rivers form an integral part of aquatic ecosystem and are fundamental to millions of lives. These dynamic ecosystems are impaired by several stressors such as pollution, construction of physical barriers such as dams, barrages and anicuts, climate change, etc. Most of the rivers have lost their connectivity flows resulting alterations in river channel and hydro-ecological regime, adversely affecting the indigenous fish populations and fishers dependent on these resources. In order to estimate the water/flows/discharge requirement, worldwide more than 200 methodologies have been developed. However, considering local fish availability and geo-morphology of Indian rivers, the present study was undertaken to assess the present biodiversity in river Kathajodi, Siang and Tamas, and to establish their correlation with hydrological alterations for developing suitable environmental flows methodology for the sustainable fishery in selected river stretches.

RIVER KATHAJODI

The river Kathajodi origins from Naraj, Cuttack district and runs approx. 96 km before joining to Bay of Bengal (Fig.31). For environmental flows estimation, the river stretch was divided into three zones represented by four stations. Upper zone with presence of barrage with 2 sampling sites, viz. Up-stream and down-stream of barrage (Fig.32), middle zone with 1 sampling site representing complete freshwater without tidal action viz. Galadhari, and lower zone with 1 sampling site representing freshwater tidal action and estuarine ecosystem viz. Nuagarh.

Fig. 31. Sampling sites in river Kathajodi

Fig. 32. Naraj barrage upstream

Discharge data from river Kathajodi were analyzed which revealed a drastic reduction in flow from monsoon to lean season. During monsoon, the discharge was 160,000cusec and represented by *Gonialosa manmina* followed by *Labeo bata* with larger fish diversity by number. While, lean season discharge was only 5000cusec, and the dominated fish species was *Puntius* sp. A total of 72 fish species belonging to 27 families were recorded from the river. About 60 % of the recorded fish diversity was represented by 7 families, *viz*., Cyprinidae (16 species), Clupeidae (6 species), Mugilidae (5 species), Engraulidae (4 species), Bagridae (4 species), Schilbeidae (4 species) and Ambassidae (4 species). The highest fish diversity (36 species) was recorded at Nuagarh (towards the estuarine mouth) with dominance of the marine migrants. There were seasonal variations in the fish catch composition at all sampling sites. The fish catch at Naraj during monsoon (Fig. 33) was dominated by the gizzard shad, *Gonialosa manmina* (28%), followed by *Labeo bata* (18%) and *Cirrhinus reba* (10%). The post-monsoon fish community (Fig. 34) were dominated by barbs such as *Puntius sophore* (43%), *P. terio* (17%) and the goby, *Awaous grammepomus* (13%).

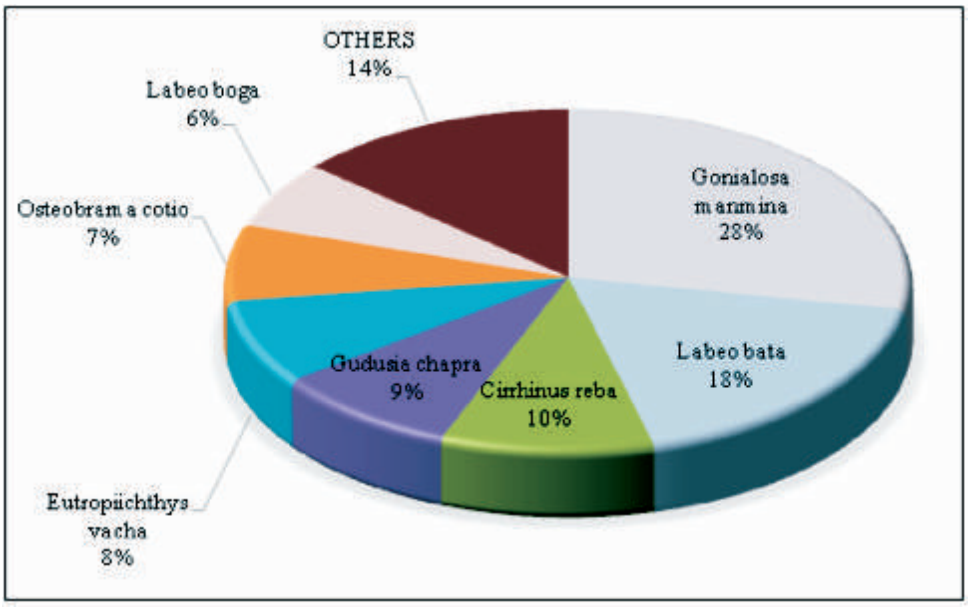


Fig. 33. Fish catch composition at Naraj (downstream) in monsoon

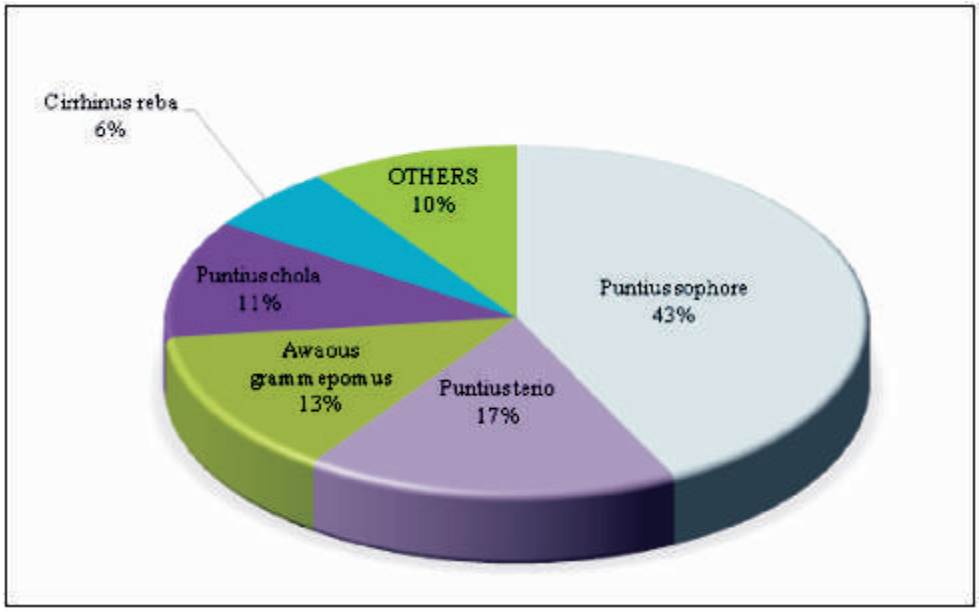


Fig. 34. Fish catch composition at Naraj (downstream) in post-monsoon

A total of 81 species belonged to 63 genera of phytoplankton were recorded from the river. Out of 8 algal groups, Bacillariophyceae was the most dominant group (42%) in terms of abundance and diversity (26 species). Regarding, quantitative spectrum of phytoplankton, Bacillariophyceae (1584±484), Cyanophyceae (710±228) and Chlorophyceae (600±528) shared key abundance in the sampling stations. *Fragilaria* sp., *Synedra ulna*, *Navicula angusta*, *Cymbella lanceolata*, *Surirella* sp., *Nitzschia palea*, *N. sigmoidea*, *N. reversa*, *Hantzschia* sp., *Gyrosigma acuminata* and *Amphora* sp. represented the prominent diatom taxa. The abundance of phytoplankton ranged from $1.11x10^3$ to $4.77x10^3$ cells l^{-1}, with highest abundance at Naraj (downstream) during post-monsoon season. Green algae also emerged as major flora during post-monsoon season: *Pediastrum simplex*, *P. duplex*, *Chlorella* sp., *Monoraphidium* sp., *Tetraedron* sp., *Oedogonium* sp., *Scenedesmus* sp., *Schroederia* sp. and *Mougeotia* sp., mostly

contributed to the green algal assemblage in the stretches. The station-wise abundance of phytoplankton is shown in Fig. About 7 (seven) groups of zooplankton were recorded and its abundance was observed highest at station Galadhari during post-monsoon season (Fig.36). Among zooplankton, rotifera (36%) recorded highest dominance followed by crustacean nauplius (22%) and cladocera (14%). The quantitative abundance of zooplankton ranged from 391-1877 ind.L^{-1}.

Diversity analysis revealed that Margalef Richness Index (d) and Shannon diversity (H´) were highest at station Nuagarh and lowest at station Galadhari. Pielou's evenness (J) was recorded highest at station Naraj DS (0.97) and lowest at Galadhari (0.94). Margalef richness and Shannon diversity were found to be more than 2.8 indicating moderate diversity of phytoplankton in the system.

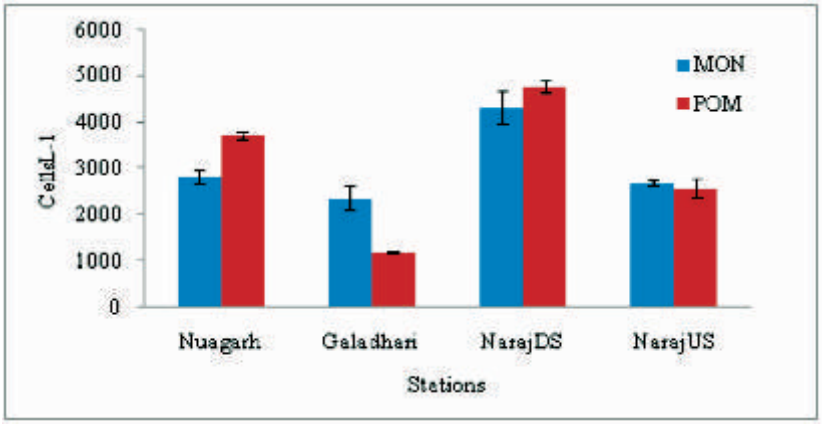


Fig. 35. Abundance of phytoplankton in different stretches of river Kathajodi

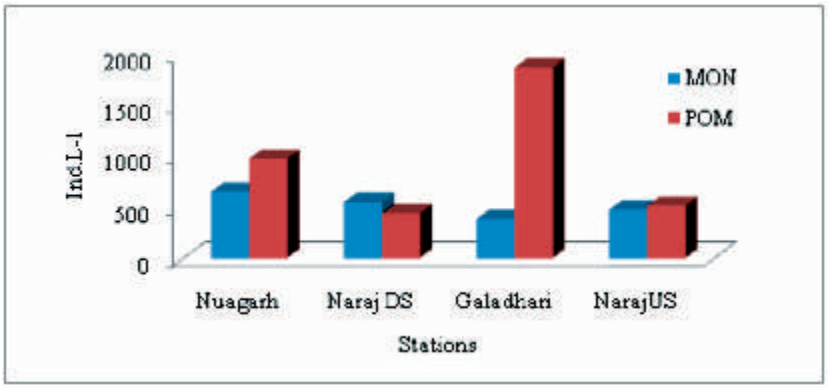


Fig. 36. Abundance of zooplankton in different stretches of river Kathajodi

A total of 38 species of macrobenthic fauna comprising of Gastropods (11families, 18 species), Bivalves (4families, 8 species), Insects (4 species), Polychaetes (3 species), Oligochaetes (2 species), Crustacean (5 species), Tubifex (2 species) and Chironomid larvae (one species)were recorded during two Monsoon and Post- Monsoon seasons. Abundance ranged from 21.9 to 128 nos./m^2 in Monsoon and 37.5 to 109 nos./m^2 in Post Monsoon.

RIVER SIANG

A total of 30 fin fish species belonging to 8 families were recorded from river Siang. Family-wise, Cyprinidae was the most dominant comprising 70% of the total species recorded, followed by Ambassidae

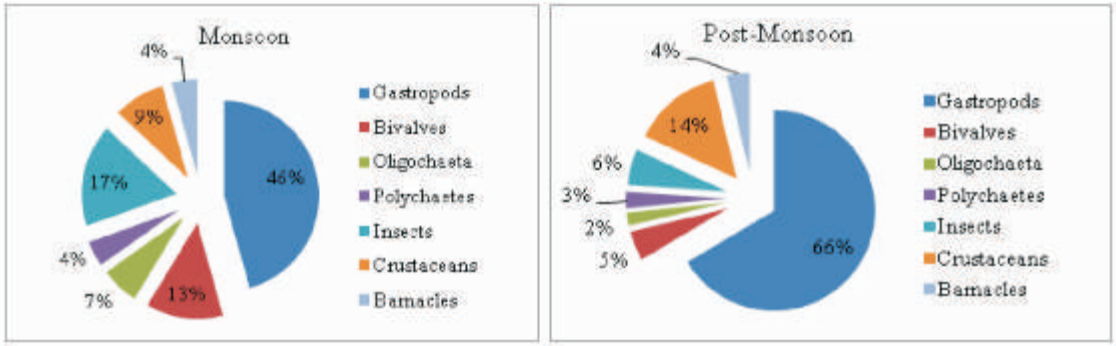


Fig. 37. Macro benthic fauna in monsoon and post- monsoon seasons in river Kathajodi

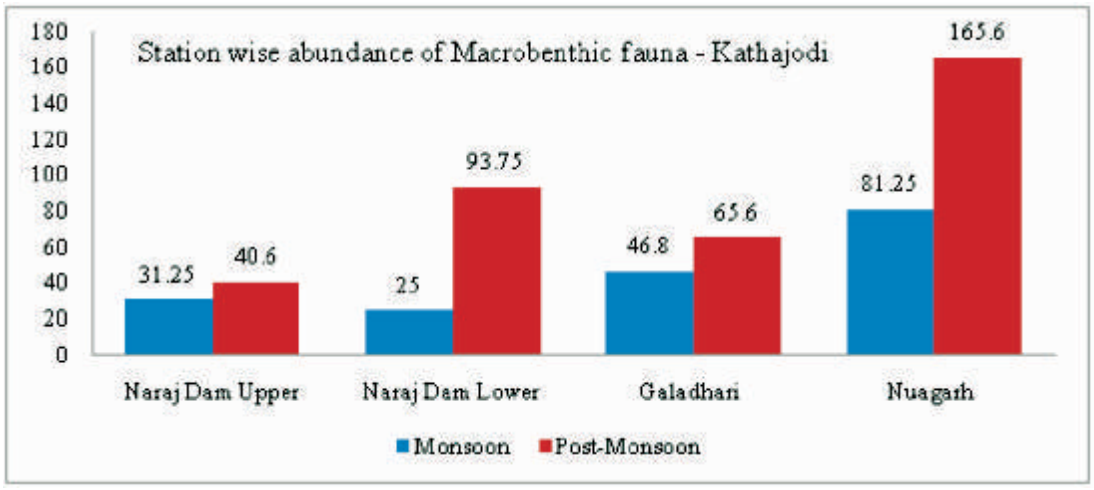


Fig. 38. Abundance of macrobenthic fauna in different stretches of river Kathajodi

(6.66%) and Schilbeidae (6.66%) as shown in Fig. Station-wise, maximum number of species was recorded from Oiramghat (15 species) followed by Pasighat (13 species) (Fig. 39). A total of 12 species were recorded from Komsing, 1 species from Boleng, 5 species from Yingkiong and 2 species from Puging sampling station. Three migratory species namely *Schizothorax richardsonii*, *Bangana dero* and *Labeo dyocheilus* were recorded during the study. A single species of benthos, *Bellamya bengalensis* (gastropod) was recorded from Oiramghat in post-monsoon with an abundance of 97 nos. m^{-2}. The heavy silt load of the river might have some adverse impact on the abundance and diversity of biotic communities in the river.

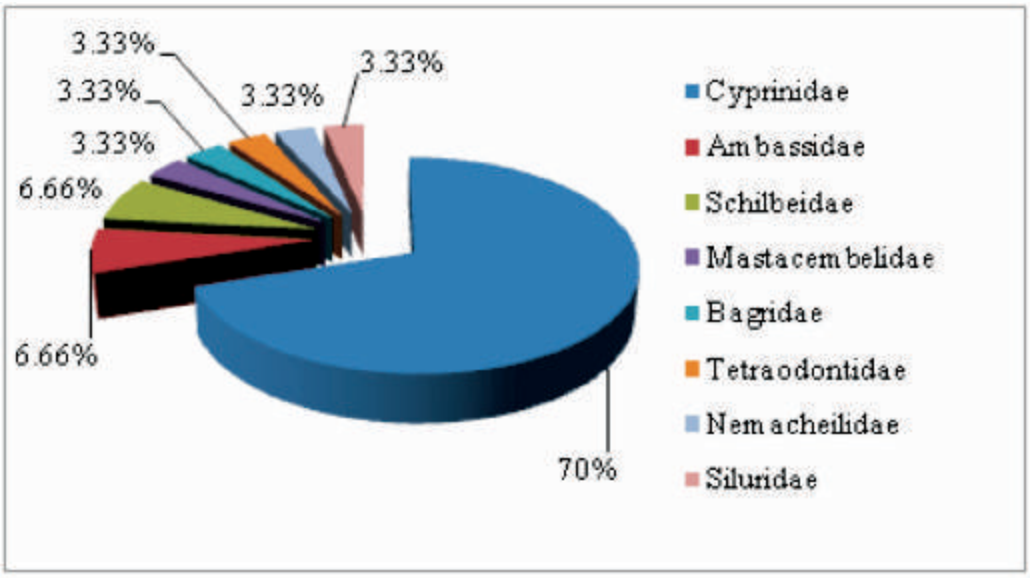


Fig. 39. Percentage strength of fish families

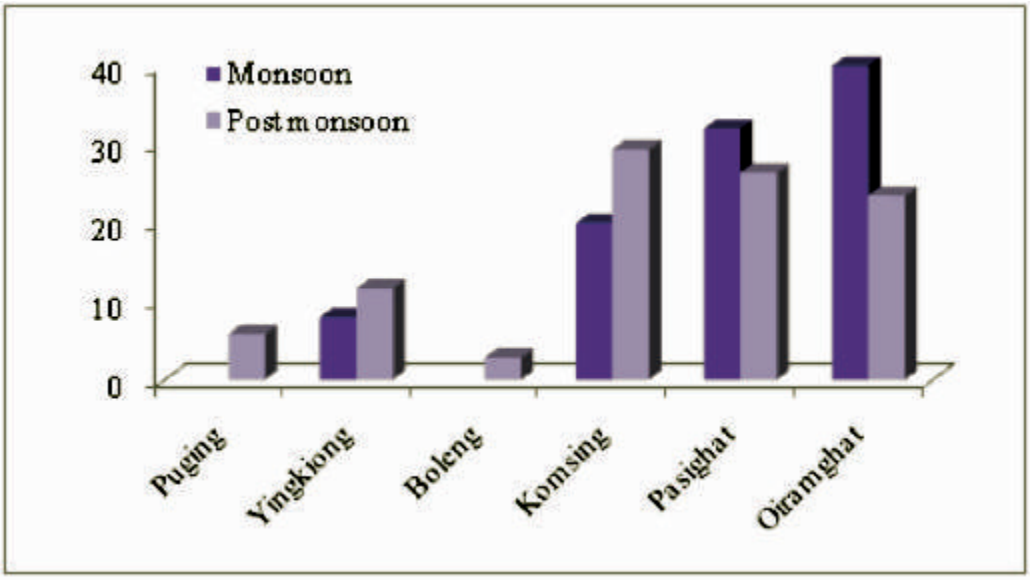


Fig. 40. Species composition across seasons and stations

RIVER TONS

The Tons River (also known as the Tamas River) is a right bank tributary of the river Ganga flowing through Madhya Pradesh and Uttar Pradesh. The river rises at Tamaskund in the Kaimur Range at an elevation of 610 meter. The total length of the river is 186 Km. The Tons sub-basin has 20 dams in the Madhya Pradesh and 12 dams in Uttar Pradesh. Tons river has three barrages, two lift canals, one weir and 2 power houses. Impact of these barriers on ecology and fisheries were studied here.

A total of 57 species belonging to 44 genera, 18 families and 8 orders were recorded. Highest species richness (47) was recorded at Chak and Panasa ghat, followed by Bakia Upstream Barrage (31), Madhavgarh (26), Bakia downstream (13) and Itahara (9).Two Exotic fish species *Cyprinus carpio*,

Fig. 41. Sampling stations in river Tons

Oreochromis niloticus were recorded at Panasa ghat. Higher relative abundance was found for *Mystus cavasius* (0.124) and *Rasbora daniconius* (0.204), and minimum abundance of *Eutropiichthys murius* (0.001) and *Tor putitora* (0.002) were observed in monsoon and winter months respectively. Cyprinidae was the most dominated family represented by 22 species in 15 genera, followed by Schilbeidae (5 species in 4 genera) and Bagridae (4 species in 3 genera).

Conservation status

Among 57 fish species recorded from the river, 15.28 % are threatened in which *Cyprinus carpio* is listed under Vulnerable, *Tor putiora* is under Endangered and *Ailia coila, Wallago attu, Ompok bimaculatus, Ompok pabda* (Fig. 42), *Chitala chitala, Bagarius bagarius* and *Tor tor* are Near Threated (NT) and *Oreochromis niloticus* and and *Botia lohachata* are listed under Not evaluated; 80.70% of the species were under category Least Concern. The IUCN Conservation status of these fish species is depicted in Fig.43

Fig. 42. Near Threated (NT) *Ompok pabda* recorded from Bakia

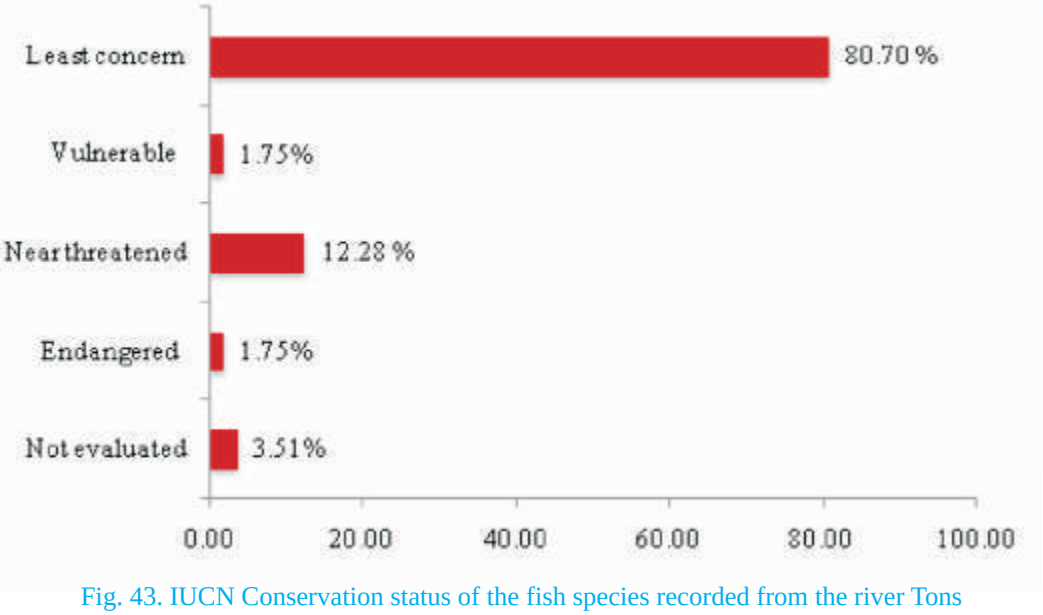


Fig. 43. IUCN Conservation status of the fish species recorded from the river Tons

Project Title : Impact of major tributaries and wetlands on biodiversity and ecological function of river Ganga

Project No : REF/17-20/10

Project Staff: R. S. Shrivastava, D. N. Jha, A. Alam, S. C. S. Das,Jeetendra Kumar, Vanketash R Thakur, Rahul Das, S. K. Srivastva, Kalpana Srivastava andVijay Kumar

Main channel Ganga has important tributaries like Bhagirathi/Ganga, Bhilangana, Alaknanda, Nayar Heval, Ramganga, Kali, Yamuna, Tons, Gomati, Karmnasha, Ghaghara and Sone rivers. The impact of important tributaries and connected wetlands like Sukar Taal, Mahane wetland and Surha Taal on ecology and fisheries of Ganga River was studied. Different physico-chemical and biological parameters above and below the confluences of rivers were studied.

Soil and water characteristics

Study revealed that sand was dominated in all stretches of Ganga and tributaries followed by silt in the soil

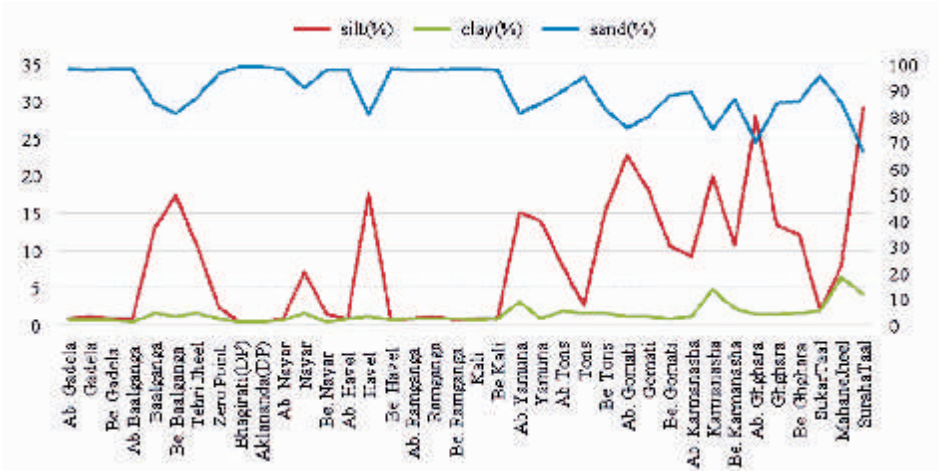


Fig. 44. Soil texture of main channel of river Ganga and its tributaries

texture. Clay was very less in hilly stretch with increasing trends towards downstream. Sukar Taal has highest percentage of sand while silt percentage is highest in Surha Taal among wetlands. Soil pH was alkaline throughout the studied course of river Ganga, except for river Nayar which was moderately acidic. Specific conductivity of soil widely varied for different rivers, with highest conductance in river Gomti and lowest in river Gadela-Ramganga.

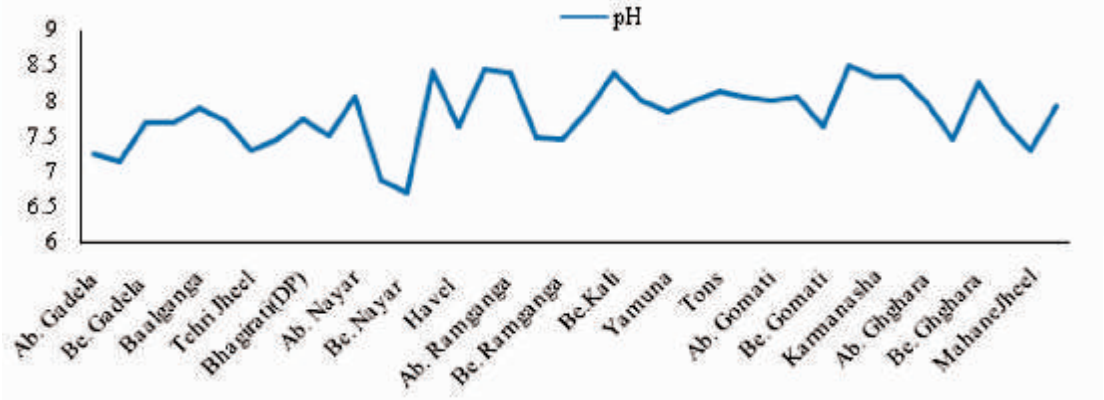


Fig. 45. Soil pH in main channel of river Ganga and its tributaries

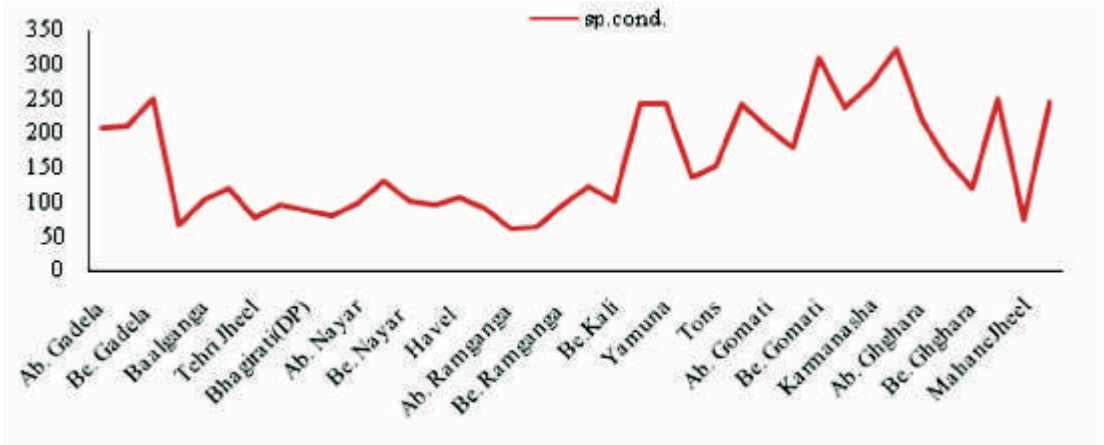


Fig. 46. Soil specific conductivity of main channel of river Ganga and its tributaries

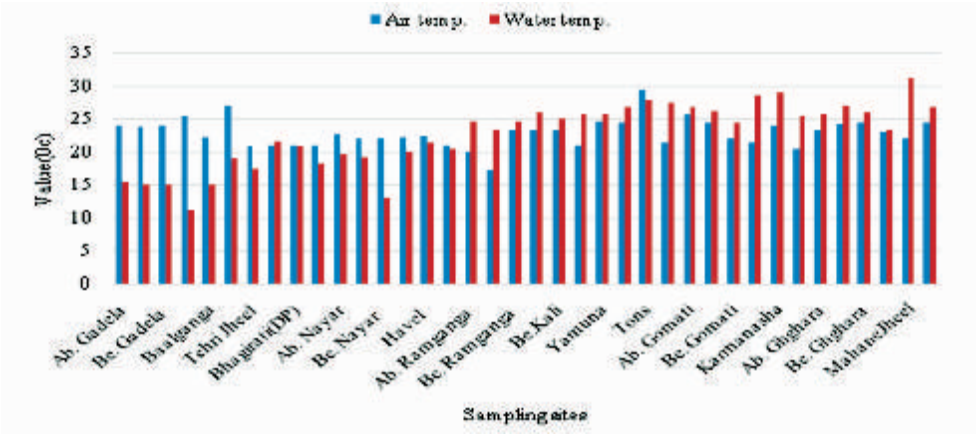


Fig. 47. Water temperature of main channel of river Ganga and its tributaries

Water temperature of different rivers above and below confluence varied widely, from 10.6-31 °C, with highest water temperature for river Gomti and lowest for river Baalganga.

Dissolved oxygen, dissolved organic matter and Biochemical oxygen demand of river Ganga and its tributaries have been presented in Fig. 48, which indicate moderate to high level of DO in most tributaries except at few rivers where its was less than 4 indicative of pollution impacts. BOD was moderate for most rivers except Ramganga, Kali and Yamuna which had high BOD due to pollution.

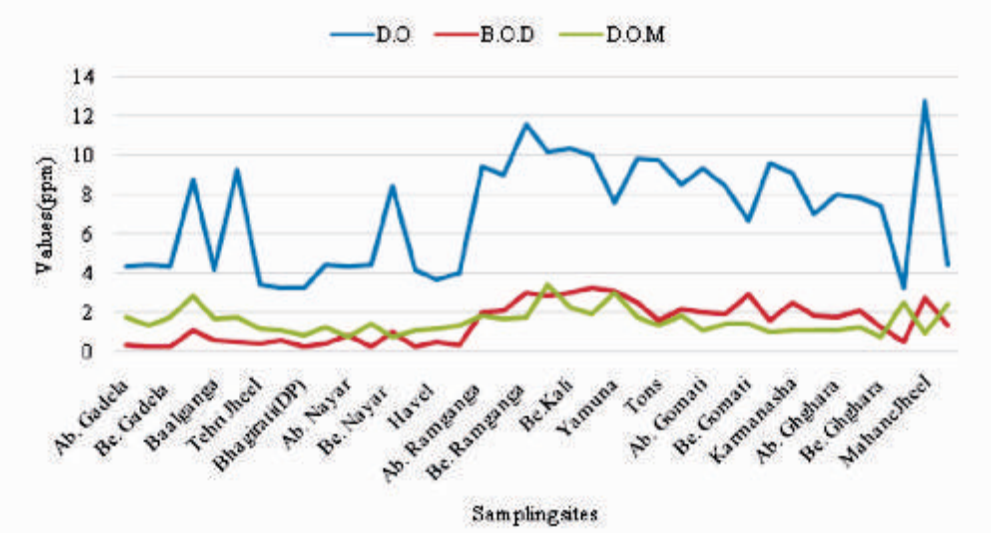


Fig. 48. Dissolved oxygen, dissolved organic matter and Biochemical oxygen demand of main channel of river Ganga and its tributaries

Other salient water quality attributes such as conductivity, hardness, TDS etc. are presented in Fig. 49, which indicate increasing trend along the downstream of river Ganga. All the parameters were very high for rivers Ramganga, Kali and Yamuna as pollution impacts.

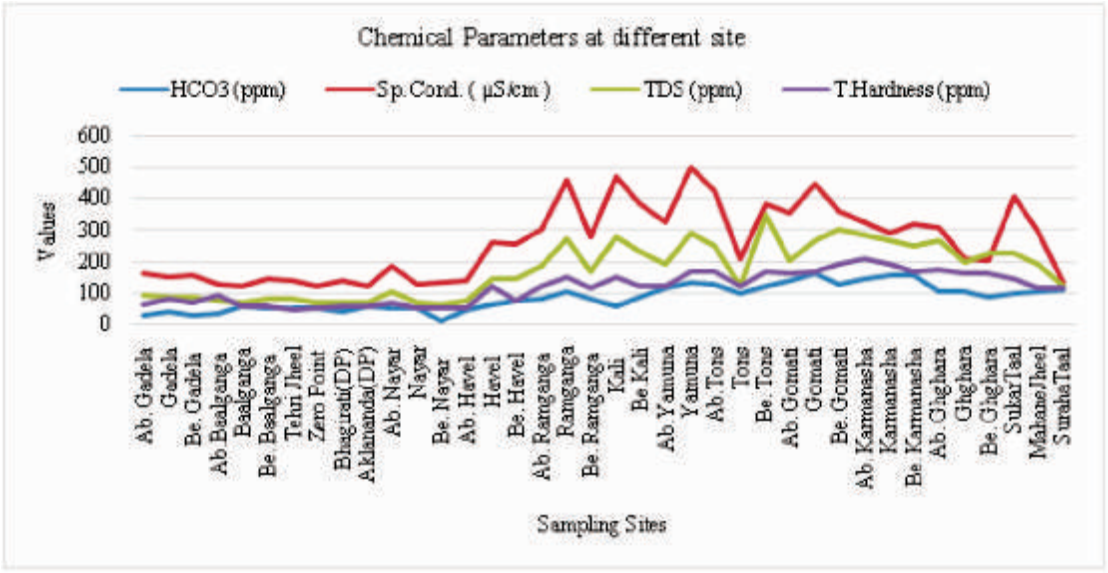


Fig. 49. Conductivity, hardness and total dissolved solids of main channel of river Ganga and its tributaries

Biological characters

Maximum abundance of periphyton was observed below Gadela in main channel, Bhagirathi river. Higher values of periphyton were observed in initial hilly part of main channel and tributaries. Remaining stretches have no clear trend. The samples of main channel and tributaries as well as wetlands are dominated by Bacillariophyceae followed by M yxophyceae in Gomati, Protozoa in above Ramganga and chlorophyceae in Sukar Taal. Maximum number (28) of taxa was observed after confluence of river Kali and the Ganga river where dominating taxa were Navicula, Synedra. A total of 106 no. of planktonic taxa comprising of 78 taxa of phytoplankton and 28 taxa of zoo-plankton were noted. Bacillariophyceae (27 taxa) was dominating in upper stretch where as Chlorophyceae (35 taxa), Myxophyceae (11 taxa) and other groups (5 taxa) dominated in down stretch of river Ganga. Availability of zoo-plankton (28 taxa) started from Sukar Taal confluence (Bijnor) of river Ganga. The plankton taxa abundance was found 5 in Mahane wetland whereas 27 taxa in Ramganga.

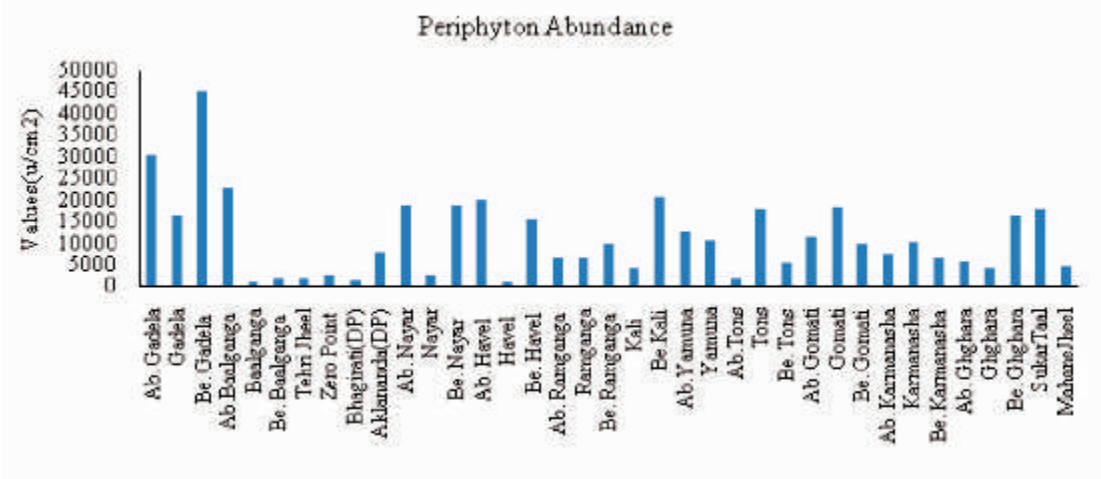


Fig. 50. Periphyton abundance of main channel of river Ganga and its tributaries

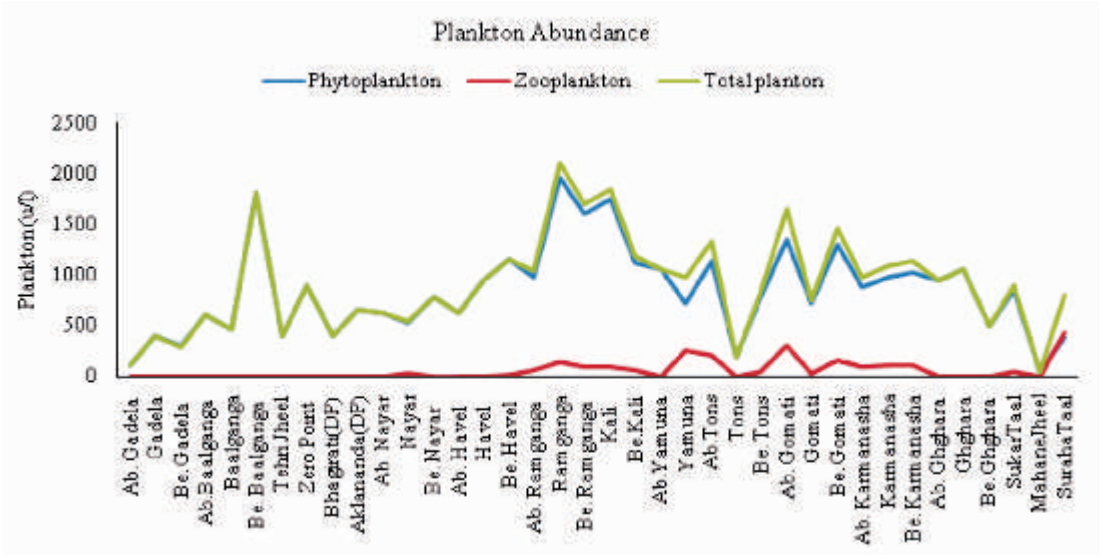


Fig. 51. Phytoplankton and zooplankton abundance of main channel of river Ganga and its tributaries

Maximum abundance of plankton was observed in the sample of Ramganga followed by Bhilangana while abundance was minimum above Gadela of Bhagirathi followed by Tons river. Higher values were observed in tributaries in general. No significant abundance of Zooplanktons were observed in the hilly stretches. Among wetlands Sukar taal had maximum and Mahane Jheel had minimum presence of plankton. The samples of the main channel and tributaries as well as wetlands were dominated by Bacillariophyceae followed by Myxophyceae in Gomati, Protozoa in above Ramganga and chlorophyceae in Sukar Taal. Maximum number (25) of taxa was observed between river Yamuna and river Tons of the Ganga river where dominating taxa were*Melosira* and *Synedra*.

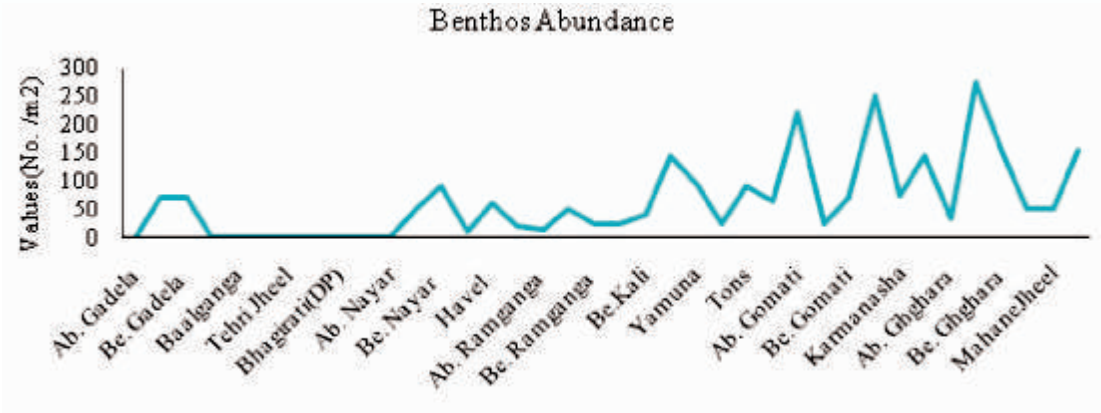


Fig. 52. Abundance of benthic fauna in main channel of river Ganga and its tributaries

An increasing trend of benthos had been observed from hilly stretch to downstream of the Ganga. Maximum abundance of benthos was observed in Ghagara. Very less benthos were observed in the hilly stretch of Ganga and tributaries.Among wetlands Surha taal had maximum benthos.The Insecta class of benthos were observed in all samples of main channel and tributaries as well as wetlands while other classes were noted from near Ramganga and downwards. Maximum abundance of Gastropoda was observed in Gaghara river and nearby wetland i.e Surha Taal.

The change in ecology of river ecosystem together with wetland and tributaries depicted the spread in diversity of fish available in above ecosystem at different points with dominance of one fish or another. The upstream channel of river Ganga had depicted abundance of Bacillariophyceae, Benthos (insects), Periphyton whereas down stream channel characterises abundance of Chlorophyceae, benthos (gastropoda). Periphyton and Bacillariophyceae showed normal pattern.

Fishes of wetlands and tributaries of River Ganga

A good number of fish species were recorded in present study and the dominant species at every sampling point are given below:

- Bhilangna Confluence- Mahseer (*Tor putitora*), Trout (*Schizothorax richardsonii*)
- Nayar Confluence: Mahseer (*Tor putitora*), Sarpora,
- Heval Confluence: Mahseer (*Tor putitora*), Asela-Trout (*Schizothorax richardsonii*), Tengra (*Sperata aor*)
- Ghaghra Confluence: Rohu, Catla, Nain, Common Carp, Padhin, Saur (*Channa marulius*), Garei (*Channa striata*), Putiya (*Puntius sophore*), Tengra (*Mystus vittatus*), Tengra (*Sperata seenghala*), Jheenga (*Macrobrachium* sp.), Baam (*Mastacembelus armatus*), etc.
- Karmanasha Confluence: Berari (*Wallago attu*), Gosta, Rohu, Catla, Nain, Common Carp, Tilapia, Gegara, Padhin, Berari, Saur, Garei, Putiya, Tengra, Jheenga (small), Baam, Chelwa, Pathri, Moi, Werari, Pharha, TinKatiya, Kauaa, Garua, Vacha, Kokaee, Suhiya, Palwa, Singhee, Mangur etc.
- Gomti Confluence: Rohu, Catla, Nain, Common Carp, Tilapia, Padhin, Aor, Seenghala,

Jheenga, Baam, Chelwa, Garua, Putiya, etc. Dominance of *Aor* has been observed in the Gomati River.

- Tons River Confluence: Rohu, Catla, Nain, Common Carp, Padhin, Saur, Garei, Putiya, Tengri, Tengra, Jheenga, Baam, etc.
- Ramganga River Confluence: Mahseer, Gunguna, Common Carp, Silver Carp, Rohu, Catla, Nain, Tilapia, Dhigra, Jheenga (small), Baam, Chelwa, Garai etc.
- Yamuna River Confluence: Berari, Gosta, Rohu, Catla, Nain, Common Carp, Tilapia, Gegara, Padhin, Berari, Saur, Garei, Putiya, , Tengra, Jheenga (small), Baam, Chelwa (*Puntius*), Pathri, Moi (*Chitala chitala*), Werari, Pharha, Kokaee, Singhee (*Heteropneustes fossilis*), Mangur (*Clarias batrachus*).
- Kali River Confluence: Chela, Kaunchhi, Gonchha, Rohu, Catla, Nain, Silvercarp, Common Carp, Tilapia, Gegara, Padhin, Saur, Tengra, Jheenga (small), Baam, Chelwa, Patara, Kauaa, Garua, Vacha, Kokaee, Singhee, Mangur (Thai) etc. Tortoise, Dolphin. Common carp is prominent.
- Sukra Taal Confluence: Rohu (*Labeo* sp.), *Catla catla*, Nain, Common Carp (*Cyprinus carpio*), Tilapia (*Oreochromis niloticus*), Mahseer (*Tor putitora*), Tengra, (*Sperata aor*), etc.
- Surahaa Taal Confluence: Rohu, Catla, Nain, Common Carp, Grass carp, Padhin, Saur, Garei, Putiya, Palabha, Mangur, Singhee, Tengri, Jheenga, Baam, Kauaa etc.
- Mahane Wetland: Saur (Nariha), Rohu, Catla, Nain, Common Carp, Tilapia (Kabai), Paidhn, Saur, Garei, Mangur, Singhee, Tengri, Jheenga, Baam, etc.

Fish landing at Allahabad

Fish landing from Allahabad stretch of the Ganga River was estimated to be 174.125 t in 2017.There is an increase of 2.10% in catch with respect to previous year. The catch was dominated by exotics and miscellaneous group of fishes.

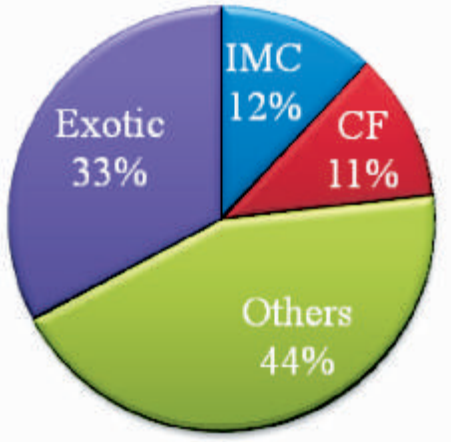


Fig. 53. Contribution of different groups of fishes in fish landing at Allahabad

Trout and Mahseer were dominating in hill stream stretch; there was also presence of common carp in Tehri Dam. Breeding of Mahseer in Tehri region was matter of serious concern while attempting for artificial breeding despite suitable climatic condition. Assessment of fish diversity, composition and catch of IMC and hill stream fishes like Trouts and Mahseer provides a picture that indigenous fish species are either endangered or threatened.The important parameters of ecology and fisheries showed that river Ganga is altered and demands restoration or conservation.Fish catch composition and fisheries has also gone to change in quantity and proportion. Tributaries and wetland found impacting ecology and biodiversity of main river through inflow of nutrients, organic load/pollution load specially during rainy season providing habitat ground for breeding and feeding of fishes of River Ganga.

Reservoir and Wetland Fisheries

Project Title: Resource assessment and refinement of fisheries management plans through co-management in selected floodplain wetlands of different eco-regions

Project No : RWF/17-20/05

Project Staff : B. K. Bhattacharjya, P. Das, S. Yengkokpam, A. K. Yadav, S. Borah, N. Sharma, N. S. Singh, U. K. Sarkar, M. A. Hassan, A. K. Das, Md. Aftabuddin, Sandhya K. M., Suman Kumari, Liamthuamluaia, Mishal P., A. K. Bera, S. K. Sahu, D. K. Meena, P. Majhi, P. DebRoy, R. S. Shrivastava, D. N. Jha, A. Alam, S. C. S. Das, J. Kumar, V. R. Thakur, Rahul Das, K. K. Sarma, A. Kakati, B.C. Ray, S.K. Srivastava, K. Srivastava, Shuvra Saha, Y. Ali, Bablu Naskar, Vijay Kumar

Ecological and biological diversity was assessed in two floodplain wetlands of Assam viz., Samaguri and Sibasthan-Potakolong beel located in Nagaon district. Both the beels were managed under fish stock enhancement regime. Physico-chemical parameters of the water indicated better water quality regimes in Samaguri than Sibasthan-Potakolongbeel which can be attributed to better macrophyte management as well as riverine connectivity. Assessment of Trophic Status Index indicated moderately eutrophic to hyper-eutrophic conditions in the beels which vary across the seasons. Phytoplankton population was moderate (91-418 ul^{-1}) and was progressively higher from monsoon to winter season in both the beels, indicating higher colonization during stable periods. Macrophyte coverage as well as macrophyte-associated fauna was higher during the monsoon seasons. Average fish yield rate was higher in Samaguri beel (698 kg $ha^{-1}yr^{-1}$) than that in Sibasthan beel (483 kg $ha^{-1}yr^{-1}$). Stocked fishes contributed to 55% of the total catch in Samaguri beel, whereas it was 70% in Sibasthan beel. *Nandus nandus*, *Mastacembelus armatus* and *Ompok pabda*, which were not recorded by CIFRI during 1996-2002, reappeared in Samaguri beel apparently because of their ingress from river Brahmaputra during a very high flood in August, 2017.

Assessment of ecological and biological diversity of wetlands of Assam

Two beels of Assam viz. Samaguri (seasonally open; 60 ha) and Sibasthan-Potakolong (closed; 92.13 ha) located in Nagaon district was selected for the study. Both the beels were managed under fish stock enhancement regime.

Physico-chemical parameters of water and soil

Physico-chemical parameters of the water analysed in the two beels indicated that Samaguri beel had

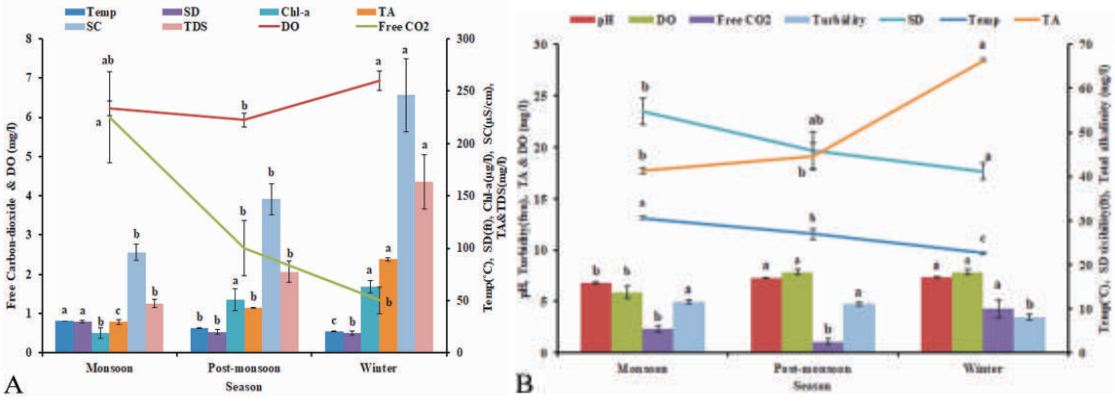


Fig.54. Water quality parameters in (a) Samaguri and (b) Sibasthan-Potakolong beel at different seasons

better water quality regimes than Sibasthan-Potakolong beel which can be attributed to better macrophyte management as well as riverine connectivity. Significant differences ($P<0.05$) in water quality parameters (pH, DO, free CO_2, total alkalinity, secchi disc visibility, temperature, specific conductivity, turbidity and TDS) was observed between seasons in the beels. Seasonal variation in important water quality parameters were agreeable with the past studies in beels of Assam. In between the beels, t-test showed that pH and DO was significantly ($P<0.05$) different.

The soil quality indicated sandy loam soil in both the beels. The beels have acidic soil with good amount of organic carbon and available nitrogen. Almost all parameters are similar in the three seasons except for pH (significantly higher in post-monsoon) and available N in Samaguri beel (significantly lower in monsoon season).

Table 11: Soil quality parameters in Samaguri and Sibasthan-Potakolong beel at different seasons.

Parameters	Samaguri beel			Sibasthan Potakolong beel		
	Monsoon	Post-monsoon	Winter	Monsoon	Post-monsoon	Winter
Sand (%)	81.33±0.88	81.00±0.58	82.33±1.20	80.33±0.33	81.00 0.58	81.33±0.88
Silt (%)	13.33±0.88	14.33±0.88	14.00±0.58	15.66±0.88	14.67 0.88	14.67±0.67
Clay (%)	5.33±0.88	4.67±1.45	3.67±0.67	4.00±0.58	4.33±0.33	4.00±0.58
pH	5.33±0.09[a]	5.73±0.3[b]	5.40±0.12[a]	5.433±0.09	5.60±0.21	5.77±0.03
Organic C (%)	0.62±0.01	0.64±0.01	0.67±0.01	0.61±0.01	0.64±0.01	0.64±0.01
Available N (mg/ 100g)	47.90±0.69[c]	52.05±1.88[b]	50.04±1.38[b]	62.60±0.60	63.87 0.28	62.27±0.26
Available P (mg/ 100g)	0.60±0.00	0.62±0.00	0.63±0.00	0.61±0.01	0.63±0.01	0.63±0.01
$CaCO_3$ (%)	2.23±0.15	2.10±0.06	2.00±0.06	2.20±0.15	2.20±0.06	2.23±0.12

Trophic status

Studies on trophic status of floodplain wetlands were conducted during monsoon, post-monsoon and winter in Samaguri (seasonally open) and Sibasthan-potakolong (closed) beel of Nagaon district, Assam. Transparency, total phosphorus (TP) and chlorophyll a (Chl-a) content of water was estimated (Table 1) to calculate the Trophic status index (TSI). TSI based on different parameters was calculated following Carlson Trophic State Index (1977) as follows:

TSI for Chlorophyll-a = 9.81(ln Chlorophyll-a) ($\mu g\ l^{-1}$) + 30.6
TSI for Secchi depth = 60 - 14.41 ln Secchi depth (m)
TSI for Total phosphorus = 14.42 ln Total phosphorous ($\mu g\ l^{-1}$) + 4.15

Table 12. Values of Transparency, Total Phosphorus (TP) and Chlorophyll a content of water in Samaguri and Sibasthan beel, Assam

Beel	Samaguri				Sibasthan			
Season	Monsoon	Post monsoon	Winter	Average	Monsoon	Post monsoon	Winter	Average
Transparency (m)	0.99±0.05	0.67±0.07	1.58±0.25	1.08±0.1	0.78±0.04	0.62±0.06	0.76±0.03	0.72±0.043
Total ($\mu g\ l^{-1}$)	60±5.77	83.33±12.26	60±5.77	67.8±13.7	50±5.76	142.33±16.2	30.33±4.84	74.2±13.8
Chlorophyll-a ($\mu g\ l^{-1}$)	18.67±5.17	50.81±10.4	63.15±5.72	44.21±7.61	14.17±2.33	19.23±1.99	23.84±3.77	19.08±1.98

Assessment of TSI indicated that the trophic status of the beels ranged from moderately eutrophic to eutrophic across the seasons. In the monsoon season, both the beelswere moderately eutrophic (TSI 50-60) based on Chl-a content and eutrophic (TSI 60-70) based on other two parameters. Samaguri beel had eutrophic condition during post-monsoon (based on all parameters) while Sibasthan beel showed

moderately eutrophic condition based on Chl-a and eutrophic based on TP and transparency. In the winter season, Samaguri beel was moderate eutrophic (based on transparency) to eutrophic (based on TP and Chl-a). Similarly, Sibasthan beel had moderately eutrophic (based on Chl-a) to eutrophic (based on TP and transparency) condition.

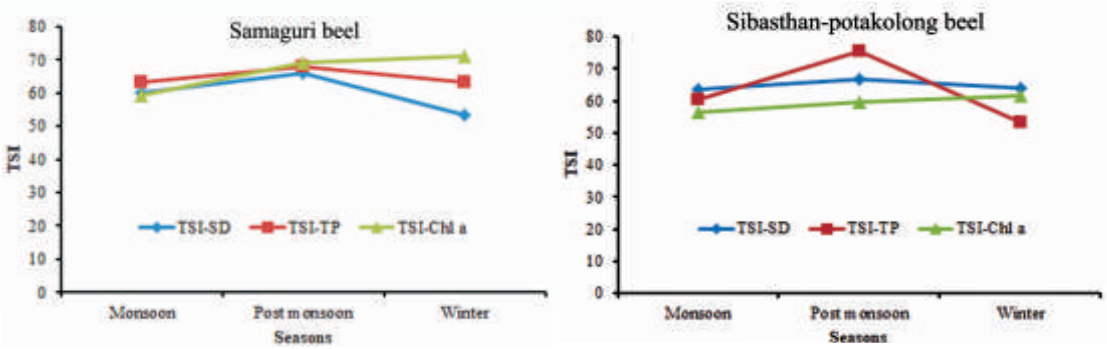


Fig.55. Trophic status of Samaguri and Sibasthan-Potakolong beel in different seasons.

Plankton and macrophyte abundance

Phytoplankton population was lower in Samaguri beel (91-251 ul^{-1}) than that in Sibasthan-potakolong beel (99-418 ul^{-1}), mainly because of low macrophyte infestation/competition for nutrient and space. Seasonal variation was progressively higher from monsoon to winter season in both the beels, indicating higher colonization during stable periods. Bacillariophyceae dominated the phytoplankton population during all the three seasons in both the beels followed by Cyanophyceae in monsoon and post-monsoon in Samaguri beel and Chlorophyceae in Sibasthan-potakolong beel. Contribution of Cyanophyceae in total phytoplankton was higher during monsoon season suggesting that many of these were brought in to the beels by surface runoff/flood water.

In periphyton, Bacillariophyceae (57.90- 86.67 %) dominated in Samaguri and Sibasthan-potakolong beel in all the three seasons. A total of 28 and 34 genera of periphyton were recorded from Sibasthan-potakolong and Samaguri beel, respectively. Total periphyton population was higher in Samaguri beel (262-2643 ucm^{-2}) than that in Sibasthan-potakolong beel (143-1828 ucm^{-2}). Seasonal variation in periphyton population was higher from monsoon to winter season in both the beels indicating higher colonization during stable seasons. Commonly observed periphyton groups were *Navicula*, *Diatoma*, *Synedra*, *Oscillatoria*, *Melosira*, *Nitzschia*, *Cymbella*, *Microcystis*, *Anabaena*, *Gonatozygon*, *Pandorina*, *Chlorella*, *Gyrosigma*, *Dictyosphaerium*, *Zygnema*, *Aulacoseira*, *Euastrum*, *Netrium*, *Surirella*, *Fragillaria* and *Volvox.*

Principal Component Analysis (PCA) was used to summarize the limnological variables (water temperature, pH, depth, dissolve oxygen, free CO_2, total alkalinity, conductivity, TDS, SDD, turbidity,

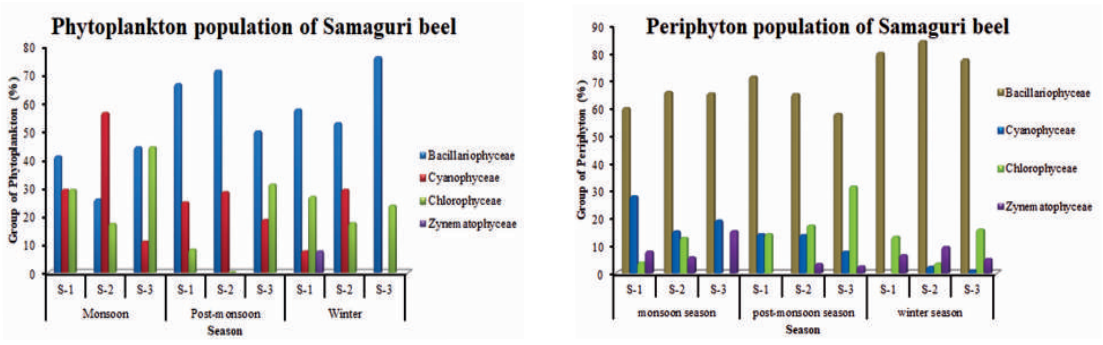


Fig.56. Phytoplankton and periphyton population in Samaguri of Nagaon district, Assam.

chlorophyll and total phosphorus) with the phytoplankton group. The two components explained 77.9% and 79.8% variability in the data set of Samaguri and Sibasthan-potakolong beel respectively. In Samaguri beel,Chlorophyceae is inversely related to total phosphorous and Bacillariophyceae is inversely related to temperature, SDD, free carbon-dioxide whereas positively influenced by dissolve oxygen, total alkalinity, conductivity, TDS and chlorophyll-a. In Sibasthan-potakolong beel, Bacillariophyceae is inversely related to temperature and SDD whereas positively influenced by dissolved oxygen and Cyanophyceae is inversely related to free carbon-dioxide and specific conductivity.

Macrophyte associated fauna and Benthic communities

The abundance of macrophyte associated fauna (MAF) was higher in monsoon season than the post-monsoon and winter season. Total abundance of MAF was found to be higher in Sibasthan-potakolong beel (24-260 nos. m^{-2}) than that of Samguri beel (40-128 nos. m^{-2}), because of low macrophyte infestation in Samaguri beel. However, the diversity of MAF was higher in Samaguri beel, since it has riverine connections. The MAF in Samaguri beel consisted of small fishes (8 species), insects (7 species), molluscs (4 species), prawn (1 species) and crab (1 species), while that of Sibasthan-Potakolong beel consisted of small fish (1 species), insects (4 species), molluscs (3 species) and prawn (1 species). Fish species observed were *Badis badis*, *Aplocheilus panchax*, *Trichogaster sota*, *Parambassis lalia*, *Puntius phutonio*, *Brachydanio rerio*, *Macrognathus pancalus* and *Lepidocephalichthys guntia*. Insects consisted of Dragonfly larvae, *Gerris* sp., *Dystiscus* sp., *Cybister* sp., *Ranatra elongate*, Damselfly and Mayfly larvae and molluscs consisted of *Pila globusa*, *Vivipara* sp., *Gyraulus* sp. and *Bellamya bengalensis*. The prawn species observed was *Macrobrachium* sp. and crab observed was *F. potamonidae*.

Average density of macro-benthic organisms in Samaguri and Sibasthan-potakolong beel was recorded at 67 and 76 nos. m^{-2}, respectively. Seasonal variation of benthic population was progressively higher from monsoon to winter season in both the beels. Mostly observed benthic taxa were *Bellamya bengalensis*, *Pila globosa*,*Viviparus* sp.,*Gyraulus* sp., *Dystiscus* sp., dragonfly larvae and mayfly larvae.

Fish diversity and catch composition

Fish yield rates of Samaguri and Sibasthan-Potakolong beel was compared with all stocked beels of Assam (87 Nos.) under administrative control of Assam Fisheries Development Corporation (AFDC) Ltd., Guwahati. Fish yield rates varied widely both in Samaguri (range: 26-1500 kg ha^{-1} yr^{-1}) and Sibasthan (range: 21-1300 kg ha^{-1} yr^{-1}) beels during 2001-17. Average fish yield rate was higher in Samaguri beel (698 kg ha^{-1} yr^{-1}) than that in Sibasthan beel (483 kg ha^{-1} yr^{-1}) in spite of similar supplementary stocking practices followed apparently because of better macrophyte management and habitat regimes. Average fish yield rate of both the beels was higher than that in all 87 stocked beels of Assam (average 478 kg ha^{-1} yr^{-1}) during the same period.

Stocked fishes contributed to 55% of the total catch in Samaguri beel, whereas it was 70% in Sibasthan beel. Among the indigenous/ natural fishes, the Indian river shad (*Gudusia chapra*) alone contributed 35%

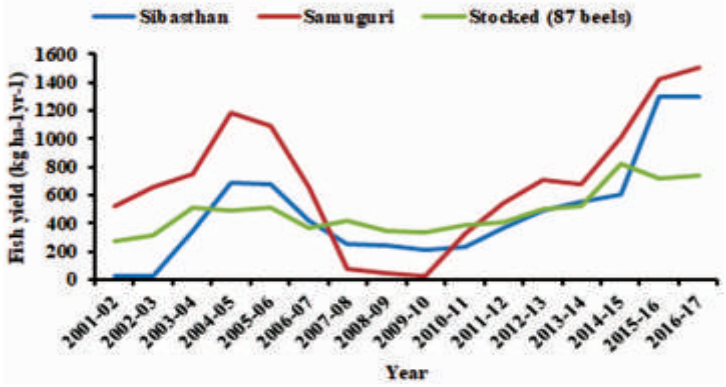


Fig.57. Fish yield rate in Samaguri, Sibasthan-Potakolong and 87 stocked beels of Assam.

of the total catch in Samaguri beel whereas small catfishes (*Mystus* spp.) contributed 10% of the total catch in Sibasthan beel. Higher fin-fish diversity (53 Nos.) was recorded in the seasonally open beel (Samaguri) than that in the closed one (Sibasthan) (42 Nos.) apparently because of riverine input in the former. *Nandus nandus*, *Mastacembelus armatus* and *Ompok pabda*, which were not recorded by CIFRI during 1996-2002, reappeared in Samaguri beel apparently because of their ingress from river Brahmaputra during a very high flood in August, 2017.

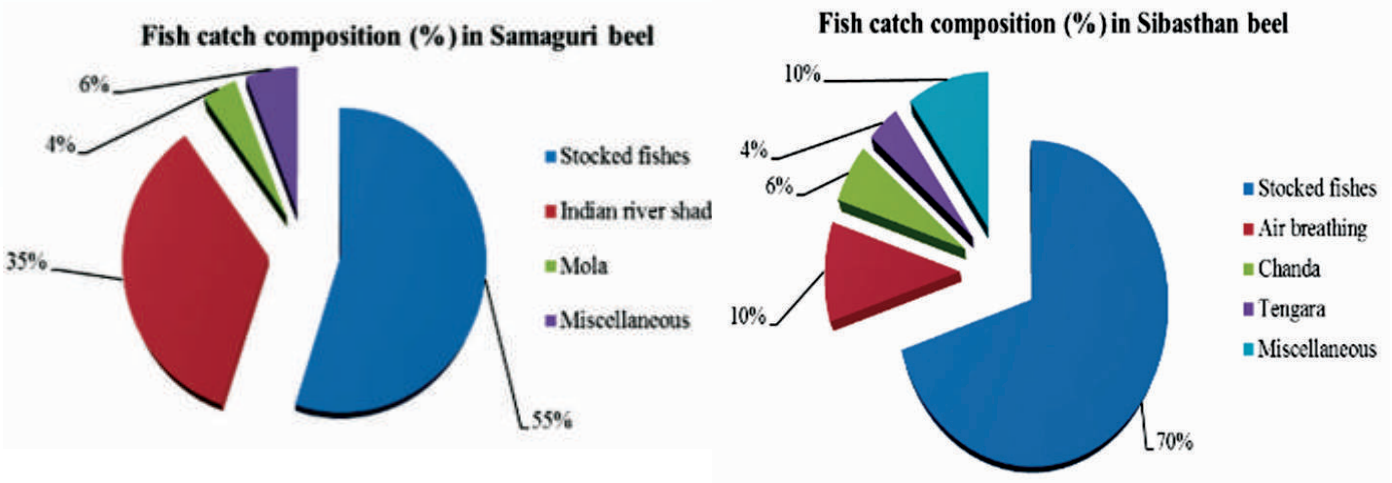


Fig.58. Fish catch composition in Samaguri and Sibasthan-Potakolong beel, Nagaon district, Assam.

Time scale variation of fish yield rates in beels of Assam

Data on fish production in 183 floodplain wetlands (beels) under the administrative control of Assam Fisheries Development Corporation (AFDC) Ltd., Guwahati were collected and analysed over the past 16

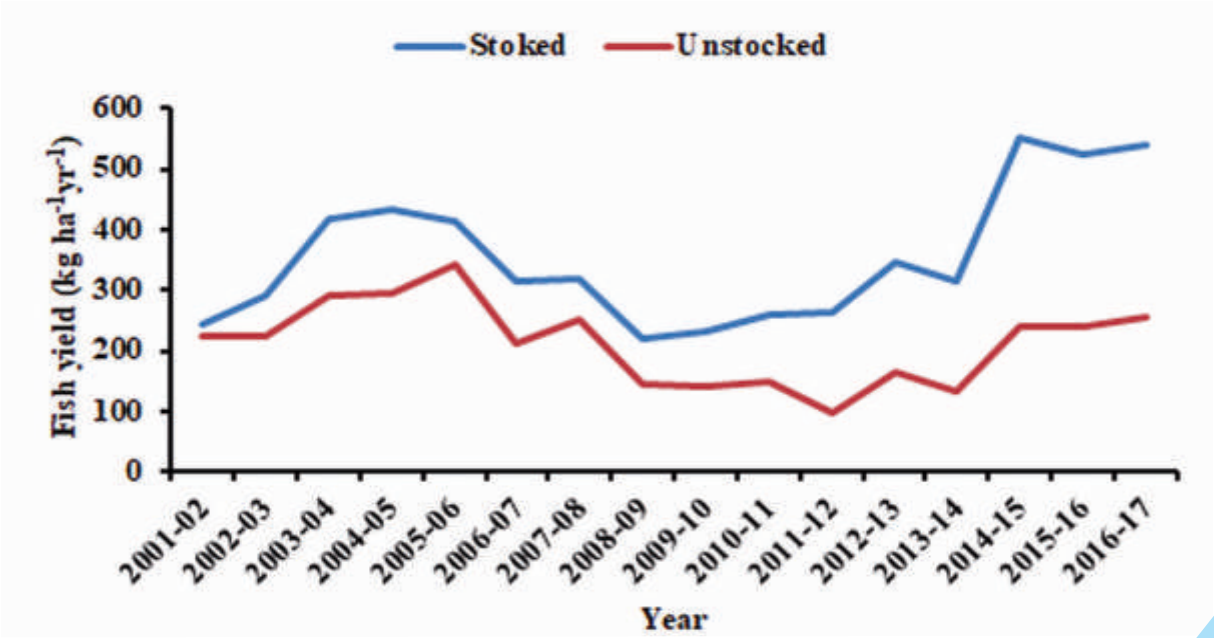


Fig.59. Weighted average fish yield of stocked and unstockedbeels

years (2001-02 to 2016-17). The beels were divided into unstocked (beels i.e. not subjected to supplementary stocking, thereby representing capture fisheries) and stocked beels (where supplementary stocking with Indian major and minor carps is practiced for fish stock enhancement). ICAR-CIFRI estimated the average fish yield rate from selected beels of Assam (23 Nos.) at 172.9 kg ha^{-1} yr^{-1} during 1996-98; supplementary stocking was not practised in any of these beels during that period. The weighted average fish yield rates from unstocked beels (96 Nos.) increased to 254.3 kg ha^{-1} yr^{-1} in 2016-17, even though the weighted average fish yield rated showed year to year variations. The lowest weighted average fish yield rate were observed in 2011-12 (97.5 kg $ha^{-1}yr^{-1}$) and highest (342.7 kg $ha^{-1}yr^{-1}$) in 2005-06.

Such fluctuations in capture fisheries production in the beels appeared to be mainly because of climatic regimes, specially precipitation and flooding patterns, which influence mortality and recruitment of natural fish stocks especially for major fishes (Indian major carps, major catfishes, featherbacks, etc.). The hypothesis is corroborated by significant positive correlation ($r= 0.73$, $p<0.05$) observed between annual average fish yield rates and rainfall. During high flood years (e.g., 2004-06), high floods submerged aquaculture ponds located in the catchments of most beels of the state, thereby washing down pond reared fishes to the nearby beels. This resulted in passive supplementary stocking in most unstocked beels and caused an increase in their fish yield. The compound growth rate of fish yield in unstocked beels was 0.9% during the period from 2001-02 to 2016-17.

As much as 47.5% of the beels of the state (87 Nos.) are now subjected to supplementary stocking for fish stock enhancement. However, the weighted average fish yield rate of stocked beels was 243.9 kg $ha^{-1}yr^{-1}$ in 2001-02, which was only 9.8% higher than that of unstocked beels. However, the weighted average fish yield rates increased to 539.1 kg $ha^{-1}yr^{-1}$ in 2016-17, which was more than double from the unstocked beels in that year. The compound growth rate of fish yield in stocked beels was 4.7% during the period from 2001-02 to 2016-17. The weighted average fish yield rates in stocked beels showed fluctuations over the years; it was the lowest (220.3 kg $ha^{-1}yr^{-1}$) in 2008-09 and highest (552.2 kg $ha^{-1}yr^{-1}$) in 2014-15. Even though supplementary stocking resulted in enhancement of fish production from the beels of Assam, the response of fish production to supplementary stocking has not been uniform across the beels and years. Some of the reasons for such non-uniform response includes non-adherence to scientific guidelines for stocking resulting in under and over stocking, escape of stocked fishes from some beels (seasonally open) during high floods and management regimes (e.g., little or no supplementary stocking in the last and first year of 7 year leasing period).

Project Title: Fisheries resource assessment and refinement of enhancement protocol through participatory mode in selected reservoirs of India

Project No : RWF/17-20/06

Project Staff : U. K. Sarkar, M. A. Hassan, A. K. Das, R. Palaniswamy, M. Karthikeyan, P. Panikkar, D. Karunakaran, S. K. Sahu, A. K. Bera, K. M. Sandhya, Lianthuamluaia, A. Alam, Mishal P., G. Karnatak, V. L. Ramya, Sibina Mol S., A. Saha, Jesna P. K., J. Kumar, P. Majhi, T. Tayung, P. Deb Roy, S. Kumari, Vijaykumar M.E., Usha Unnithan, S. Manoharan, Y. Ali, Bablu Naskar and Subrata Das

Systematic information on ecological characteristics including habitat complexity, fish diversity and fisheries enhancements are essential for understanding and defining characteristics of population and habitat use in open water ecosystem. The information on ecology and fisheries of Indian reservoirs including status of biodiversity, habitat quality, food niches etc. are useful for development of ecosystem-management based plans for sustainable enhancement of fisheries in reservoirs. Keeping in view the above, exploratory surveys were conducted in twelve reservoirs covering states of Jharkhand (4 reservoirs), Uttar Pradesh (1), Tamil Nadu (3), Karnataka (2), Odisha (1) and Kerala (1). Detailed study is being carried out in seven reservoirs belonging to six states for generating spatio-temporal data on 30 habitat parameters, biotic communities, fish diversity, assemblage, stocking details and fish production etc.

Table 13: Reservoirs studied in relation to status of ecology and fisheries in India

Sl. No.	Reservoir	State	Area (ha)	Category
1	Patratu	Jharkhand	980	Small
2	Derjang	Odisha	530	Small
3	Mettur	Tamil Nadu	14690	Large
4	Krishnagiri	Tamil Nadu	1232	Medium
5	Harangi	Karnataka	1910	Medium
6	Jango	Uttar Pradesh	3108	Medium
7	Mangalam	Kerala	323	Small

Eastern reservoirs

Detailed samplings were conducted at Patratu reservoir, Jharkhand and Derjang reservoir, Odisha. Habitat characteristics studies revealed both the reservoirs to be medium productive with most of the water quality parameters showing significant difference ($p<0.05$) between monsoon and winter season. Preliminary assessment of trophic state index values indicated oligotrophic state of the reservoirs. During the study period, the gross primary productivity varied from 300-875 mg $Cm^{-3}day^{-1}$ in Patratu to 1750-2000 mg $Cm^{-3}day^{-1}$ in Derjang reservoir. Based on net primary productivity (plankton based) the fish production potential was estimated to be 240 kg ha^{-1} $yr^{-1}$and 1053 kg ha^{-1} yr^{-1} in Patratu and Derjang reservoirs, respectively.

Sixty-three phytoplankton and twenty-six zooplankton taxa were identified from Derjang reservoir. Cyanophyceae (*Phormidium* sp.) was dominant in monsoon as well as in winter season. Phytoplankton abundance was significantly higher in winter ($p<0.05$) compared to monsoon. Copepod dominated the zooplankton population in monsoon and Rotifer in winter. Zooplankton abundance in winter was significantly higher ($p<0.05$) as compared to monsoon season. In Patratu reservoir, zooplankton abundance was higher in lotic zone (river site) (115 ind. l^{-1}) than in lentic zone (Dam site) (64 ind. l^{-1}), while phytoplankton abundance was higher in lentic zone during monsoon season. During winter, zooplankton abundance in lentic zone was 42 ind. l^{-1} while zooplankton abundance was nil in lotic zone. Phytoplankton abundance was 460 cells l^{-1}in lotic zone and 22070 cells l^{-1} in lentic zone.

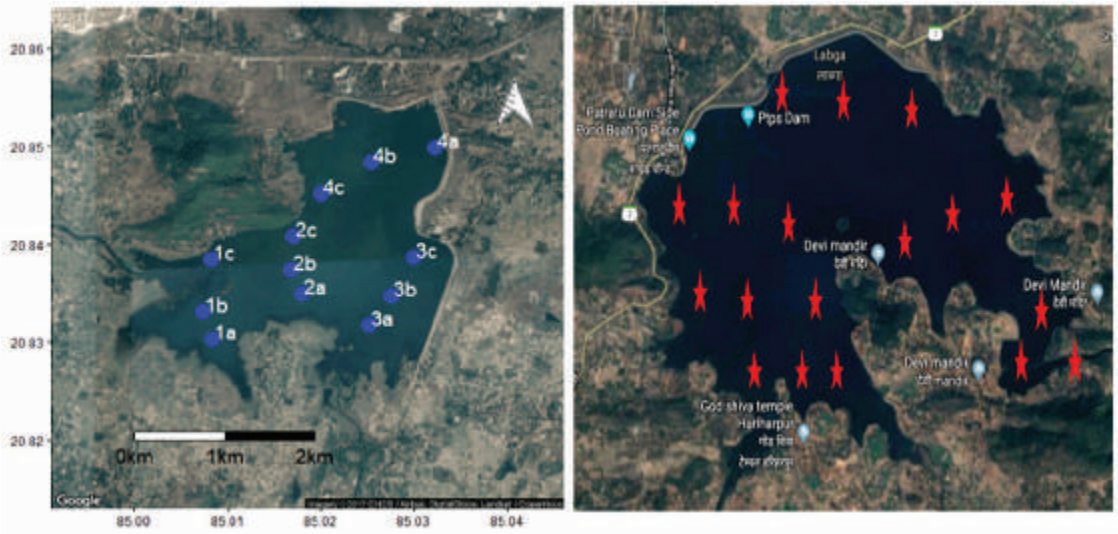


Fig.60. Sampling Sites in Derjang and Patratu reservoirs

The fish catch in Patratu reservoir was dominated by IMCs (56%) with *Labeo rohita* as dominant species followed by *Oreochromis niloticus* (16%), other carps (7%), small indigenous fishes (3%), catfishes (2%) and miscellaneous fishes (16%). In Derjang, IMCs contributed about 80% of the catch. Fish yield was estimated at 100 and 200 kg ha^{-1} yr^{-1} for Patratu and Derjang reservoirs, respectively. In Derjang reservoir, average catch per day during winter (910 kg) was comparatively higher than monsoon (342 kg). The CPUE was comparatively higher during winter as compared to monsoon. The major carp catch increased drastically in winter (from 76 to 97%). The CPUE for gillnets was maximum during monsoon in Patratu reservoir (350 g100 m^{-2} hr^{-1}) and during winter in Derjang reservoir (82g 100 m^{-2} hr^{-1}).

Fish diversity studies indicated maximum species richness and diversity at lotic zone followed by lentic zone. Maximum values of richness and diversity were observed during monsoon season in Patratu reservoir whereas in Derjang species richness was higher in monsoon but diversity and dominance indices were almost similar in both the seasons.

Peninsular reservoirs

Surveys were carried out in Harangi and Kabini reservoirs in Karnataka, Mettur, Bhavanisagar and Krishnagiri reservoirs in Tamil Nadu and Nagarjunasagar reservoir in Telangana for assessment of status of ecology and fisheries. Physical water quality parameters ranged from 6-42 m for depth, 22.6-29.5 °C for temperature, 0.106-4.75 m for transparency and 6.8-9.25 for pH. The water was well oxygenated in all the reservoirs, particularly in post-monsoon season. Reservoirs had lower values of alkalinity with the exception of Krishnagiri and Mettur. Krishnagiri recorded the highest value of hardness followed by Mettur while Kabini and Harangi showed the lowest. Relatively higher values of silicate and phosphate were recorded in post-monsoon period as compared to monsoon period. High phosphate content in Krishnagiri reservoir indicated its hyper-eutrophic nature. The soil reaction in all the reservoirs was neutral to slightly alkaline in nature except slightly acidic in Harangi reservoir. Except Bhavanisagar, soil was rich in organic carbon, optimal for high production in all the reservoirs. Available sediment phosphorus was low in all reservoirs with the exception of Krishnagiri, which might be due to its eutrophic nature. The values of available nitrogen were high in all the reservoirs except Bhavanisagar. Most of the water/sediment quality parameters were within the range recommended for fisheries; however, high levels of phosphorus and nitrate in the water/sediment of Krishnagiri are of concern.

A total of 36 species of phytoplankton were recorded from Krishnagiri reservoir during monsoon dominated by *Gonatozygon* sp., followed by *Chlorella* sp. and *Cyclotella* sp. In Mettur, 26 species of

phytoplankton were identified, where *Oscillatoria* dominated the population followed by *Microcystis* sp. and *Chlorella* sp. In Harangi reservoir, total 10 species of phytoplankton species were identified with *Chlorella* sp. as the dominating species followed by *Rivularia* species. Eleven species of phytoplankton were recorded from Kabini reservoir, where *Selenastrum* dominated the population followed by *Ankistrodesmus* and *Microcystis*. Total 17 species of phytoplankton were recorded from Bhavanisagar reservoir where *Scenedesmus* sp. dominated the population followed by *Microcystis* sp. Among zooplankton, rotifers dominated in Mettur reservoir, whereas cladocerans dominated in Harangi and Krishnagiri reservoir.

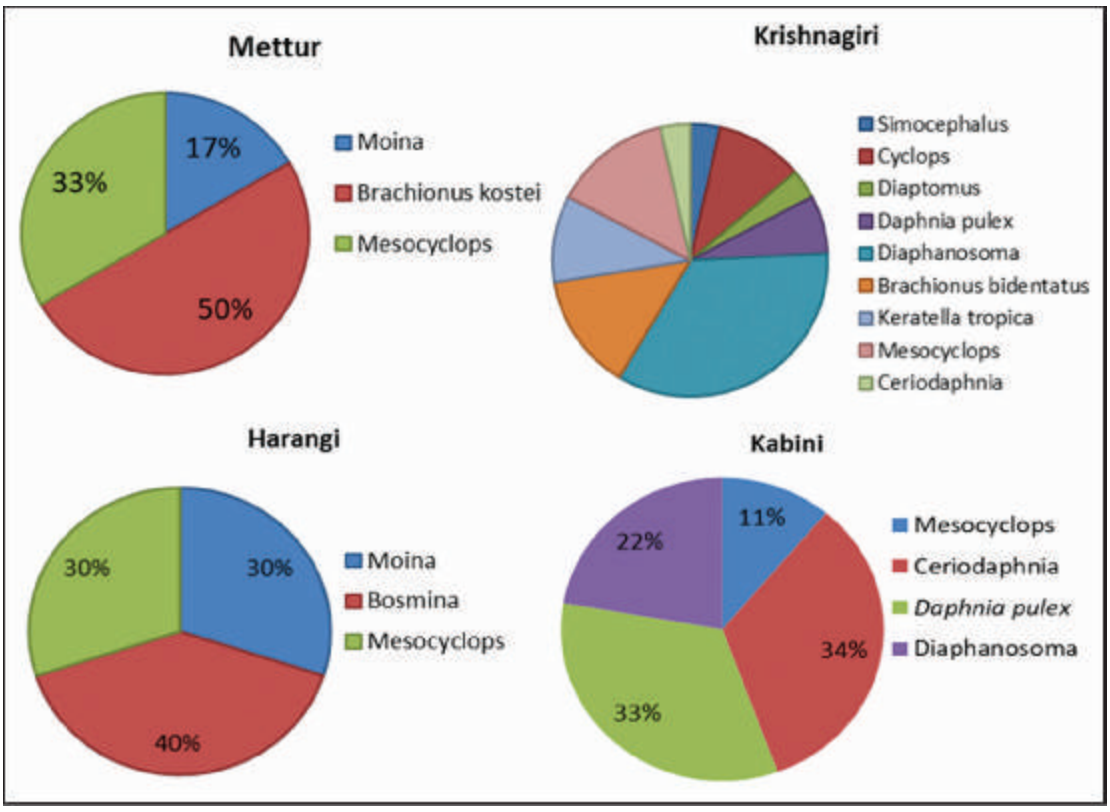


Fig.61. Zooplankton abundance in peninsular reservoirs

Nagarjunasagar was the most diverse reservoir harbouring 26 species of fishes belonging to 19 genera. Ten, twenty-three, fourteen and twenty fish species were recorded from Bhavanisagar, Harangi, Krishnagiri and Mettur reservoirs, respectively. Diversity was highest in Nagarjunasagar reservoir followed by Krishnagiri, Mettur, Harangi and Bhavanisagar. Evenness index was low in Harangi and Dominance index was high in Bhavani. Small indigenous fish species dominated the catch in number in all the reservoirs. In Nagarjunasagar 28% of the catch was composed of *Salmophasia* sp. while *Puntius sophore* contributed around 58% of the catch in Bhavanisagar reservoir. In Harangi reservoir, *Amblypharyngodon mola* (53%) dominated while in Krishnagiri and Mettur reservoirs *Puntius vittatus* (26%) and *Pethia conchonius* (34%) dominated the catch. In Harangi *Ompak pabo* distribution is common in all sites. *Salmostoma bacaila, S. sardinella, Tor putitora, Tor khudree* were abundant in lentic zones, while *Macrognathus aral* and *Barilius gatensis* were common in lotic sites. In Krishnagiri, species abundance was common in all zones owing to smaller size. Carps abundance was higher in intermediate sites. In Nagarjunasagar, *Labeo calbasu* was abundant in lotic sites.

Table 14: Fish diversity and abundance in peninsular reservoirs

Reservoirs	Nagarjunasagar	Krishnagiri	Mettur	Harangi	Bhavanisagar
Taxa	26	14	20	23	10
Individuals	287	733	476	890	248
Order	6	4	5	6	5
Family	11	6	8	8	5

Habitat parameters, planktonic composition and fish catch composition of Mangalam reservoir, Kerala were also assessed. Carlson's trophic status index (TSI) indicated eutrophic nature of the reservoir. The gross primary productivity was estimated at 46.875 mg Cm^{-3} hr^{-1}. Predominance of Myxophyceae (*Microcystis* sp, *Lyngbia* sp.) in the planktonic composition was also in conformity with the eutrophic condition of the water body. Cladocerans contributed to the tune of 45% to zooplankton diversity. Shannon diversity index for benthic community was high (1.41) at intermediate site during monsoon season. The evenness index was also high (0.88) at intermediate sites showing that the species is evenly distributed during monsoon. Fish catch in the reservoir is mainly constituted by stocked IMC (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*) and by indigenous fishes (*Dawkinsia filamentosa* and *Puntius sarana*) of family Cyprinidae. The estimated gap between fish production potential of 285 kg ha^{-1} $yr^{-1}$and actual average fish production of 76.13 kg ha^{-1} $yr^{-1}$is nearly 73%, leaving huge scope for fish production enhancement in the reservoir.

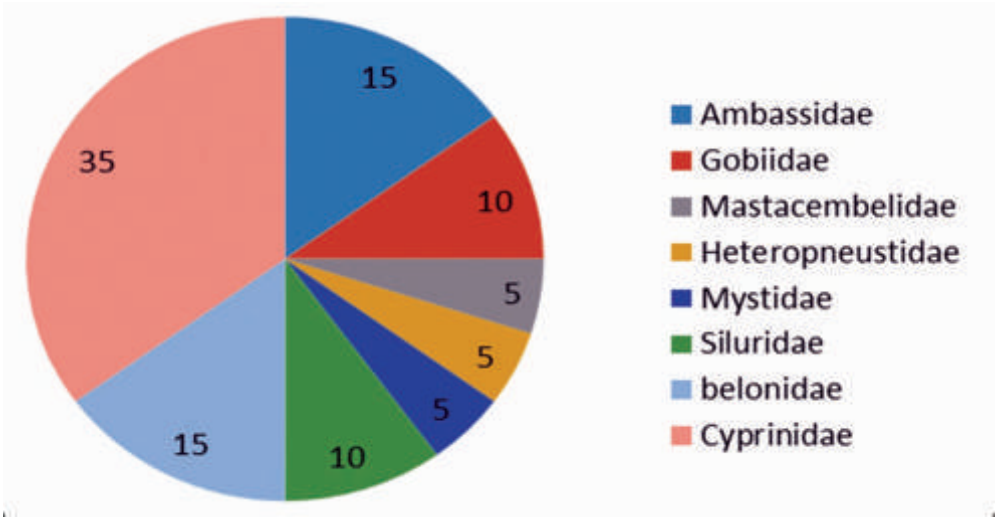


Fig.62. Fish diversity (family-wise) of Mangalam reservoir, Kerala

Reservoir fish catch assessment using Electronic Data Acquisition System (*e-DAS*)

Collection of fish catch data from Mettur, Krishnagiri, Patratu and Tunga (Karnataka) reservoirs was done using *Electronic Data Acquisition System* (*e-DAS*). The species-wise fish catch data (2017-18) from Tunga indicated that total fish catch from the reservoir was of 29.2t. The catch was dominated by *Labeo rohita* (21.4%) followed by catfishes (19.8%), catla (9.3%), mrigal (6.9%) and miscellaneous fishes contributed 42.6% to the total catch. Suitable modifications were made in the *Electronic Data Acquisition System* (*e-DAS*) for the efficient storage of data and for customized data retrieval by assigning access credentials.

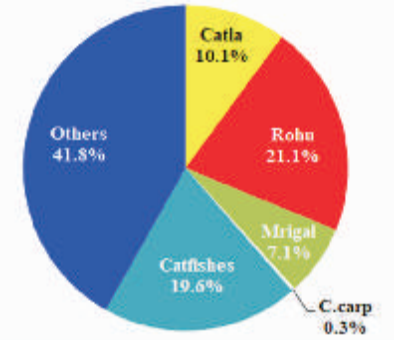


Fig.63. Estimated fish catch in Tunga reservoir (2017-18)

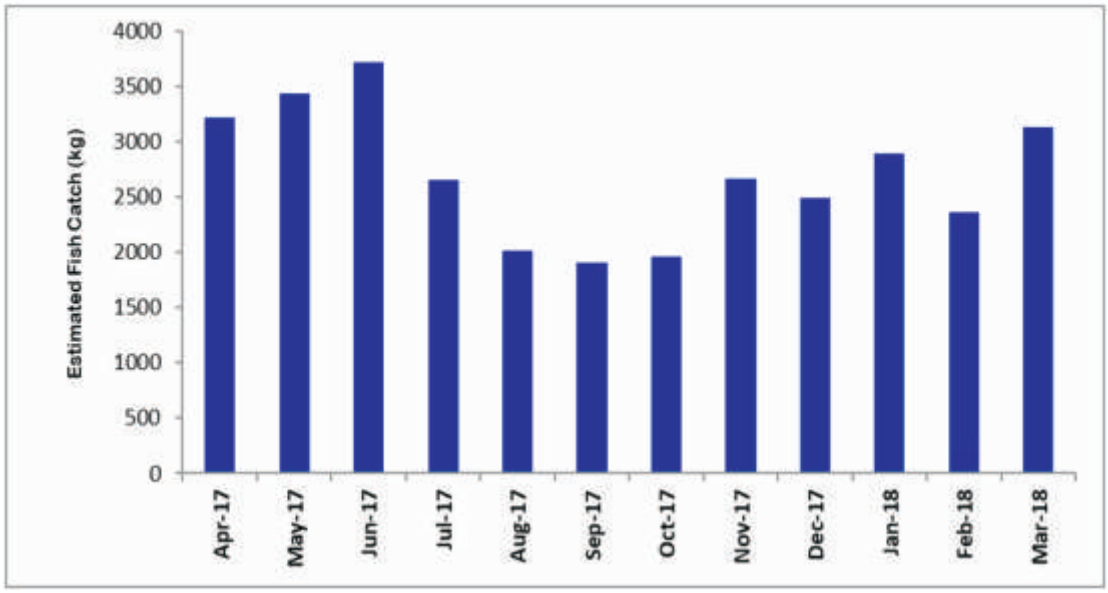


Fig.64. Fish species composition in Tunga reservoir (2017-18)

Demonstration and implementation of *e-DAS* in Patratu reservoir

Northern reservoirs

Jargo reservoir is located in the Mirzapur district of Uttar Pradesh (25°01?45.07?N and 82°56?57.4 ?E) fed by Pancwahni, Kumahiya, Barahi, Mamniya and Jargo rivers. The hydrological features of the reservoir, in general reflected productive characteristics. Twenty-five species of phytoplankton were documented with 11 species belonging to Chlorophyceae, 6 to Myxophyceae, 6 to Baccilariophyceae and 2 to Euglinophyceae. The mean phytoplankton abundance was 1.6 x 10^4 ul^{-1}. Relative abundance of macrobenthos ranged between 140 to 290 um^{-2} with a mean of 210 um^{-2}. The molluscan population dominated the benthic macrofauna (129 um^{-2}) indicating high detrital load. The energy fixed by the primary producers accounted to 3456 mg Cm^{-2} day^{-1}, depicting a photosynthetic efficiency of 0.18%. Considering the photosynthetic efficiency, the production potential at 1.2% of energy conversion was estimated at 127 kg ha^{-1} yr^{-1}.

Thirty-two fish species belonging to 23 genera, 13 families and 7 orders were recoded from this reservoir, including two exotics namely, *Cyprinus carpio* and *Oreochromis niloticus*. Assessment of fish catch composition of Jargo reservoir revealed that the contribution of fishes other than Indian Major Carps (IMC) was high (42%). The fish yield potential of the reservoir can be realized by appropriate management strategies like stocking of the IMC fingerlings that feed at the lower trophic chain.

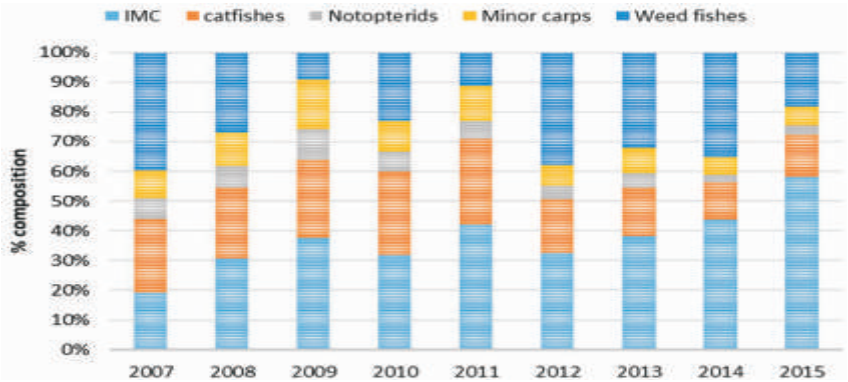


Fig.65. Fish catch composition from the Jargo reservoir (2007-2015)

Impact of fish seed stocking in reservoirs

Jargo Reservoir, Uttar Pradesh

The annual yield fish in Jargo reservoir showed an increasing trend from 31.85t in 2007 to 51.12t in 2010 to 121.45t in 2015. The dominant fish species was *Labeo rohita* followed by *Sperata seenghala* and

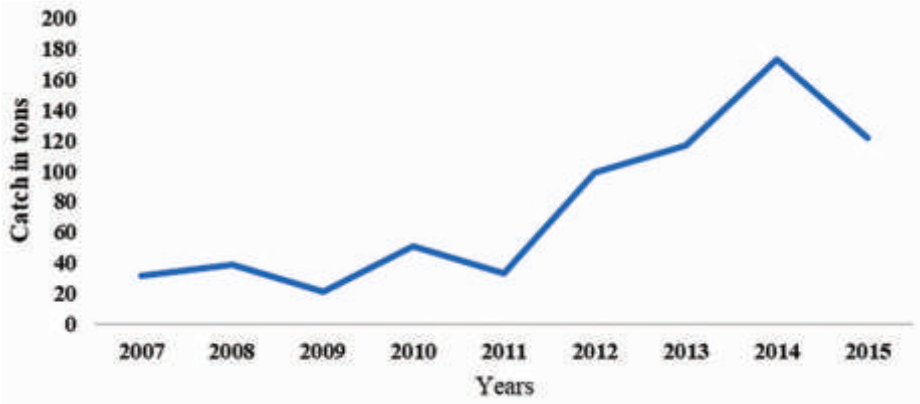


Fig. 66. Fish catch from the Jargo reservoir (2007-2015)

Cirrhinus mrigala. IMC catch increased from 19% to 58% during 2007 to 2015. Culture based fisheries is practiced in the reservoir using 35 lakhs IMC fry (25 mm size). The stocking of IMC has positively affected the fish production from this reservoir.

Mettur reservoir

During 2011-12, 23.02 lakh advanced fingerlings were stocked in the Mettur reservoir. The annual catch of exotics in the reservoir increased from 1.6% in 2007-08 to 5.3% in 2009-10, and then declined to 1.6% in 2013-14. Advanced fingerlings of IMCs at the rate of 25 lakh $ha^{-1}yr^{-1}$ in 2009-10, 42.86 lakh in 2010-11, 24.22 lakh in 2011-12 were stocked in Mettur reservoir for fisheries enhancement. The stocking rate was comparatively lower in 2012-13, which was reflected in a decline in the fish yield in the consecutive year. Stocking of 773 tons of seeds in 2015-16 had positive impact on fisheries of the reservoir.

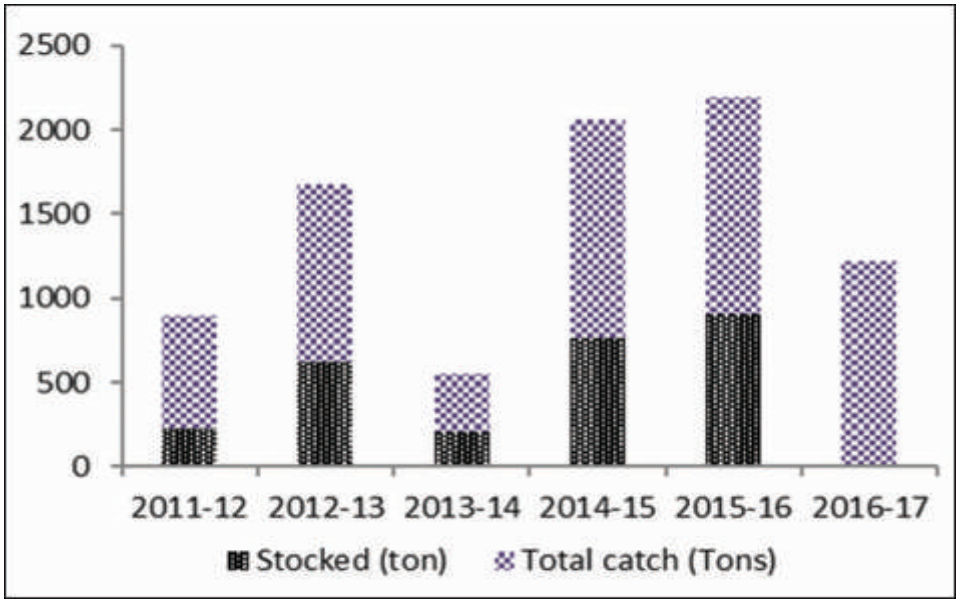


Fig. 67. Fish seed stocking and fish yield in Mettur reservoir

Project Title: Assessment and validation of potential fishery zones in medium and large reservoirs using hydro acoustics

Project No: RWF/17-20/07

Project Staff : M. Feroz Khan, Sibinamol. S and Vijaykumar M. E

Hydroacoustic survey was carried out in a medium reservoir i.e. Bansurasagar reservoir, Kerala. The Portable Simrad EY60 split beam echo sounder with frequency 120 kHz and elliptical transducer (opening angles at -3dB were 4 and 10 degrees) were used. The pulse duration was set to medium (0.3ms), the ping repetition rate to 5Hz, and the Target Strength and Sv thresholds to –33dB and –70dB, respectively. The water parameters, dissolved oxygen, temperature and conductivity were measured at surface using portable instrument and conductivity, salinity were estimated and incorporated in SIMRAD ER60 software.

The acoustic runs were made and the received histograms were de-convoluted to account for random aspect of fish distribution and then used for scaling the integrator values. The acoustic surveys and depth

profiling was conducted in intermediate zone. Three transects at intermediate zone showed number of fishes ranging from 136 – 185 by echo counting using ER60 portable echo sounder at Banasurasagar reservoir.

Krishnarajasagar (KRS) reservoir was selected in large reservoir category for the study. It is located in the Mandya district of Karnataka state with an area of 12,900 ha at the confluence of river Kaveri with its tributaries Hemavati and Lakshmanatheertha. Experimental fishing conducted at intermediate zone has shown dominance of *Salmostoma acinaces* followed by *Cirrhinus mrigala* during post monsoon season. Licensed fishing is carried out in the reservoir. License is issued to two persons to operate one coracle at the rate of ` 3000 yr^{-1}. There are 500 registered fishermen fishing in the reservoir. The major craft operated is fibre coracle and the major gear is gill net. The estimated average catch is about 70 kg $m^{-1}p^{-1}$. Every year the reservoir is stocked with fingerlings of *Gibelion catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Cyprinus carpio*. Experimental fishing conducted using multimesh gillnet in this reservoir revealed that *Salmostoma* sp. contributes maximum (60%) to the catch by number while *cirrhinus mrigala* contributed maximum (44%) by weight. The occurrence of *Clarias gariepinus* (African catfish) in the reservoir has also been recorded which has been observed for the last three years.

Project Title: Studies on exploitation of insects as feed and food (Collaborative project with ICAR-NBAIR)

Project No: RWF/17-20/08

Project Staff : Preetha Panikkar, Jesna P. K, Amala. U (ICAR-NBAIR), M. Feroz Khan, Selvaraj. S, and Vijayakumar M.E.

Feed is the major input cost in aquaculture and fishmeal is a costly ingrediant in fish feed. Insects could an alternate protein source in fish feed. With this view an experiment was conducted to evaluate the effect of Black soldier fly (BSF), *Hermetia illucens*, on the growth performance of GIFT Tilapia (*Oreochromis niloticus*). BSF is amenable for mass production in the decaying food, agricultural and slaughter house waste. The experiment consisted of four treatments with three replicates each, viz., 1) fishes fed BSF pre

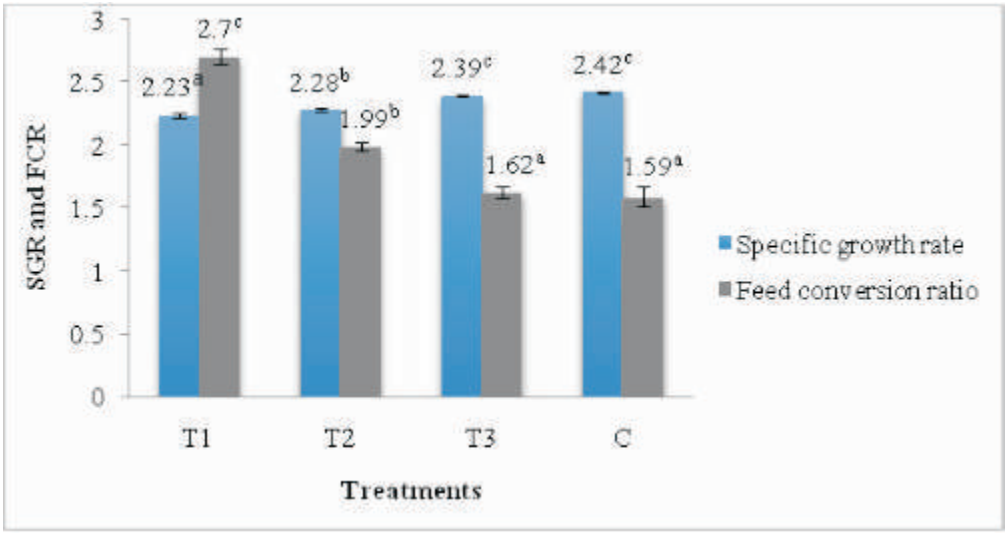


Fig.68. Specific growth rate and feed conversion ratio of the fishes after 90 days of experimental period

Egg | Mature larva | Pupa | Adult

Fig.69. Life stages of Black Soldier fly, Hermetia illucens

Eggs of BSF laid on decomposing fruits | Larvae of BSF in decomposing wastes

Fig.70. Life stages of Black Soldier fly, *Hermetia illucens*

Harvested prepupae of BSF | Formulated BSF fish feed

Fig.71. Growth of BSF and feed preparation

pupae, 2) fishes fed BSF pre-pupae and formulated diet containing BSF pre pupae in 1:1 proportion, 3) fishes fed formulated diet containing BSF pre pupae and 4) Fishes fed fish meal diet. Fishes of average weight 3.98±0.07 g and length 6.3±0.26 cm were stocked at the rate of 150 no.m^{-3} based on completely randomized design.

The study showed that fishes readily accepted all the diets. Fishes fed with fish meal diet and BSF incorporated diet showed significantly higher ($P \leq 0.05$) final weight and mean weight gain compared to other treatments. Growth rate viz. SGR also showed similar pattern as that of PWG, with highest values ($P \leq 0.05$) in fishes fed with fish meal diet and BSF incorporated diet. The FCR of all the treatments differed significantly with lowest FCR ($P \leq 0.05$) recorded for fishes fed with fish meal diet (Fig.68). Survival rate of fishes ranged from 74% (fishes fed BSF prepupae) to 86% (fishes fed BSF prepupae and formulated diet containing BSF prepupae in 1:1 proportion). Other than crude protein content there was no significant difference ($P \geq 0.05$) in the proximate composition (crude lipid, ash and carbohydrate) of the fishes of different treatments after 90 days of feeding trial. However the crude protein content of fishes fed with dried BSF pre pupae was significantly lower ($P \leq 0.05$) than other treatments. The results indicate that BSF could be a cost effective and viable option for fish feed formulation in aquaculture practices.

Project Title: Diversification of fish species in enclosure culture in reservoirs and wetlands

Project No: RWF/2017-20/09

Project Staff: B. K Das, U. K. Sarkar, A. K. Das, M. A. Hassan, A. K Sahoo, D. Debnath, S. Kamble, S. Kumari, Jesna P. K., G. Karnatak, Mishal P., H. S. Swain, T. Tayung, M. Ramteke ,V. R. Thakur, A. Sengupta, Subrata Das, Y. Ali, B. Naskar and D. Saha

The experiments for diversification of fish species for cage culture in reservoirs and wetlands are being executed in various locations in different agro climatic zones of the country using regionally important and indigenous fish species.

Cage culture at Salia Dam

Salia Dam (19.79°78´ N; 85.07°51´ E) is a small reservoir located on Salia river in Ganjam district of Odisha. *Pangasianodon hypophthalmus* (P) and *Barbonymus gonionotus* (G) were stocked in a polyculture system at different stocking ratios (P: G- 80:20, 60:40, 50:50, 40:60, and 20:80) and at stocking density of @45-50 nos.m^{-3}. *P. hypophthalamus* and *B. gonionotus* were stocked at initial weight and length of 8.14 g, 6.3 cm and 6.12, 6.3 cm respectively. After 120 days of rearing, the highest growth and survival in

Stocking of fish in cage

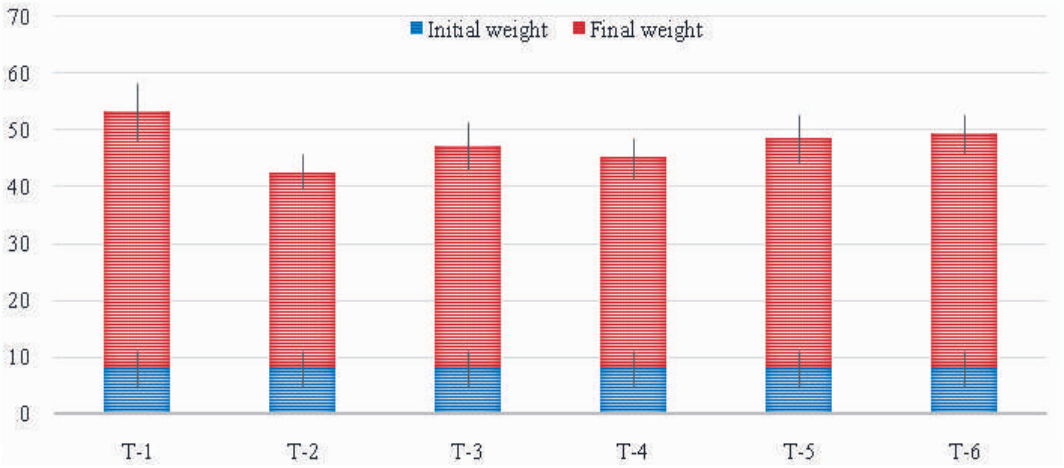


Fig.72. *P. hypophthalmus* showing significantly higher growth rate in T-1 (**P:G- 8:2**) compared to other treatments

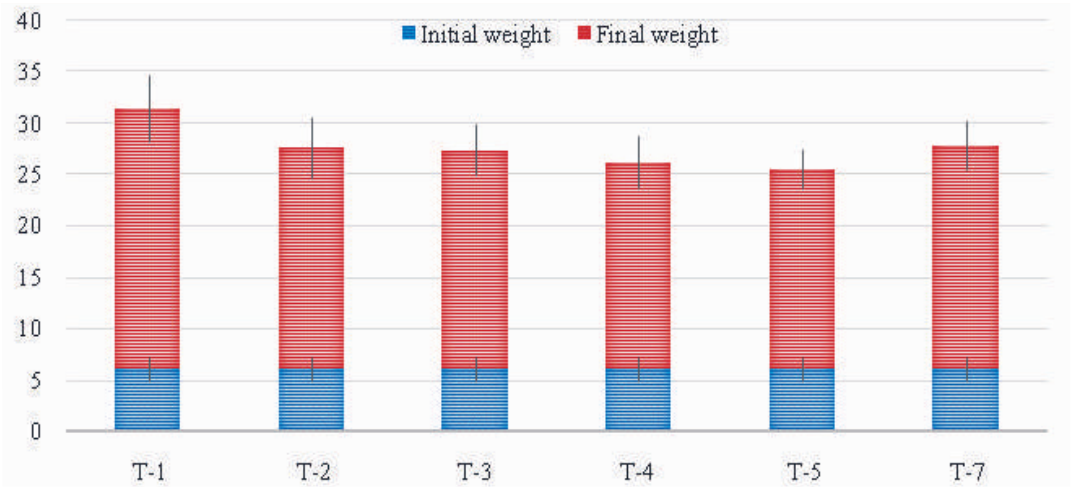


Fig.73. *B. gonionotus* showing significantly higher growth rate in T-1 (P:G -8:2) compared to other treatments

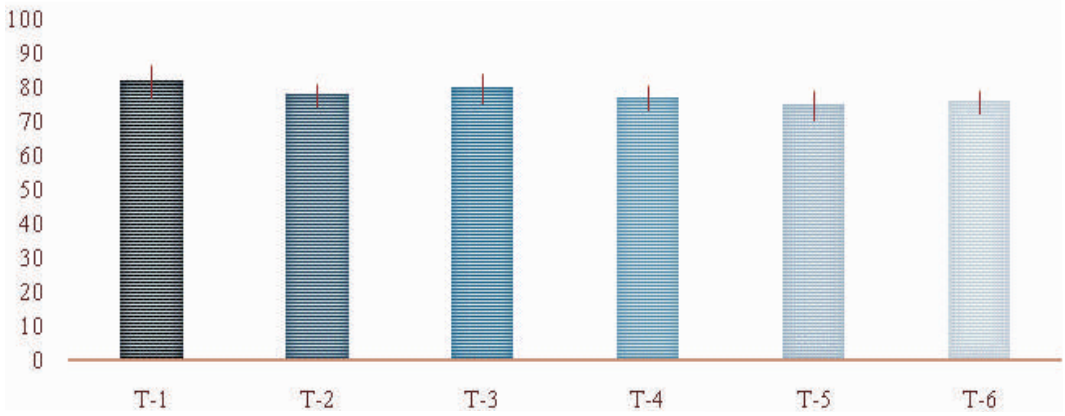


Fig.74. Survival (%) of *P. hypophthalmus* in different treatments

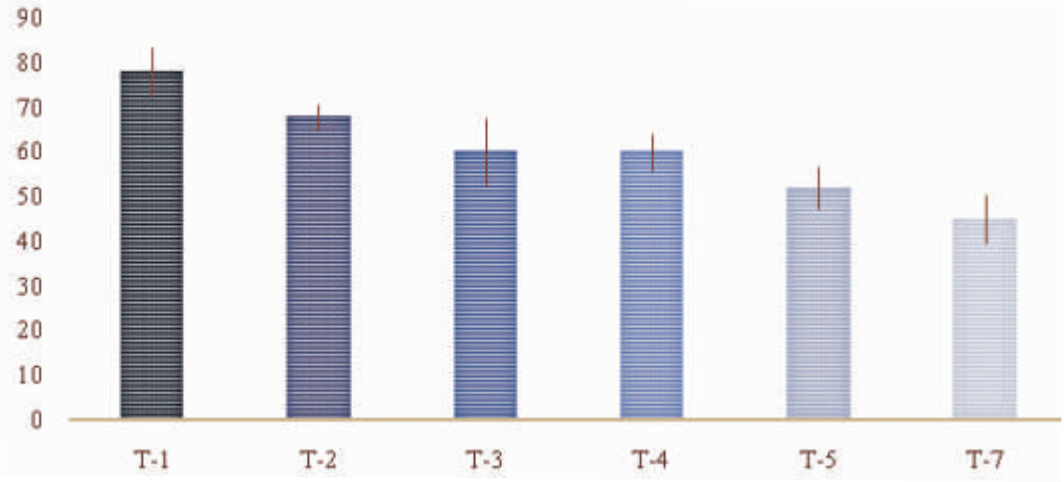


Fig.75. Survival (%) of *B. gonionotus* in different treatments

P. hypophthalmus and *B. gonionotus* were recorded in the treatment 1 (P:G::80:20). Lowest growth and survival was recorded in treatment 2 (P:G:: 60:40) for *P. hypophthalmus* and in treatment 5 (P:G::20:80) for *B. gonionotus*. The growth observed was slow as expected due to low temperature during study period (November-January).

Cage culture at Maithon reservoir, Jharkhand

Experiments on evaluation of growth performance of *Labeo bata* and *Ompok bimaculatus* in cages have been initiated at Maithon reservoir, Jharkhand. *Labeo bata* (8.8±0.67cm and 6.18±1.32 g size) has been stocked in cages in three stocking densities @ 50 nos. m^{-3}, 75 nos. m^{-3} and 100 nos. m^{-3} in duplicate for optimization of stocking density for its growout culture. *O. bimaculatus* (7.25±0.93 cm and 2.18±0.78 g) in combination with *L. bata* (8.8±0.67 cm and 6.18±1.32 g) @ 50 nos. m^{-3} (30 nos. m^{-3} pabda ± 20 nos. m^{-3} bata) has been stocked in cages in duplicate to study feasibility of polyculture of these species in cages.

Fig.76. Cage culture activities at Maithon reservoir, Jharkhand

L. bata is being fed thrice a day @ 8% of body weight with 1.5mm floating feed (32 % Crude Protein and 6% Crude Lipid) and *O. bimaculatus* is being fed @ 10% body weight three times a day with soaked crumbled sinking feed (500 micron) having 38% CP and 6.5% CL.

Cage culture at Samaguri Beel, Assam

Samuguri beel (26°25?45?N; 92 °51?69 ?E), located in Nagaon district of Assam (60 ha) is a seasonally open beel under stock enhancement regime. Abiotic and biotic variables in the cage site indicated suitability of the site for fish culture. The water quality parameters were characterized by alkaline pH (7.4), high dissolved oxygen (6.0 mg l^{-1}), moderate total alkalinity (28 mg l^{-1}), low free CO_2 (1 mg l^{-1}) and low turbidity (4.1 FNU). The site had phytoplankton density of 91-122 ul^{-1} and periphyton density of 1262-1612 ul^{-1}. Macrophyte coverage in the beel was medium (30-40% of floating macrophyte).

A battery of CIFRI-GI cages consisting of 16 units having 5m x 5m x 2m dimensions each (length x breadth x depth) was installed in Samaguri beel after clearing macrophytes from the site having more than 5 m depth. Among the minor carps, *Labeo bata* is one the most preferred fish species and fetches relatively higher price in the local markets of Assam. *L. bata* fingerling (avg. length 8.2 cm; avg. weight 4.8 g) were stocked in cages at five stocking densities, viz., 25 (S1), 50 (S2), 75 (S3), 100 (S4) and 150 fingerlings/m^3 (S5) in triplicates. An experimental feed (sinking, 2mm) was made from locally available ingredients such as dry fish powder/ fish meal, soybean meal, mustard oil cake, rice polish, maize flour, wheat bran and vitamin-mineral premix. The feed had crude protein (CP) content of 30.04%, lipid 4.82%, ash 6.56%, fibre 4.28% and total carbohydrate 54.31%. Tray feeding was done twice daily @ 5% body weight.

Feeding trays used for *L. bata* feeding in cages

After five months of rearing, growth of *L. bata* in terms of specific growth rate (SGR) and weight gain% (WG%) was observed to be significantly higher ($P<0.05$) in the lowest stocking density group (i.e., 25 $No.m^{-3}$), followed by those stocked at 50 and 75 nos. m^{-3} (which were not significantly different from each other). The lowest growth was observed in highest stocking density group (i.e., 150 nos. m^{-3}). The WG% and SGR of the different groups were 521.09% and 1.22 in S1, 293.29% and 0.91 in S2, 322.75% and 0.96 in S3, 250.17% and 0.83 in S4 and 152.76% and 0.62 in S5. Survival of *L. bata* in cages ranged from 85.5 to 94.07% in different stocking densities. Health of *L. bata* fingerling was monitored every month by physical observation for the presence of ulcers and parasites on the body surface. Fish were observed to be in good health throughout the culture period periodical examinations. Higher survival of *L. bata* fingerlings in low water temperatures (sometimes below 15°C in Dec to Jan) without showing any pathological conditions testified the hardy nature of the species, which can be a candidate species for cage culture in Assam even during winter season.

Cage culture at Krishnagiri reservoir

HDPE Floating cages with 210D Nylon knotless net is used for the experiment. Grow out cages of 6m x 4m x 3m dimension with mesh size of 15mm was stocked with *Etroplus suratensis* @10 nos.m^{-3}. Average length and weight of fishes at stocking was 5.03±0.15cm and 5.98 ± 0.42g respectively. Water and soil quality parameters at the cage site is being monitored on monthly basis. Growth monitoring of the fishes is in progress.

Experimental cages at Krishnagiri reservoir, Karnataka

Cage culture at Chandil reservoir

A preliminary 90 day field trial was conducted to evaluate growth and survival of Amur carp, *Cyprinus carpio haematopterus* in cages as an alternative fish species for cages during winter period at Chandil cage farm, Jharkhand.

Fig. 77. a. Cage site b. Acclimatization of fish seed and c. Sampling of fish

Fishes (avg. length: 6.05±1.04 cm and avg. wt. 2.79±1.47 g) were stocked @ 27 nos. m^{-3} in HDPE cages (6m x 4m x 4m). The fishes were fed twice a day with floating pelleted feed (28% CP, 5% Lipid) @ 5 % of body weight. The weight gain was recorded from the month of December to January was very low due to low temperature during the study period. At the end of 90 days, 57 % survival was recorded with average weight of 13.12±1.45 g.

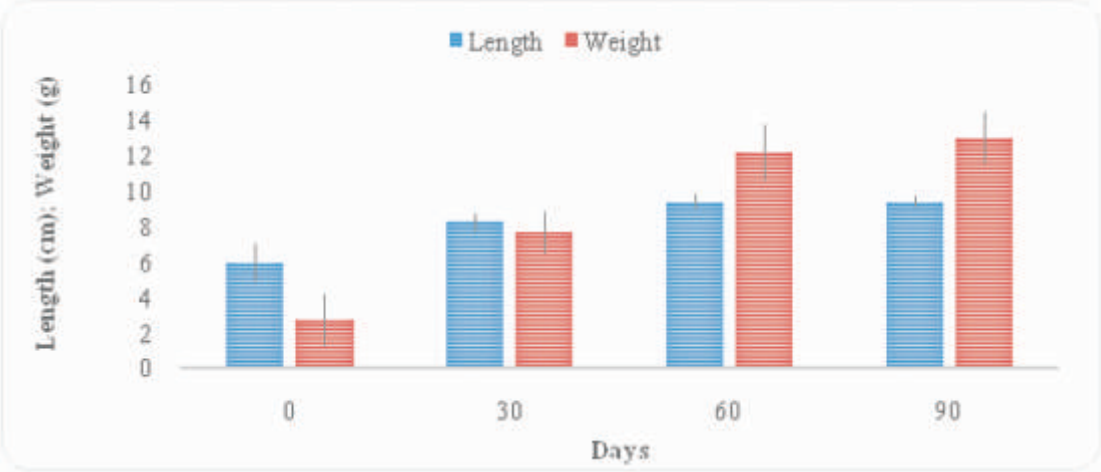


Fig.78. The growth performances of Amur carp (*Cyprinus carpio haematopterus*) after 90 days of field trial

Demonstration of cage culture at Himachal Pradesh

Pangas (*Pangasianodon hypophthalmus*) cage culture was demonstrated in Pong reservoir of Himachal Pradesh. Total 3.0 lakhs of Pangas fingerlings (avg. length 7cm and avg. weight 2.54g) were stocked @ 63 nos. m^{-3} in 48 HDPE cages ($6\times4\times4m^3$) installed in two reservoirs during third week of April 2017. The fishes were fed with 32% crude protein floating pellet feed @ 8% of body weight during initial three months thrice a day. Feeding was later reduced to 5% of body weight, twice a day for a feed containing 28% crude protein. After 6 months of culture duration, in Pong reservoir, 45.81t of Pangas was harvested from 24 cages with an average weight of 666g. The average fish production per cage was 1.9 t.

Table 14 : Growth performance, survival and production of Pangas in cages installed in pong reservoirs of Himachal Pradesh

Reservoir	Growth parameters (after 180 days of culture)								
	Initial length (cm)	Initial weight (g)	Final Avg. length (cm)	Final Avg. weight (g)	Weight gain (g)	ADG (g)	FCR	Survival rate (%)	Production (in tonnes)
Pong	7	2.54	39.92	666	663.37	3.68	1.6	44	45.81

Fishery Resource and Environment Management

Project Title : Pollution benchmarking and monitoring of rivers Kathajodi and Godavari

Project No : FREM/17-20/11

Project Staff: S. Samanta, S. K. Nag, M. Naskar, Sajina A. M., Vikas Kumar, S. Bhowmick, K. Saha, S. K. Paul, S. Bandyopadhyay and A. Ghosh

The entire stretch of River Kathajodi from Naraj Barrage to Bandar was assessed during premonsoon, monsoon and postmonsoon seasons for assessment of pollution, water and sediment qualities and fisheries status. The total length, approximately 120 km was divided into two stretches: 1. The non-tidal riverine stretch covering the sampling sites Naraj Barrage, Matagajpur/ Italanga, Daleighai, Dhuleswar (above Alipingala) and 2. The tidal stretch with the sampling sites of Mahira, Garoi (above Machhagaon), Gandakula, Bandar.

The water availability in the river is limiting and is controlled by the Naraj barrage. During monsoon season the water availability is good but in non-monsoon months it reduces drastically to negligible flow. The river bed is sandy.

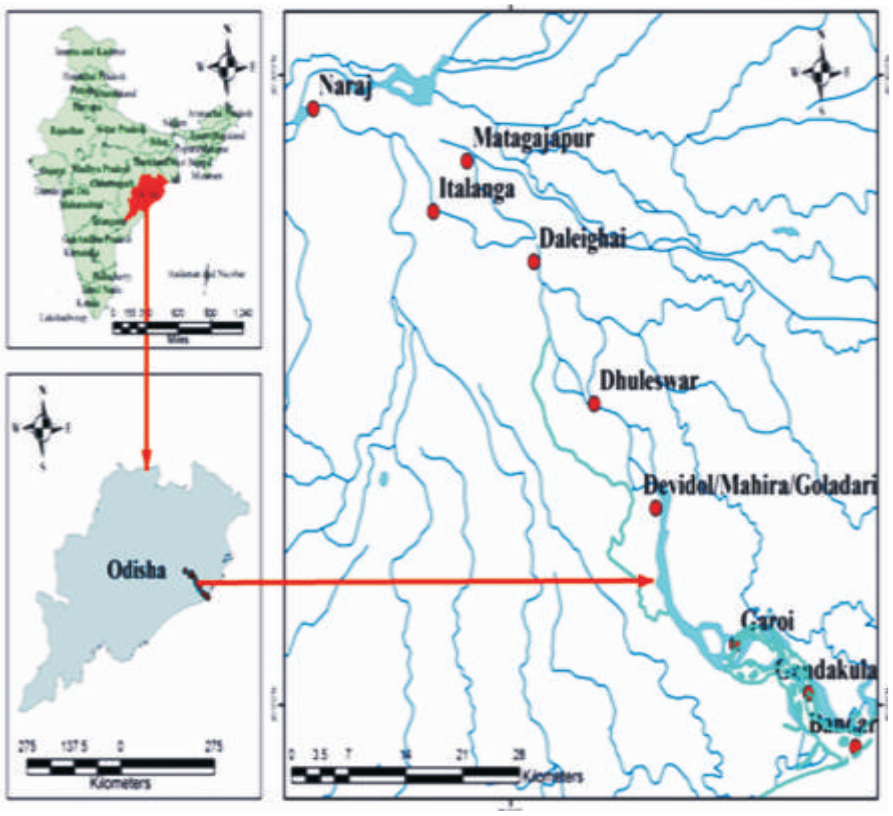


Fig.79. Sampling sites of river Kathajodi

The river receives untreated effluents from Cuttack city which has significant influence on water and sediment qualities of the river.The impact of city effluent on river water quality was prominent;maximum impact was recorded in Matagajpur area with high BOD (up to 14.0 mgl^{-1}), high specific conductivity (up to 366 µS cm^{-1}) and relatively high nutrient content (nitrate up to 0.32 mg l^{-1} and phosphate up to 0.10 mg l^{-1}). The impact was prominent upto about 15 km downstream of the effluent discharge site, i.e. up to Daleighai. The impact was prominent on sediment quality aspects of the river also, as observed by relatively high organic matter content in sediment (up to 0.45%), specific conductivity (up to 2490 µS cm^{-1}) in Matagajpur area.

The trace element (Cd, Cr, Cu, Mn, Pb, Zn) content in river water was assessed. Other than Mn, all the other element were recorded at below detection limit of the flame mode of Atomic Absorption Spectrometer (AAS). Recorded concentration of Mn was 26-128 µg l^{-1}. Thus, the concentration of the elements were safe for the aquatic community.

Study on metal contents in sediments recorded Cd at BDL, Cr BDL-79.4 mg kg^{-1}, Cu BDL to 68.7 mg kg^{-1}, Mn 53-991 mg kg^{-1}, Pb BDL-25 mg kg^{-1} and Zn 16-78 mg kg^{-1}. Cu and Cr exceeded the associated pollution limits and were in the moderate pollution range as per the US EPA permissible limits for sediment.

Study on metal contents in fish fleshes indicated that Cd, Cr and Cu were below the detection limits. Mn was recorded in the range of BDL to 17.8 mg kg^{-1}, Pb BDL to 7.64 mg kg^{-1}, Zn BDL to 31.28 mg kg^{-1}. Comparison of the data with the permissible limits in fish flesh for human consumption indicated that only Pb content exceeded marginally in some of the samples from the permissible limits 5.00 mg kg^{-1}.

Presence of organochlorine, organophosphate and synthetic pyrethroids in some of the water samples was recorded in low levels which are comparable to the other aquatic systems.

Ichthyofaunal diversity of river Kathajodi was assessed and 71 fish species was recorded from the three samplings. The Cyprinidae dominated the population (11 species), followed by Bagridae and Mugilidae (5 species each)(Fig.80).

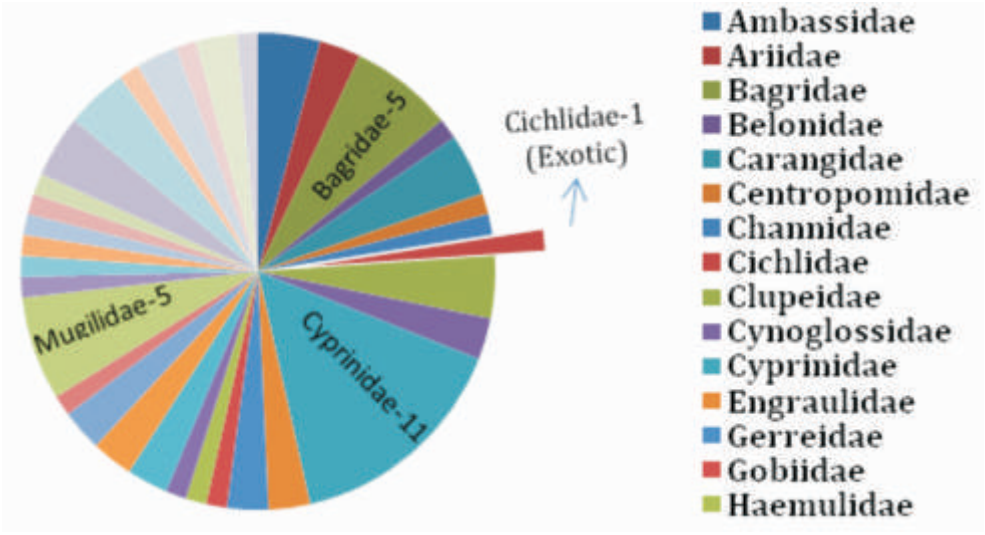


Fig.80. Ichthyofaunal diversity of River Kathajodi

Project Title : Emerging contaminants in rivers (Teesta, Torsa) and East Kolkata Wetland and their effect on selected biota

Project No : FREM/ER/17-20/12

Project Staff : S. K. Nag, Md. Aftabuddin, Soma Das Sarkar, Kavita Kumari,Vikash Kumar, R. K. Raman, Raju Baitha, Keya Saha, S. K. Paul, Sudarshan Bandyopadhyay and Arijit Ghosh

Water, sediment and fish collected from River Torsa were monitored for pesticide residue contamination. Residues of antimicrobial compounds Triclosan and Triclocarban, antibiotics oxytetracycline and tetracycline were also analysed in East Kolkata wetland ecosystem. Ecotoxicological studies of few contaminants were also conducted.

River Torsa

The river originates from the Chumbi Valley in Tibet, China. It flows into Bhutan, where it is known as the Amo Chu Bhutan and from there it enters into North Bengal through Alipurduar district and passes through Coochbehar. Torsa meets with Kaljani at Balarampur near Coochbehar and then flows into Bangladesh. On its course it comes across Tea gardens, national reserve forests and vast agricultural fields, run off of which mix with the river in many places. Domestic and city sewage drainage systems also discharge into the river in several places along its course.

Sampling points

Five locations along the river viz., Dalshingpara, Subhasini Tea Estate, Silbarighat, Kachubon and Harinchora (N26°17' - N26°48' and E89°20' - E89°27', Elevation 149m - 30m) were selected for sampling (Fig. 81).

Fish diversity of river Torsa

River Torsa has rich diversity of fresh water fishes. A total of 868 indigenous fish individuals belonging to 4 orders, 10 families, 24 genus and 32 species were recorded. Cyprinids were the dominant group (44.82 %) followed by Bagrid (13.79%) and Schilbeid (6.89%) respectively (Fig. 82). The dominant

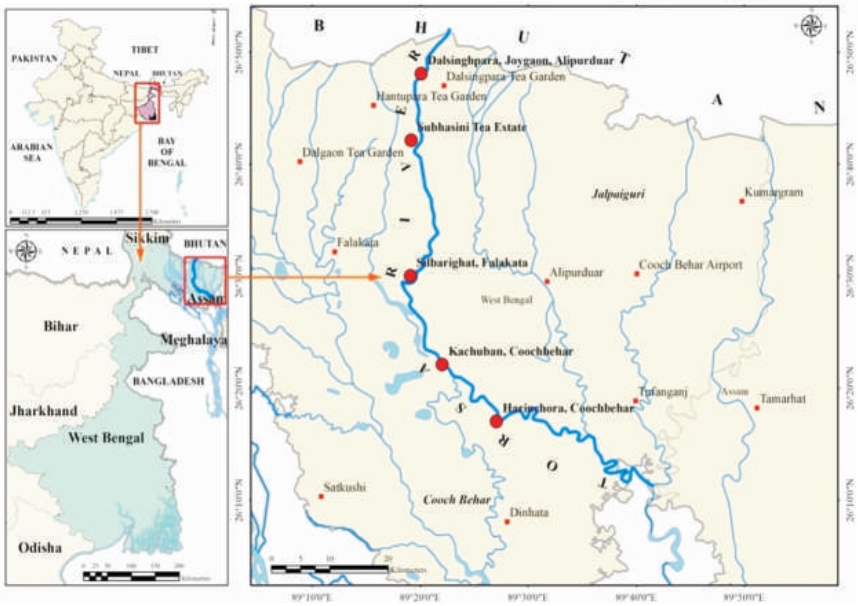


Fig. 81. Sampling points on River Torsa

species was *Barilius barna* (Relative Abundance, 18.59%) and subdominant species were *Pethia ticto* (RA, 12.57%) and *Puntius sophore* (RA, 10.32 %). An important observation is that, out of 32 species, 30.05% are potential indigenous ornamental fishes, 62.58 % important food fishes and 8.20 % as sport fishes (Fig. 83).

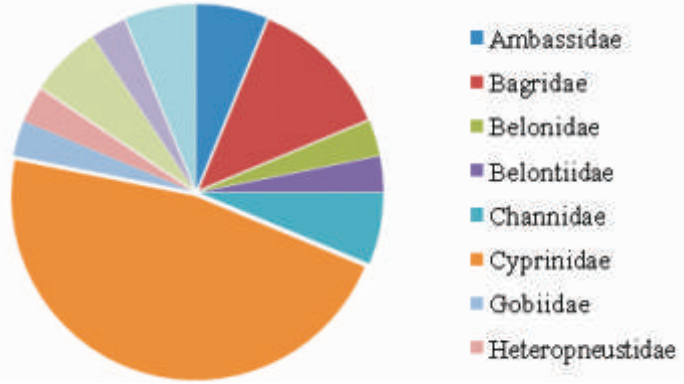


Fig. 82. Distribution of fish family in River Torsa

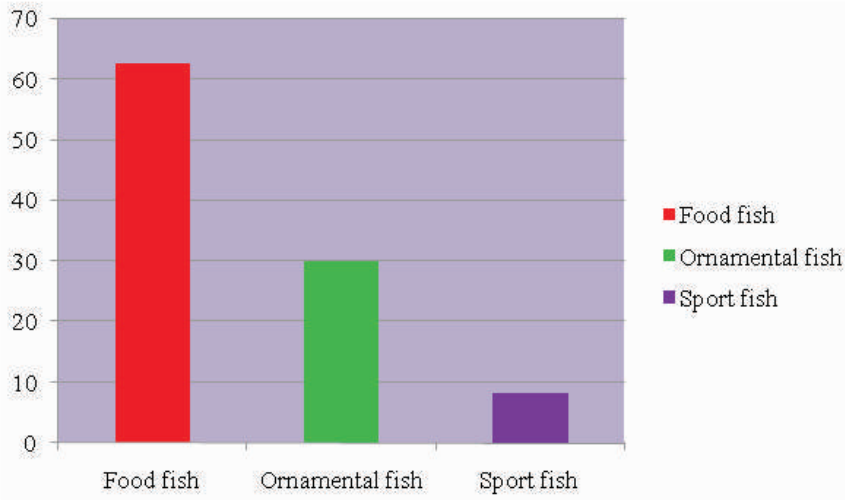


Fig. 83. Percentage-wise distribution of food, ornamental and sport fishes in river Torsa

Physico-chemical parameters of water and sediment

The pH of water was neutral to slightly alkaline (pH 7.3-8.1) in nature. Specific conductance was low (117-220 µS cm^{-1}) and dissolved oxygen level varied from 6.0-9.2 mg l^{-1} at different sites. Total alkalinity varied from 88-200 mg l^{-1} while hardness was in the range of 40-80 mg l^{-1}. In terms of textural class the sediment was sandy with 1-2% clay. Sediment pH was alkaline (7.9-8.8) with free $CaCO_3$ varying from 3-10%. Organic carbon content was quite low (0.03-0.17%). Nitrogen content varied from 0.03-0.07% while total phosphate was in the range of 12.4-35.8 mg kg^{-1}.

Pesticide residues in water, sediment and biota

A total of 34 compounds including pesticides and their metabolites belonging to three groups viz., Organochlorines (OC), Organophosphates (OP) and Synthetic pyrethroids (SP) were targeted for residue analysis.

Water samples

Among the OCs analysed, HCH isomers (0.015-0.025 µg l^{-1}), DDTs (0.029-0.356 µg l^{-1}) and endosulfans

(0.016-0.062 µg l^{-1}) were detected through GC-ECD in few samples. Residues of OPs like chlorpyriphos (0.01-0.232 µg l^{-1}), me-parathion (Tr – 0.014 µg l^{-1}), acephate (0.296-0.584) and triazophos (0.19-0.271 µg l^{-1}) were also present. In regard to SPs cypermethrin (0.018-0.056 µg l^{-1}) and fenvalerate (0.014-0.025 µg l^{-1}) were recorded frequently while bifenthrin (0.063 µg l^{-1}) and fenpropathrin (0.011-0.07 µg l^{-1}) were also detected in few samples. The concentrations of pesticides in water were mostly within the critical maximum concentration (CMC) as recommended by USEPA for aquatic life.

Sediment samples

Pesticide residue loads in sediments were meagre. Only in samples of Subhasini Tea Estate, minute concentration of OCs viz., pp DDE, op DDE and op DDD (0.001-0.005 mg kg^{-1}) could be detected. Among the OPs, malathion (0.007-0.011 mg kg^{-1}), chlorpyriphos (0.003-0.005 mg kg^{-1}) and triazophos (0.028-0.064 mg kg^{-1}) were found. Residues of SPs were almost absent. One sample contained cyfluthrin (0.009 mg kg^{-1}) and another had fenvalerate (0.011 mg kg^{-1}) residues.

Biota (Fish)

About one third of fish samples were found to contain OC residues. Extent of contamination with SPs was comparatively less (11%). However, out of eight SPs analysed, residues of five viz., bifenthrin (0.01-0.17), fenpropathrin (0.011-0.351), cypermethrin (0.02-0.112), fenvalerate (0.01-0.02), fluvalinate (0.011) could be detected. Analysis for OPs is in progress and in samples analysed so far quinalphos, traizophos and traces of malathion, chlorpyriphos and me-parathion were detected.

Triclosan and Triclocarban residues in sewage fed aquaculture system of East Kolkata Wetland

Triclosan [TCS, 5-chloro-2-(2,4-dichlorophenoxy)-phenol] and Triclocarban (TCC, 3,4,4'-trichlorocarbanilide) are antibacterial compounds commonly added in different personal care products like soaps, detergents, toiletries, disinfectants, toothpastes, cosmetics etc. at range of 0.1-1% (w/w). Although these compounds are quite safe at the level at which used in different products, but are highly toxic to aquatic organisms, particularly microalgae, crustaceans and fish. TCS is also reported to have endocrine disruptive properties. Both TCS and TCC have been detected in water and fish from Jhagrasisa wetland of East Kolkata. In water the level of TCS was 0.02 - 0.241 g l^{-1} indicating that it exceeded the predicted no effect concentration of TCS i.e. 0.05 g l^{-1}. TCC concentration (0.109-0.95 g l^{-1}) was comparatively higher than that of TCS. In muscle tissue of fishes such as, *Catla catla*, *Cyprinus carpio*, *Hypophthalmichthys molitrix* and *Cirrhinus mrigala* TCS and TCC were recorded at levels of 0.014-0.058 and 0.241 – 0.545 mg kg^{-1} respectively. Like in water, the level of TCC was higher than that of TCS in fish tissues. However, methyl-TCS, one of the metabolite of TCS was not found in any sample. Keeping in view the acceptable daily intake (ADI) of TCS i.e. 50 g kg^{-1} body wt the present level of TCS detected in fish would not pose any health hazard to the consumers.

Oxytetracycline (OTC) and Tetracycline (TC) residues in fishes of East Kolkata Wetland

An isocratic reversed phase HPLC method was standardised for analysis of OTC and TC residues in fish tissues. Some edible fishes like *Aristichthys nobilis*, *Labeo bata*, *Cyprinus carpio*, *Cirrihinus mrigala* collected from Bheri No. 2 of East Kolkata wetland were found to contain OTC residues in the range 0.946-3.617 mg kg^{-1}. TC residue (1.19-1.68 mg kg^{-1}) was detected in *A. Nobilis* and *Labeo bata*. Concentrations of both OTC and TC exceeded the MRL of 0.1 mg kg^{-1}. The result indicated use of these antibiotics for fish disease management in the wetlands.

Ecotoxicological studies of toxicants in microalgae

Toxicological implication of TCS exposed to test microalga was experimented in wet lab condition. The results revealed decrease in generic richness from 4.75 x 10^4 cells ml^{-1} (initial) to 2.41 x 10^4 cells ml^{-1} in 48 hrs in treated sample with 5 mg l^{-1} TCS. Cell deformities in *Nitzschia* sp., *Chlorella* sp., *Navicularadiosa*, *Selenastrum* sp. were also observed in comparison with control. Effect of TCS at further lower concentrations is being experimented.

Biomolecular responses to emerging pollutant stressors

Catla catla specific and degenerate primers have been selected and designed for Phase-I biotransformation, antioxidant pathway, reproductive, growth and immune gene as a result of exposure to pollutants like TCS and OTC. The degenerate primers for Cu-Zn SOD, Catalase, GPx and IGF1gene has been designed and PCR conditions has been standardised to amplify these genes. The Cu-Zn SOD (286 bp) and IGF1(436 bp) has been characterised for the first time in *Catla catla* and deposited to NCBI with Accession no. MH039796 and Accession no. MH039797 respectively. The gene specific primers for quantitative PCR have been designed and PCR amplified to check the specificity.

Static Non-renewal acute toxicity was conducted on *Catla catla* to see the effect of TCS and OTC at environmental relevant dose. The cDNA have been synthesized from pooled RNA samples and PCR amplified with GAPDH house-keeping gene.

Project Title: EIA and mitigation of arsenicosis as a serious environmental challenge with special reference to fish and fishery resources

Project No : FREM/17-20/13

Project Staff: B. P. Mohanty, S. Samanta, S. K. Manna, A. K. Bera, S. K. Sahu, Soma Das Sarkar, P. K. Parida, P. R. Behera, P. Majhi, N. Sharma, A. Alam, R. K. Raman, G. Chandra, Sanjoy Bhowmick, Keya Saha, S.K.S. Hameed, L. R. Mahaver, S.K. Paul, Sudarshan Bandyopadhyay, Sk. Rabiul, K.K. Sarma and A. Kakati

Arsenic contamination: A serious concern

Arsenic (As), the naturally occurring metalloid is one of the most toxic environmental contaminants and a human carcinogen. Ground water contamination with arsenic is a major public health concern globally and a huge population of Indian subcontinent especially from rural settlement of West Bengal, Assam and Bangladesh in the Ganga-Brhmaputra-Meghna Basin is under high risk of arsenic exposure via contaminated drinking water and subsequently through food chain. In aquatic bodies, fishes are the dominant species on which a large population of these regions is greatly dependent as the protein source of the diet. Further, it is obvious that bioaccumulation of As in piscine host by means of trophic transfer could cause different health ailments like respiratory distress and body tremors associated with illness due to chronic exposure.

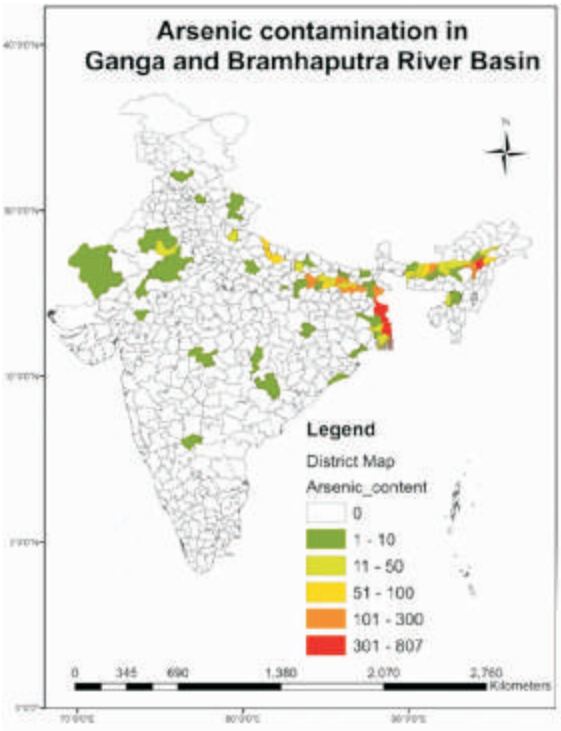


Fig. 84. Map showing Arsenic contaminated areas of India (colors indicate the intensity of Arsenic concentration in ground water in ppb range)

Arsenic contaminations in inland water bodies from endemic areas of West Bengal

In West Bengal three ponds from the villages of Ghetugachi, Gontra and Dakshin Panchpota and two wetlands Khalsi and Chandania in the arsenic affected Nadia district of West Bengal were studied. Results revealed the presence of arsenic contamination in the studied water bodies. Total arsenic concentrations in surface water ranged

between 11-26 ppb, which is above the guideline value (5 ppb) for the protection of aquatic life by the Canadian Council of Ministers of the Environment (CCME, 2001). Arsenic concentrations in hepatic tissues (250-783 ppb) of fish were found higher than the muscles (9-17 ppb). Arsenic in whole body tissues of small indigenous fishes were also detected with moderate concentrations (32-97 ppb).

Ponds in As contaminated zones

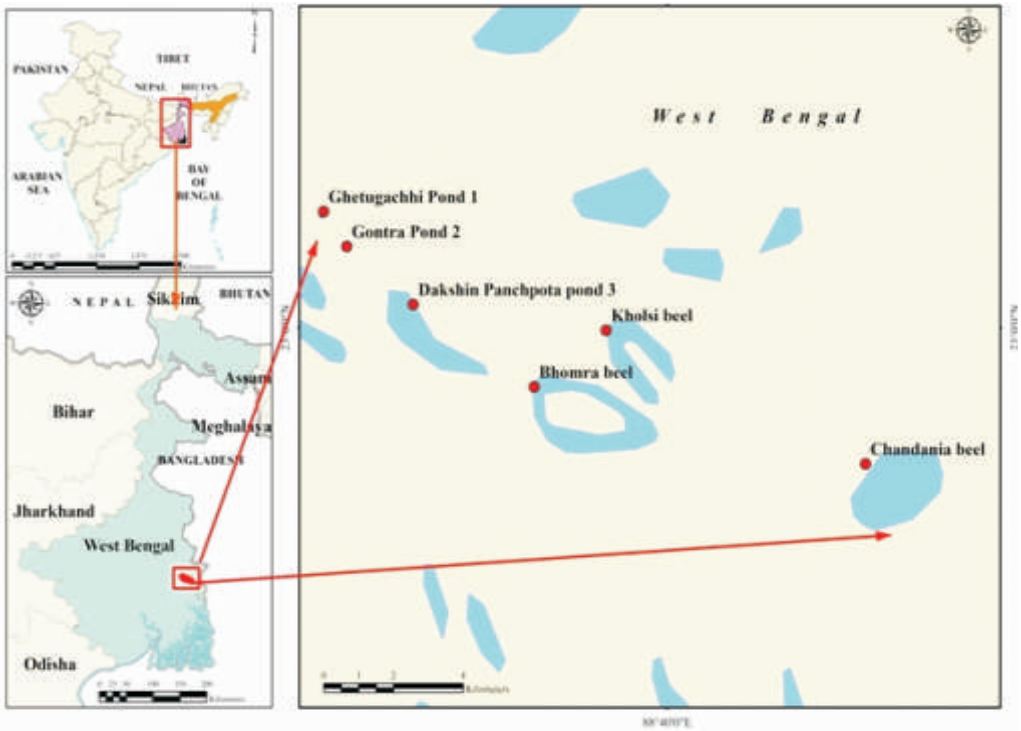


Fig.85. Map showing the selected water bodies in the arsenic endemic zone

Preliminary observations on Arsenic contamination in North Eastern India (Assam)

In Assam, a preliminary study was carried out to examine the arsenic contamination in Mayang block, Morigaon district of Assam. Water samples (27 nos) were collected from different water bodies (i.e. river, wetlands, ponds, tubewells and ringwells) from 9 villages of Mayang block, to estimate the total arsenic concentration in both surface and groundwater. In respect to the permissible limit formulated by the World Health Organization (10 ppb), out of the 17 groundwater samples, 7 nos. (41%) were found arsenic contaminated. The highest arsenic content (51 ppb) was found in the groundwater of Gagalmari Kachari

Gaon, along River Brahmaputra. In surface waters (i.e. wetlands and river) the total arsenic content was found to be within permissible limit of 10 ppb (WHO) and 50 ppb (BIS) respectively.

Fig.86. Map showing arsenic affected zone in Northeast India

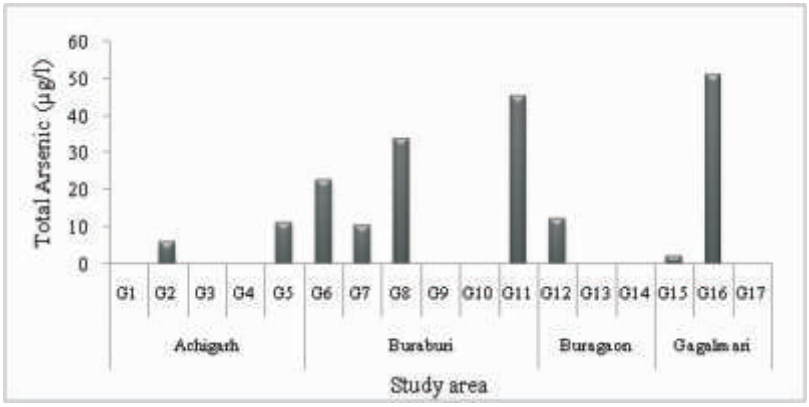


Fig.87. Total arsenic in groundwater of Mayang, Morigaon, Assam

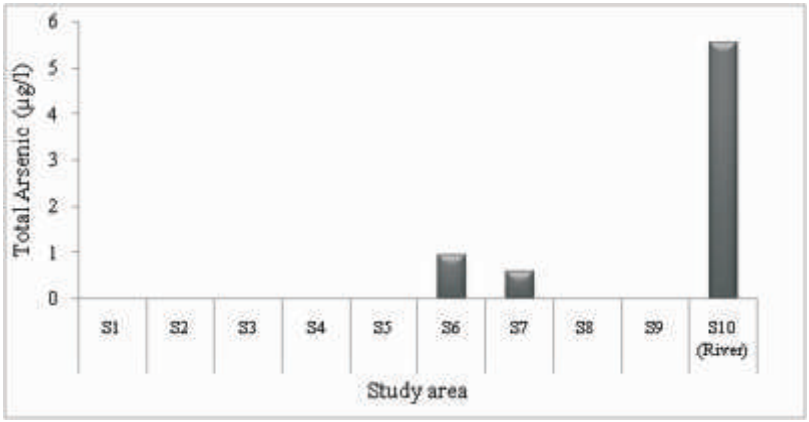


Fig.88. Total arsenic in surface waters of Mayang, Morigaon, Assam

Identification and characterization of arsenic resistant bacteria

Arsenic toxicity is a serious geogenic public health problem in Bengal delta. Mobilization of arsenic from soil to underground aquifer is the main cause of such widespread arsenic pollution, and bacteria are involved in the arsenic mobilization process. However, bacteria play important roles in remediation of several pollution problems. In this perspective arsenic resistant bacteria were isolated from several ecological niches like pond water, sediment, and faecal samples. The bacteria were identified to belong to diverse genera viz., *Clostridium*, *Paraclostridium*, *Pseudomonas*, *Rhodococcus* and *Lactobacillus*. Arsenic resistance gene ArsC was detected only in bacteria from sediment, but not in bacteria from other sources.

Arsenic exposure studies

Cell lysis and malformations

Toxicological responses of microalgae, exposed to contaminants released from agriculture, industries and households have been reported worldwide (Rocchetta et al., 2006). Morphological abnormalities in sub-cellular structure of *Chlorella vulgaris* showed cell shape distortion, cell membrane lysis and chloroplast granulation after exposed to organic solvents (Wu et al., 2014). Deformities of phytoplankton cell (*Nitzschia* sp., *Navicula* sp.) were observed in the present experiment as well (with 5 mg l^{-1} sodium metaarsenite).

Ameliorating effect of curcumin against arsenicosis

To evaluate the impact of arsenic on lower vertebrates' and ameliorating effect of curcumin against arsenicosis a laboratory exposure study was carried out by using *Labeo rohita* fingerlings as test species. Fishes were divided into seven groups; three groups were fed with basal diet; two groups were fed a low-dose of curcumin-supplemented-basal diet and two were fed high-dose of curcumin-supplemented-basal diet, for seven days prior to arsenic (sodium arsenate) exposure and this continued for 12 days.

Apolipoprotein gene expression in arsenic exposed carp, *Labeo rohita* and therapeutic potential of curcumin.

By plasma proteomic analysis of arsenic-exposed *Labeo rohita*, biomarker response of Apolipoprotein (Apo) as a diagnostic marker have been reported from our earlier study (J Hazard Mater 336:71-80). Since Apo contains several variants, to identify which isoform of the gene *ApoA1* better responds to arsenic toxicity, gene expression analysis of three *ApoA1* variants viz., *ApoA1 1*, *ApoA1 2a* and *ApoA1 2b* was carried out. Whether dietary supplementation of curcumin, a potential herbal drug/food supplement, has any ameliorative potential against arsenicosis was also investigated. The *ApoA1 1* and *ApoA1 2a* variants were down-regulated in arsenic- exposed fishes and their expression was found to be the same as in control in the curcumin-supplemented-diet-fed fishes. Expression of *ApoA 2b* variant was found only in arsenic-exposed fishes but not in the control and curcumin-supplemented-diet-fed fishes. This study showed that, *ApoA1 2b* responds well to arsenic toxicity and down-regulation of *ApoA1 2b* proves the efficacy of curcumin against arsenicosis (J Proteins & Proteomics 8 (suppl.) : JPP16.

Impact of arsenic on innate immune response

To evaluate the impact of arsenic on innate immune response of fish and ameliorative effect of cucurmin on arsenic toxicity, gene expression analysis of proinflammatory cytokines and Toll like receptors (TLRs) in head-kidney, tissues of *Labeo rohita* was carried out. It was observed that under arsenic exposure, expression of the molecules associated with first line of defence (TLRs) was up-regulated, whereas the expression of pro-inflammatory cytokines was down-regulated in fishes fed with basal diet. In curcumin supplemented group, down-regulation of *TLR 4* and up-regulation of *IL-1β* and *IL-10* was observed, indicating the immunostabilizing ability of curcumin against arsenic toxicity.

Whole liver transcriptome analysis to evaluate the effect of arsenic and ameliorative potential of curcumin against arsenic toxicity

To evaluate the effect of arsenic and ameliorative potential of curcumin against arsenic toxicity whole transcriptome analysis of liver tissues of *Labeo rohita* from three groups of fishes (Group 1: fishes fed with basal diet, Group 2: fishes fed with basal diet and exposed to arsenic, Group 3: fishes fed with curcumin supplemented diet and exposed to arsenic) was carried out by next-generation sequencing (NGS) under illumina Hiseq2500 platform. Liver transcriptome of *Labeo rohita* showed highest sequence homology with *Danio rerio* followed by *Astyanax mexicanus*, *Cyprinus carpio* (Fig. 89). Among 135,102 transcripts, 4922 transcripts were differentially expressed in exposure to arsenic. Similarly, 4651 transcripts were differentially expressed in curcumin supplemented group, relative to arsenic exposed group with basal diet. Findings of the study showed that, nucleic acid binding, zinc ion binding and ATP binding functions were highly affected by arsenic exposure. Up-regulation of chemokines and other immune genes prove the efficacy of curcumin as potential ameliorative agent. Liver transcriptome data of *Labeo rohita*has been submitted to NCBI-Sequence Read Archive (SRA) (SRA Accession No. SRR6365041).

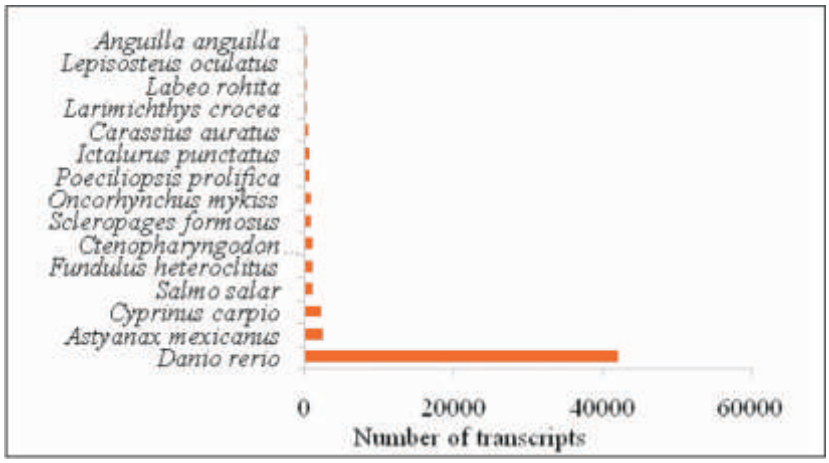


Fig.89. Homology of liver transcriptome of *Labeo rohita* with other fish species

Project Title: Fish Health Management and Antimicrobial Resistance in Inland Open Waters

Project No: FREM/17-20/14

Project Staff: B. K. Das, B. P. Mohanty, S. K. Manna, B. K. Behera, R. K. Manna, A. K. Bera, A.K. Sahoo, T. Abdulla, R. Baitha, V. Kumar, D.K.Meena, H. Sekhar Swain, D. Das, D. J. Sarkar and H. Chowdhury

The study observed frequent occurrences of fish diseases in wetlands and reservoirs. Disease pattern of different fish pathogens is being studied in wetlands and cage culture system. Bacterial pathogens are being isolated from diseased fish samples and identified by molecular tools. Fish immune response was recorded against *Enterobacter cloacae*. It was documented that to control these diseases, farmers uses huge amount of antibiotics like tetracycline/oxytetracycline and other chemical products like Cloropyriphos, Cypermethrin, Deltamethrin, etc. Antimicrobial resistance (AMR) pattern in the selected bacteria has been studied. Further to avoid AMR, different extracts of plants (*Choerospondias axillaris*, *Sonneratia apetala*, *Terminalia arjuna*, *etc.*) are being tried against these pathogenic bacteria. To increase the efficacy of traditional chemical products and to reduce their dosages, nano-technological tools are being tried for development of nanoproducts.

Investigation of fish diseases in cage culture

Surveys were conducted at Patratu, Kanke, Tenughat, Getalsud and Chandil reservoirs, Jharkhand to identify fish diseases in cage culture systems. Generally, no disease was encountered in the cages in July, 2017. Fungal infection and septicemia were recorded in *Pangasianodon hypophthalmus* reared in cages of Chandil reservoir in winter. Low water temperature and unclean cage net were identified as probable triggering factors for the disease outbreak. Isolation followed by 16S rRNA sequencing identified the bacterial pathogens as *Aeromonas veronii and Klebsiella pneumoniae*. To control morbidity and mortality, use of oxytetracycline through feed, dip treatment in methylene blue solution or use of $KMnO_4$ in cages as slow release were recommended.

Surveys were also conducted at Pench and Bor reservoirs, Maharashtra for disease outbreaks and mortality. Ulcerative disease was recorded from *P. hypophthalmus* in cages (Fig. 90). Isolation from fish skin lesion followed by 16S rRNA sequencing had identified the bacterial pathogens as *Pseudomonas aeruginosa* and *Aeromonas veronii*.

Fig. 90. Ulcerative condition in *P. hypophthalmus* in cages

Mass fish mortality in Srirama Sagar Reservoir, Telangana

Mass mortality of *Catla catla* (Fig. 91) was reported in Srirama Sagar Reservoir (18° 57' 36.64? N; 78° 20' 48.27? E). The isolates were identified through 16S rRNA partial gene sequence as *Aeromonas veronii*.

Fig.91. *Catla catla* mortality in Srirama Sagar Reservoir

Investigation of fish disease in wetlands

East Kolkata wetlands and Moyna wetlands in West Bengal are frequently reported with the occurrence of fish diseases. Bacterial diseases like skin ulcers, haemorrhagic diseases are common in *Labeo* sp. in these wetlands. Hence, regular monitoring was being carried out in selected water bodies of East Kolkata and Moyna and also in Khalsi wetland for understanding seasonal impact on disease occurrence. *Enterobacter cloacae, Aeromonas veronii, Strenetrophomonas maltophila, Pleisomonas shigelloides* are the main bacterial pathogens isolated from the diseased fishes of East Kolkata wetlands and Moyna wetland.

The survey also identified Argulosis and Myxoboliasis from Khalsi and Moyna wetlands respectively. Both Argulosis and Myxoboliasis were reported from the various parts of the body surface (fins, base of fins and opercular openings) and gills of *Labeo rohita* respectively.

Fig. 92. Infected fishes of *Labeo bata, Catla catla, Labeo rohita* from East Kolkata wetlands and Moyna wetland

Mortality of Silver carp was reported in the culture based fisheries in Khlasi wetland of Nadia district, West Bengal (22°59' 36.24" N 88°38' 34.87" E) in the month of April. *Aeromonas hydrophila* (Accession number: MG686235) has been isolated from the liver of infected Silver Carp (Fig. 93).

Fig. 93. Body haemorrhages in Silver carp infected with *Aeromonas hydrophila*

***Catla catla* and *Labeo rohita* mortality at Khalsi beel**

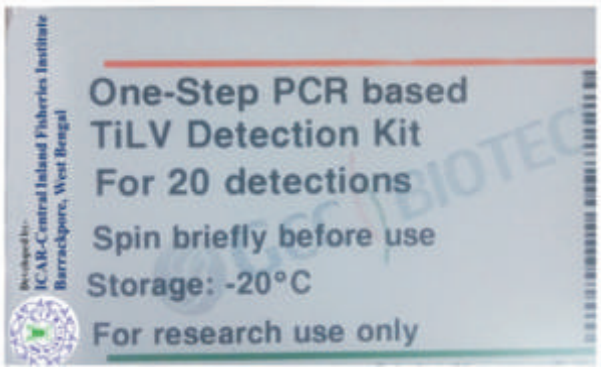
Fish diseases outbreaks and mortality in IMC in Khalsi wetland,West Bengal in monsoon season were investigated. A total of eleven bacterial isolate from various freshwater fish species (*Catla catla, Labeo rohita* and *Hypophthalmichthys molitrix*) (Fig. 94) were isolated and have identified from diseased fishes of Khalsi beel. These bacteria are *Lysinibacillus* sp. strain CILBRG1 (MG757657), *Pseudomonas mosselii* strain CIPMRG_3 (MG757398) from gills of *L. rohita*, *Kurthia gibsonii* strain CIKGCS_8 (MG754428) from scales of *Catla catla*,*Acinetobacter* sp. strain CIABSS_2 and *Acinetobacter* sp. strain

CIABCS4 from scales of *Hypophthalmichthys molitrix* (MG757247) and *C. catla* (Mg788344) respectively, *Exiguobacterium indicum* strain CIEICG (MG788343) and *Vogesella perlucida* strain CIVPCG-1(MG757246) from gills of *C. catla*, *Enterococcus faecalis* strain CIEFRB (MG788342) and *Aeromonas hydrophila* strain CIAHRT_11 (MG754418)from blood and tail of *L. rohita* respectively, *Acinetobacter pittii* strain CIACST3 (MG786615) and *Macrococcuscaseolyticus* strain CIMCSCG (MG786578) from tail and gills of *H. molitrix* respectively.

Fig. 94. Diseased *Catla catla* and *Labeo rohita* in Khalsi wetland

Tilapia Lake Virus detection

Tilapia fish samples were collected and inspected for occurrence of Tilapia Lake Virus. The study showed presence of this virus in the native Tilapia fish population in East Kolkata and Moyna wetlands. One-Step PCR based Tilapia Lake Virus detection kit has been developed for the fast and sensitive diagnosis of Tilapia Lake Virus in the Tilapia fish population.



De novo whole transcriptome profiling of *Edwardsiella tarda*

Transcriptome study of *E. tarda*, isolated from diseased *Catla catla*, identified few genes which are significantly related to bacterial infection. This study will be helpful for understanding the pathogenic mechanism of *E. tarda* infection that would help in identifying reliable therapeutic targets against the disease.The most significantly enriched KEGG pathways (Fig. 95) included biosynthesis pathways, immune diseases, metabolism, degradation, infection and transport). Other pathways included bacterial chemotaxis, endocytosis, mRNA surveillance pathway etc.

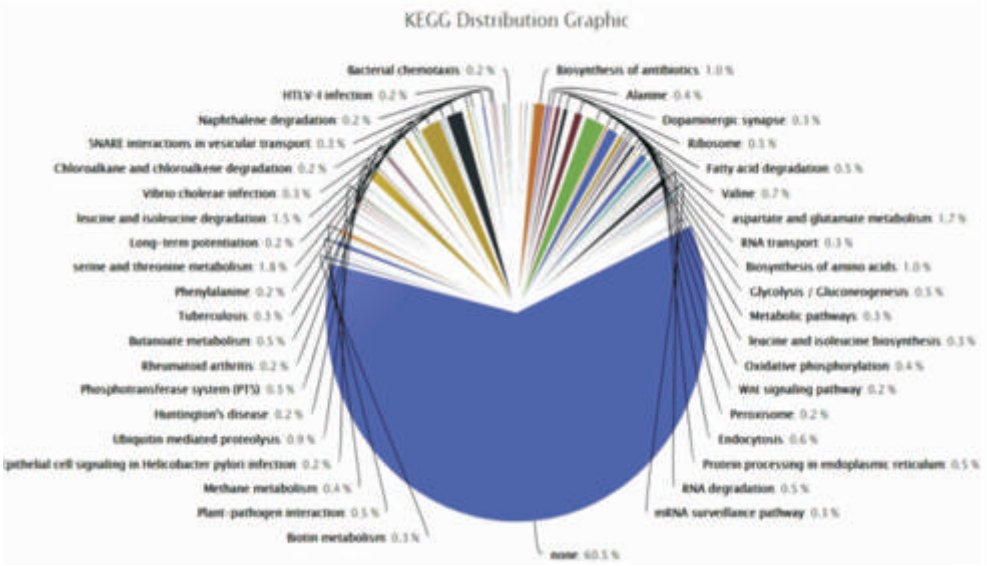


Fig. 95. KEGG Enrichment Analysis of *E. tarda*

Immune genes pathways of Black carp (*Mylopharyngodon piceus*)

To understand the molecular mechanism of MAVS (Mitochondrial Antiviral-Signaling protein) in Black carp, structural bioinformatics analysis was performed by combinational approach of molecular modelling, docking and molecular dynamics simulation. 3D structure modelling of BcMAVS (Black

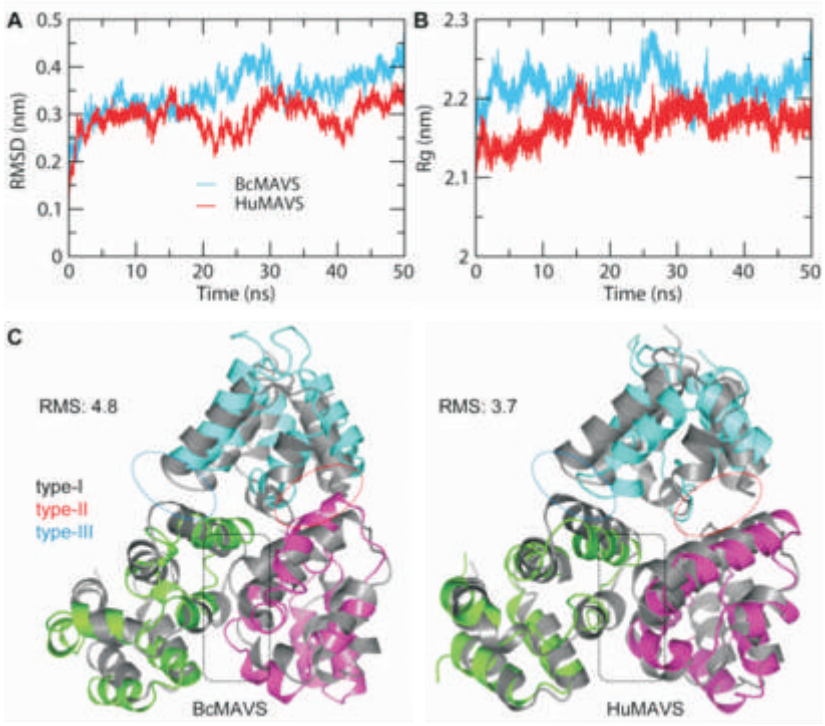


Fig. 96. Analysis of complex stability in dynamic condition; (A) back bone RMSD; (B) Radius of gyration (Rg) of Trimers; and (C) Superimposed view of pre- and post-MD snapshots.

Carp MAVs) revealed a total of six alpha-helics which are interconnected with short loops/coils. Long range molecular dynamic study revealed structural properties of BcMAVS-CARD in dynamic condition and stability was observed just after 10 ns of simulation time and higher fluctuation was observed in the helix-6. The energy optimised model of BCMAVS-CARD was stereo-chemically validated and good score was perceived. Card-Card interaction between BcMAVS (Black carp) and HuMAVs (Human) revealed complex 1 to be stable and interaction analysis suggest positive surface of HuMAVs and negative surface of BcMAVS signalling proteins, respectively.

ATP binding mechanism in zebra fish Cycline Dependent Kinase Like (zCDKL5)

Cycline Dependent Kinase Like (CDKL) plays pivotal role in controlling cell division and curb transcription in response to several extra and intra-cellular signals essential for enzymatic activity in molecular pathways. To understand the ATP recognition pathway of CDKL5 of zebrafish structural integrity and mode of binding was explored through computational insights. Docking revealed that ATP prefers to bind zCDLKs5 at cervix formed between the catalytic domains surrounded by strong bonding, electrostatic and hydrophobic interaction. Molecular dynamic simulation reveals that the binding of ATP to zCDKL5 contributes highly stabilised complex. For ATP binding few crucial amino acids in ZCDKL5 was identified and they are Glu 81, Gly 8, Val 7, Glu 127, Val 180 and Asp 141.

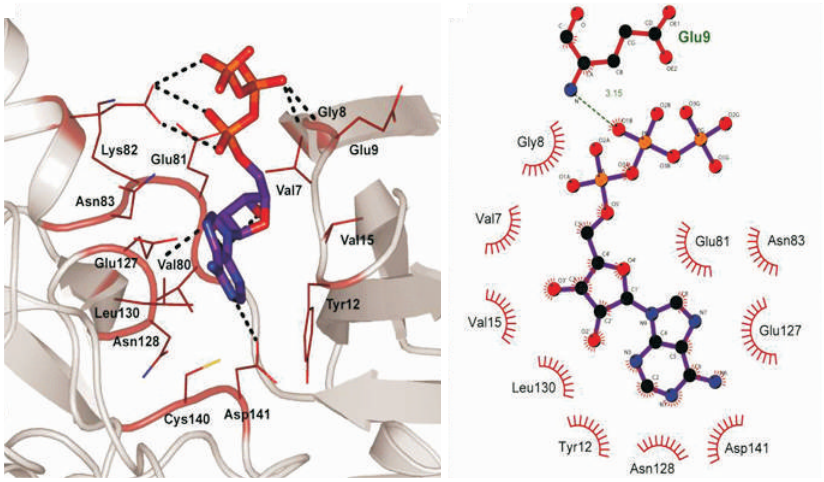


Fig. 97. Mode of ATP binding in stable HOLO 3 complex (A) PyMOL view and (B) LigPlot + View

Immune pathways interaction of fish PGRPs with microbial ligands

To understand the recognition pathway peptidoglycan recognition proteins (PGRPs) against microbial ligands, 3D models of zebrafish PGRPs (zPGRP2) was constructed and conformational and dynamic properties of the same was studied. Molecular docking study of zPGRP2 with Muramyl Tripeptide, Tetrapeptide, Pentapeptide-DAP(MTP-DAP, MTeP-DAP, MPP-DAP)-LYS (MTP-LYS, MTrP-LYS, MPP-LYS), Tracheal Cytotoxin (TCT) through Autodock Vina revealed that β1, α2, α4, β4 and loops connecting β1-α2, α2-β2, β3-β4 and α4-α5 as the key interacting domain of zPGRPs for MTP-DAP, MtrP-Dap, MTP-Lys, MTrP-Lys, MPP-Lys and TCT, respectively. The dynamic study also revealed plasticity in the binding of PGRP site with microbial ligands suggesting intrinsic capacity of fish innate immune system to rapidly evolve specificities to meet new microbial challenges.

Metagenomic studies of mangrove and non-mangrove sediment samples

Metagenomic DNA was isolated from soil samples of mangrove and non-mangrove ecosystem. Comparative microbial analyses showed greater abundance of *Pseudomonas, Alcanivorax, Desulfovibrio, Escherichia, Geobacter, Nitrosomonas, Paracoccus, Shewanella* and shows the property of bioremediation. In non-mangrove soil major occurrences of *Dechloromonas, Deinococcus,*

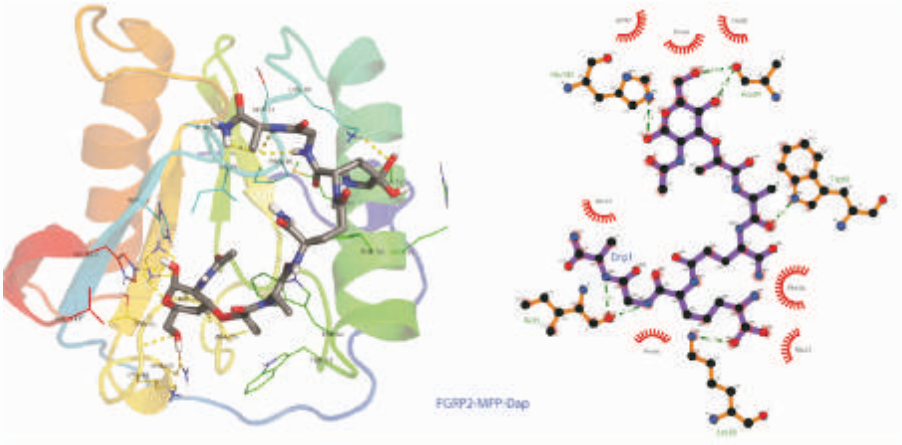


Fig. 98. Molecular interaction of zPGRP2 and Muramyl Tripeptide-DAP

Methylibium, Nitrobacter, Rhodoferax were observed. A significant correlation (0.44 and p value 0.00) for relative abundance of probiotics speciesamong total percentage between mangrove versus non-mangrove samples were observed. Data mining of antimicrobial resistant genes were done from the metagenomic data ofmangrove soil from Sunderbans.

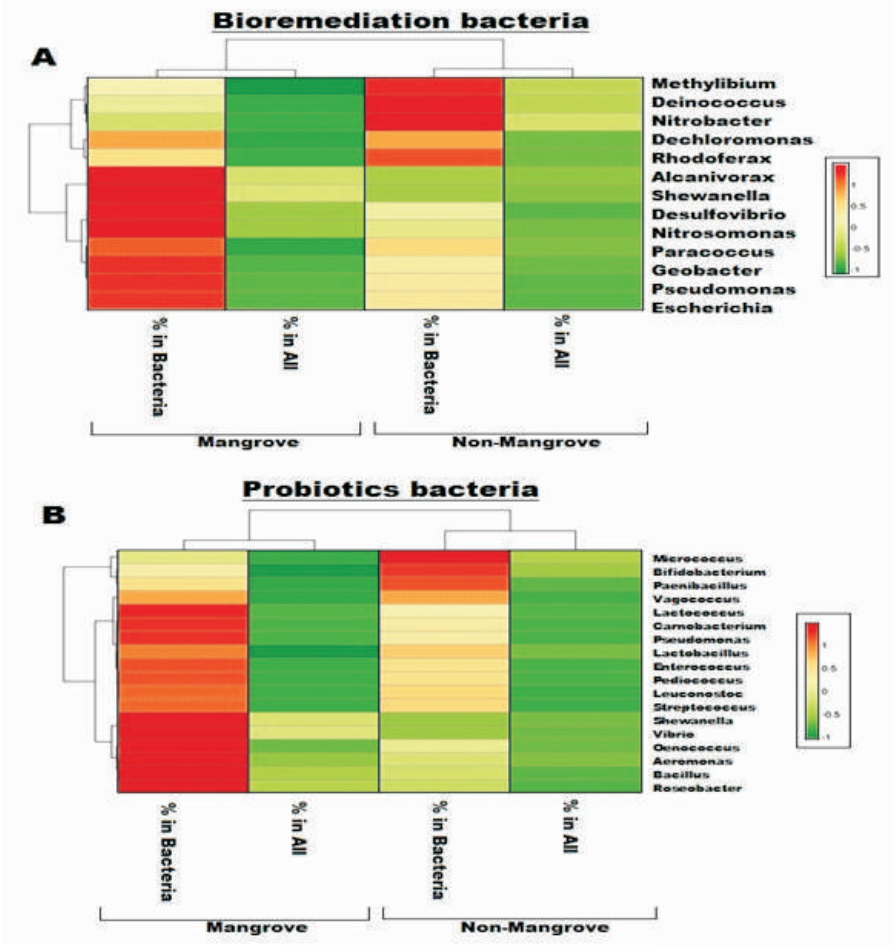


Fig. 99. Metagenomic profiling of mangrove bacteria from Sunderbans

Identification of bacterial diversity in mud volcano sediments

With a vision to search for potential novel genes including AMR resistance genes from wild sources, bacterial isolates were collected from 'Mud Volcano' of Andaman and Nicobar Islands. Culturable microbial diversity of the sediment from mud volcano was measured. Following standard microbiological culture procedure, a total of 41 bacteria were isolated in pure culture on to TSA and R2A agar, under aerobic and anaerobic condition. By 16S rDNA sequencing, the isolates were identified to belong to diverse genera: *Pseudomonas, Halomonas, Acinetobacter, Methylobacterium, Clostridium, Bacillus, Brevibacillus, Staphylococcus, Kocuria, Curtobacterium, Microbacterium, Luteimonas, Lutibaculum.* Members belonging to the genera *Microbacterium* and *Acinetobacter* dominated.

Plant extracts for management of fish diseases

Antioxidant activity of *Choerospondias axillaris* extract: fruits of *C. axillaris*, a Himalayan plant from Nepal was extracted and tested for antioxidant activity. The % antioxidant activity of the plant extract was found to be 25% compared to 55% of the positive control (BHT) at 0.3 mg ml^{-1}. IC_{50} of 0.158 mg ml^{-1} defines the extract to be a strong antioxidant (0.1-0.25 mg ml^{-1}). DPPH test (instant and 30 mins incubation) also resulted in higher antioxidant activity by 6.9% at 0.3 mg ml^{-1} and depicted profound antioxidant potential of IC_{50} of 0.055 mg ml^{-1} and 0.025 mg ml^{-1} respectively (Ref range: 0.1-0.25 mg ml^{-1}).

Antimicrobial activity of *Sonneratia apetala*: Raw fruits of mangrove *Sonneratia apetala* were extracted with methanol which had high antioxidant content bearing LC_{50} at 0.0047 mg/ml. The sample and BHT (positive control) were observed to be linearly correlated. Antimicrobial activity of petroleum ether, chloroform and methanol extract of fruit pulp of *S. apetala* was tested on fish pathogens *P. putida, E. tarda, S. aureus* and *C. freundii*. The methanol fraction showed IZD > 20 mm in all the four bacterial species; Significant activity was observed for *E. tarda* (IZD = 24 mm). The Chloroform fraction also showed nominal zones for *P. putida* and *E. tarda*.

Antimicrobial activity of *Terminalia arjuna*: Different parts (bark, fruit and leaf) of *Terminalia arjuna* were extracted with 7 different solvents (hexane, ethyl acetate, chloroform, acetone methanol, ethanol and water). The maximum antioxidant value was recorded with Arjuna bark extracted with ethanol solvent followed by methanol.The maximum inhibition was shown by methanolic extract of Arjuna bark (45 %). The anti-bacterial properties of these herbal extracts were studied against *Edwardsiella tarda (Etml-3), Pseudomonas* sp. and *Aeromonas hydrophila* and observed that *E. tarda* is more sensitive with an inhibition zone (20mm) followed by *Pseudomonas* sp. (16 mm) and *A. hydrophila* (9mm) (Fig. 100.)

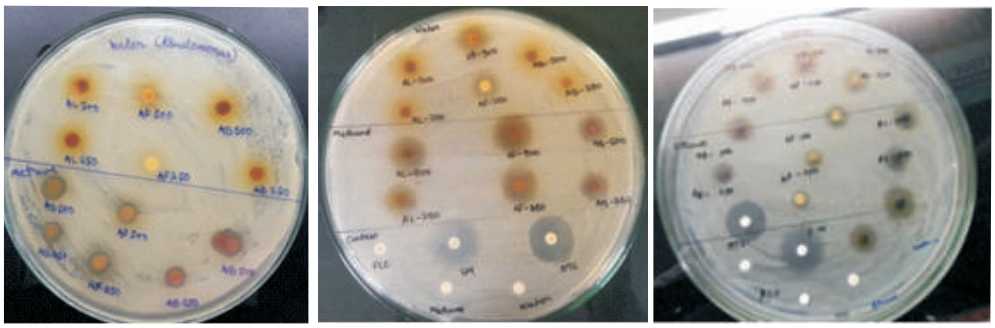


Fig.100. Anti-bacterial properties of Arjuna extracts against different pathogens

Antiparasitic activity of plant extract: *In vitro* trial of methanol (SPM) and hexane extract (AH) of two different plant parts were done against the fish predatory aquatic insect *Notonecta* sp. The SPM and AH extracts were tested at concentrations ranging from 1 ppm to 25 ppm. The LC_{50} value of SPM and AH were found to be 3.375 ppm and 4.75ppm respectively.

Antimicrobial activity of plant essential oils*:* Essential oils from seven plants, viz. *Cymbopogon*

nardus, C. citratus, Mentha piperata, M. arvensis, Lippia geminata, Callistemon lanceolatus, Eucalyptus globulous were extracted by hydrodistillation in Clevenger apparatus. Extracted oils after drying over anhydrous sodium sulphate bed were explored for *in vitro* antibacterial efficacy against *E. tarda* in agar diffusion method. Oils produced dose dependant growth inhibition against the bacteria and good zone of inhibition (10-22 mm) was recorded up to 20 µl dose level (Fig. 101).

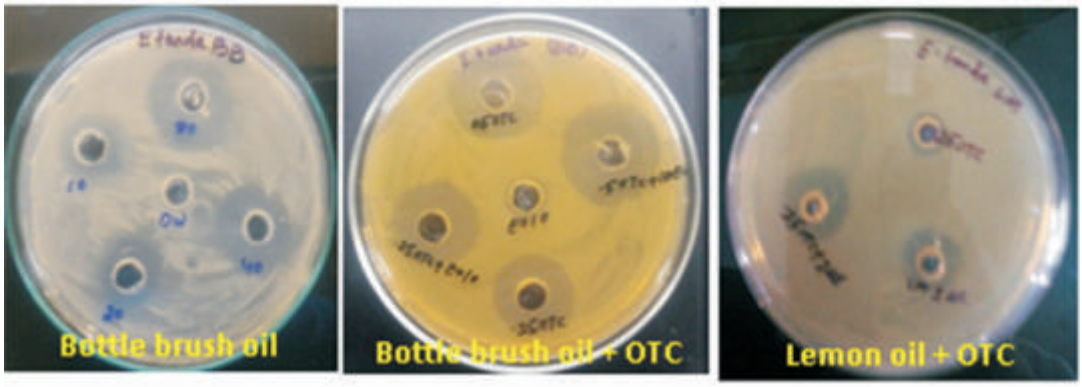


Fig. 101. Antibacterial efficacy of essential oils against *E. tarda*

Prebiotics for fish health management: Hydrocolloids (water soluble polysaccharides) from plant sources (04 nos.) were extracted and purified for exploration as prebiotics for fish health management. Ready to use fish feed pellets were surface coated with a polysaccharide (0.3% w/w) to obtain free flowing pellets. (Fig. 102)

Fig. 102. Extracted polysaccharide from plant origin and fish feed pellet before and after coating with the polysaccharide

Nanoproducts for better fish health

Pesticidal nanoproducts were developed through a sequential design of synthesis. The developed nanoproducts showed comparable physiochemical properties with commercial product. The size of nanoproducts was estimated using DLS instrument and the size found to be ranged from 100-200 nm. The zeta potential of the developed nanoprodcuts was found to be ranged from - 42.4 to - 53 mV. Toxicity of the developed nanoproducts was tested in fingerlings of *L. rohita*. It was found that all the test formulations including commercial formulation are highly toxic to fingerlings of *L. rohita.* However, some nanoproducts showed higher LC_{50} value as compared to commercial products. The bio-efficacy of developed nanoproducts was tested against an aquatic predatory back swimmer insect, *Notonecta* sp.The LC_{50} of the developed product had showed lower LC_{50} value (0.00355 mg l^{-1}) as compared to commercial product (0.02 mg l^{-1}).

Project Title :Application of statistical tools for assessing inland fisheries management

Project No : FREM/17-20/15

Project Staff: Malay Naskar, M. Karthikeyan, S. K. Sahu, D. Karunakaran, D.N. Jha,A. K. Yadav and Rohan Kumar Raman

Application of geostatistical tool for spatial characterization of commercial fishing of *Tenualosa ilisha* in Hooghly-Matlah estuary

Geostatistics coupled with GIS, which is recognized as a powerful tool for handling data with spatial uncertainty, has become an integral part of fisheries resource management. Several geo-statistical approaches have been applied to a wide range of fisheries resources assessment, which include estimating fish abundances from survey data, describing spatial distribution of fish catches and catch rate.

The study area Hooghly-Matlah estuary belongs to the Bay of Bengal (BOB) region (Fig.103), bounded between latitude 20^0 35' N and 23^0 20' N, and longitude 87^0 45' E and 89^0 00'E. It is a meso-macrotidal estuarine system formed by the two main rivers, Hooghly and Matlah and recognized highly for its commercial fisheries, especially Hilsa fishery. Longitudinal and latitudinal span of this study area are 170 km and 110 km respectively (Fig. 103). The data used in this study was collated from the logbooks of five randomly selected fishing vessels. The logbook depicted that geo-referenced catch data was recorded by using navigation tools during the year June 2010 to January 2012. The distribution of CPUE was highly skewed (skewness = 5.014) varying between 0 to 120 kg/hour with mean value of 6.5 kg/hour. For computational simplicity, a multiplicative factor of 10 was multiplied to CPUE for further analysis. Kriging being sensitive to highly skewed distribution, typical log transformation was used to overcome this issue.

Geo-statistical Methods

Basic descriptive statistics and graphical tools were used to explore the data that were subsequently employed for geo-statistics tools. In essence, geo-statistical methods applied in this study involved two steps. First, spatial structure of Hilsa CPUE was quantified by using variogram analysis. Then, kriging

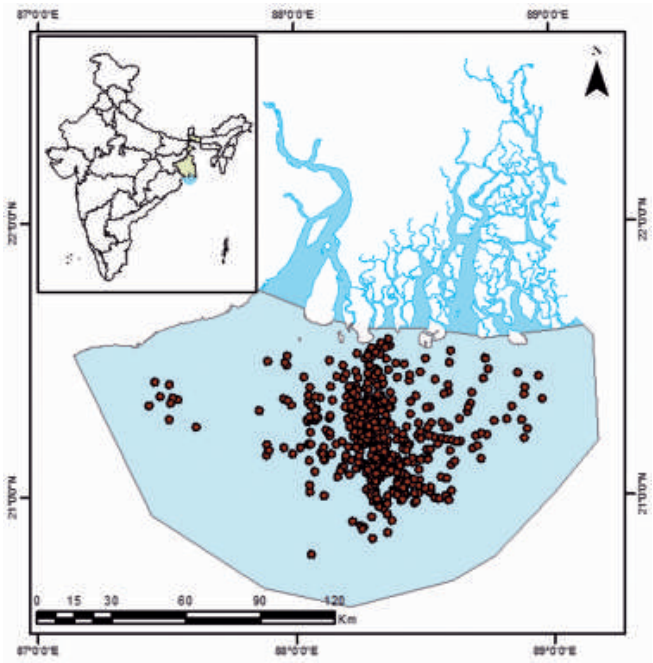


Fig. 103. The Study area and the locations of recorded Hilsa catch

method was applied to predict CPUE values for the un-sampled locations. Finally, isopleth maps derived from the adopted geo-statistical method were presented for interpretation.

Variogram

The variogram, which essentially provides a spatial partitioning of the sample variance, has been widely applied to quantify the spatial variability of data. Three basic parameters that summarize the structure of spatial dependence are range, sill and nugget. Empirical variogram models were fitted to estimate the above mentioned parameters. Among several empirical variogram models, exponential, spherical, Gaussian and stable were tried. Weighted Least Square (WLS) method was applied to fit those empirical models. Best model was selected based on Weighted Residual Sum of Square (WRSS) criterion. In terms of WRSS the goddness-of-fit criteria, stable model was found to be the best-fit followed by exponential model. But the asymptotic range (188 km) was beyond the maximum distance (170 km). For exponential model, the increasing semivariance attenuated at the distance of 17.73 km and reaches to plateau with the semivariance value of 0.876 at the asymptotic distance of 52.80 km (Fig. 104).The cross-validation analysis resulted highest correlation of 0.57 for exponential model. The same for stable, spherical and Gaussian models were 0.55, -0.27 and 0.55 respectively. Exponential model was selected to plug-in into the ordinary kriging method for predicting CPUE over the study domain.

Kriging

Kriging is a geo-statistical interpolation technique that considers both the distance and the degree of variation between known data points while estimating values in unknown areas. In order to generate geo-statistical isopleth map a prediction grid with suitable resolution (1 x 1 km) was created on the study area and thereafter prediction of CPUE was made on the grid using above method. The predictive map depicting different levels (high, medium and low) of abundance region is useful for rationalized fishing, which is one of requirements to achieve sustainable Hilsa fisheries. For example, fishing restriction in the high abundant region (Fig. 105) may be imposed to control over-fishing. Directional abundance pattern (Fig. 105) reflected in the predictive map provided an indication of spatial movement pattern of Hilsa. For example, relatively higher catch rate was predicted towards the shorelines. Geo-statistical map also revealed that predictive catch rate of Hilsa was relatively higher towards the North-Eastern direction.

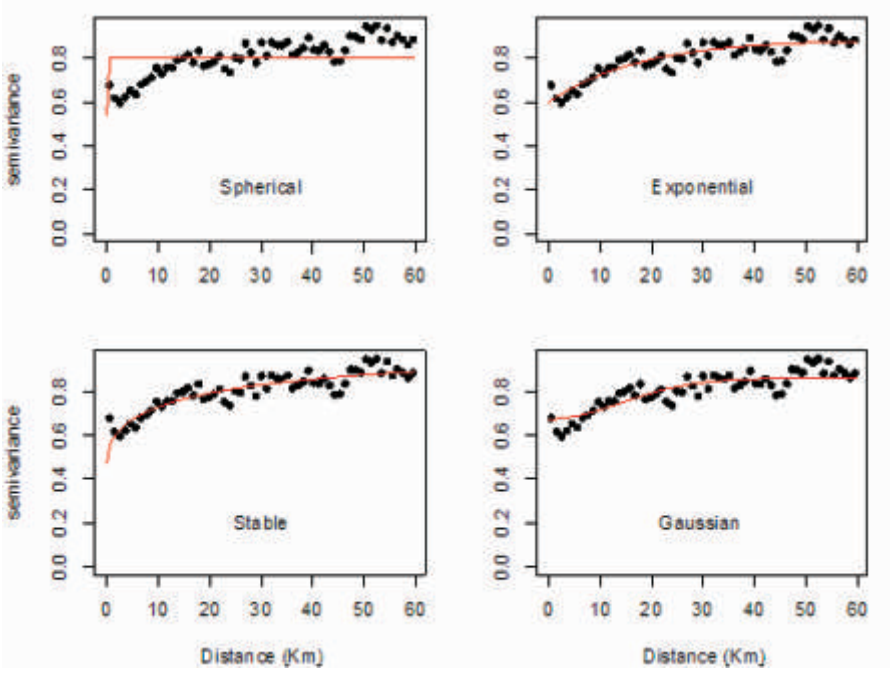


Fig. 104. Experimental and fitted empirical variogram models

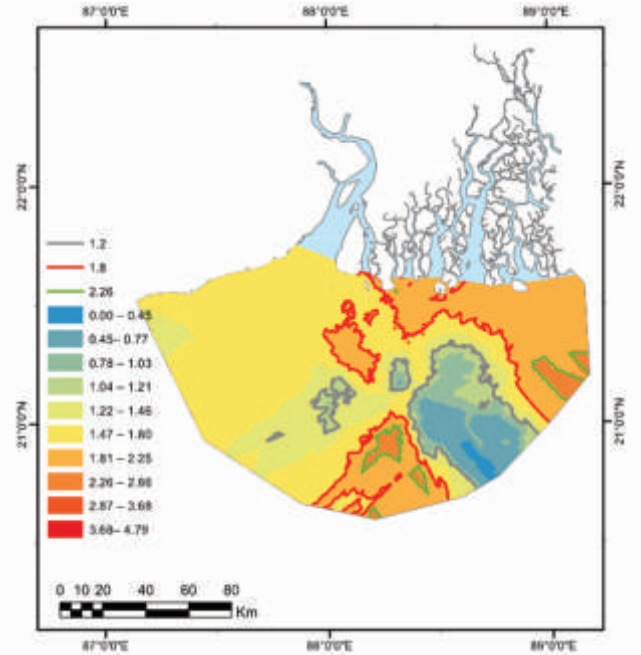


Fig. 105. Predictive map of Hilsa CPUE (in log scale). Contour lines corresponding to three quantiles are demarcated for high, medium and low CPUE.

Model-based forecast of multispecies fish landing at Allahabad stretch of the River Ganga

Allahabad stretch is an indicator of alteration in the fisheries of the River Ganga. Appearance of exotic in the river system has reduced the native fishes, especially IMC (Indian Major Carp). Therefore, it is worthwhile to investigate the landing pattern over time of these fishes in the river so that future forecast can be made. Based on market arrival of fishes in Sadiyapur fish market of Allahabad, landings of total fish species, IMC and exotic have been recorded as 143.46 tonne, 181.15 tonne, and 49.88 tonne respectively during 2017. Historical data of the same from 1972 up to 2017 have been updated. ARIMA (Autoregressive Integrated Moving Average) modelling approach has been applied to the annual landing data for short term 5-year forecasts. Best ARIMA model has been selected on the basis of minimum AIC value. The following Table 15 shows the best ARIMA model and AIC value for total fish catch, IMC and Exotic

Table 15: ARIMA model and AIC value for Total Catch, IMC and Exotic.

	Best ARIMA	AIC Value	ARIMA Model
Total Catch	ARIMA (2,2,2)	400.33	$(1-B)^2Y_t = 0.74949\frac{(1-0.74949B-0.82583B^2)}{(1-1.19517B-0.57711B^2)}a_t$
IMC	ARIMA (1,2,1)	305.52	$(1-B)^2Y_t = -0.36049\frac{(1-B)}{(1-0.32037B)}a_t$
Exotic	ARIMA (1,2,1)	117.2	$(1-B)^2Y_t = 5.85241\frac{(1-B)}{(1-0.50553B)}a_t$

Note: B is Backshift operator; Y_t is catch at time t; α_t is independent disturbance or random Error at time t

Forecasted values show (Table 16) that there will be increase in total fish catch but landing of IMC will continue to decrease and that of exotic will increase in the years to come.

Table 16. Forecasted values with Standard Error for next 5 years.

Year	Total Catch	IMC	Exotic
2018	148.96+21.69	18.18 = 7.54	67.92 +19.87
2019	134.68±24.85	17.49 = 9.16	64.82 ± 22.17
2020	153.04±27.86	17.90±10.86	73.50 ± 26.71
2021	136.95±32.13	17.11±12.24	70.81 ± 29.43
2022	150.04+34.74	17.55+13.51	79.28 + 32.43

Forecasting of Hilsa landings of river Brahmaputra, Assam

For effective fisheries management and future planning of sustainable fisheries development in the river, it is important to know how the fish landings and catch changes over the years. The study was undertaken with an objective to carry out trend analysis and forecasting of Hilsa and other fish landing of River Brahmaputra at Guwahati. Statistical significance of trend was carried out by employing a non-parametric, rank-based Mann-Kendall test on Hilsa landings of River Brahmaputra at Guwahati and magnitude of trend was determined by Sen's slope estimator. Data on fish landings of River Brahmaputra at Uzanbazar landing center collected by ICAR- CIFRI was used for the study. Minor carps (32.6%) dominated in the commercial fish landings followed by miscellaneous fish group (31.8%), major carps (16.7%), catfishes (12.5%), Hilsa (3.4%) and featherbacks (3%) (1987-2016). Landings showed a more or less upward trend since 1987 until it reached the peak value in 2002 and thereafter a gradual decrease occurred. The study revealed a significant decreasing trend in annual landing of major carps, minor carps, Hilsa and featherbacks landings @ 1.4, 1.8, 0.15, and 0.26 tons/year respectively during the 30 year period. Only miscellaneous fish group landings experienced increasing trend of 0.3 tons/year, though this increase is not statistically significant.

Trend analysis of Hilsa landings: Non-parametric approach

Monthly, seasonal and annual time-series landings data (1987-2016) of Hilsa landings were analyzed to measure monotonous trend of landings employing Sen's slope estimator. Statistical significance of trend was determined using non-parametric Mann-Kendall (M-K) test. The analysis showed that Hilsa landing is decreasing in all the seasons except winter.

Model-based forecasts of Hilsa landings in River Brahmaputra at Guwahati

Seasonal autoregressive integrated moving average (SARIMA) methodology has been applied for modelling and forecasting of quarterly landing of Hilsa fish from River Brahmaputra at Guwahati. The data was log-transformed to scale down the variability. Augmented Dickey-Fuller test used for testing the stationarity of the series. Autocorrelation (ACF) and partial autocorrelation (PACF) functions estimated, which have led to the identification and construction of SARIMA models, suitable in explaining the time series and forecasting the future landings of Hilsa. Out of total 120 data points (1987:1 to 2016:4), first 108 data points, i.e., data from 1987:1 to 2013:4 used for developing the model. The developed model validated with the actual quarterly Hilsa landings for the remaining 12 data points (i.e., data from 2014:3 to 2016:4). On the basis of AIC and BIC values, the best model was found out as SARIMA (1,0,0; 0,1,1). The parameter estimates along with standard-error (SE) of estimates and their significance are given in Table 3. The mean absolute error (MAE), mean absolute prediction error (MAPE) and relative mean absolute prediction error (RMAPE) values for fitted model computed as 79.69, 0.085 and 8.56 respectively. The residuals of the fitted models used for the diagnostic checking. The fitted model used for out-of-sample forecast values of Hilsa landings in River Brahmaputra for the period 2017:1 to 2019:4 along with their 95 per cent confidence limit are given in Table17 and shown in Fig 106.

Table 17. Parameter estimates of the fitted SARIMA (1,0,0; 0,1,1) model

Variable	Estimate	Standard-error	t-value	Significance
Intercept	-0.03681	0.0402	-0.92	0.3599
AR, lag 1	0.55987	0.0881	6.35	<.0001
Seasonal MA	0.28558	0.0095	2.99	0.0028

Table 18. Out-of-sample forecasts of Hilsa landings (in kg) of River Brahmaputra at Guwahati

Quarter	Forecast	Lower confidence interval	Upper confidence interval
2017:1	1211.66	161.02	4451.06
2017:2	548.87	72.39	2022.39
2017:3	327.01	43.13	1204.91
2017:4	1247.76	164.56	4597.53
2018:1	1223.89	139.46	4768.95
2018:2	554.41	62.71	2166.14
2018:3	330.31	37.36	1290.55
2018:4	1260.35	142.57	4924.30
2019:1	1236.24	121.52	5078.71
2019:2	560.00	54.66	2306.22
2019:3	333.64	32.57	1374.01
2019:4	1273.06	124.26	5242.75

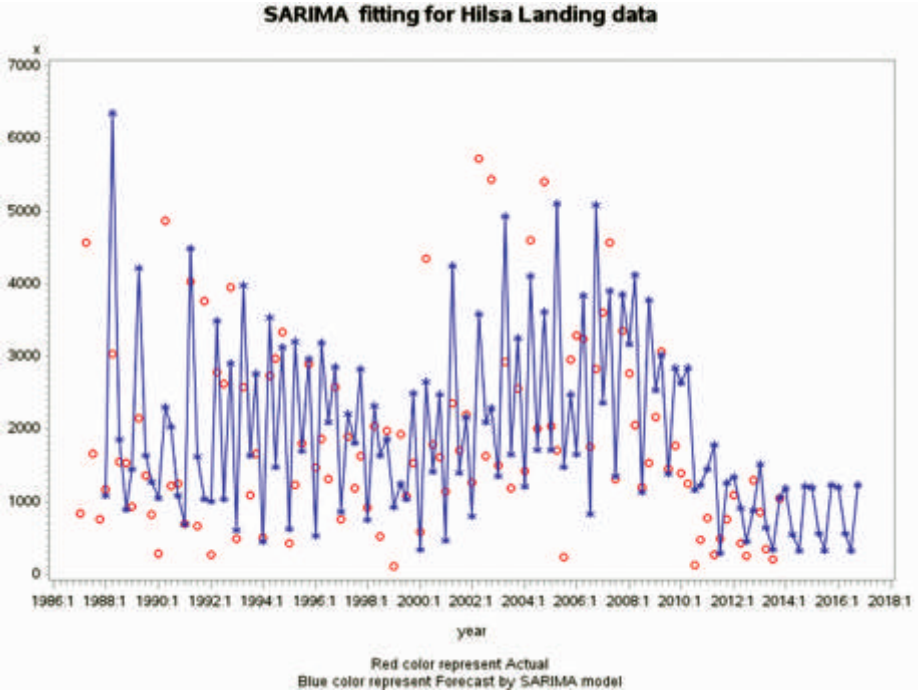


Fig. 106. Quarterly Hilsa landings (kg) in River Brahmaputra during 1986:1st quarter-2013:4th quarter along with fitted values and forecasts for the SARIMA model

Application of Generalized Linear Mixed Model (GLMM) in assessing fish species richness of river systems

Fish species distribution modelling (SDM) has been a notable tool due to more biological understanding and advanced computational tools during last few decades. Generalized Linear Model is often used to handle fish species richness data. However, fish species richness data are subject to high degree of heterogeneity which can't be captured through GLM approach. Generalized Linear Mixed Models (GLMMs) provides flexible statistical modelling tools for analysing such non-normal over-dispersed count data by incorporating of both fixed and random effects. Additionally, when biotic and abiotic parameters data collected on different rivers over space and time then the multivariate data matrix becomes very complex and thereby invites challenges to assess fish species richness in relation to those environmental factors.

A modelling framework has been developed for fish species richness in river system, using GLMMs coupled with principal components scores using R software. For suitability of the GLMM, four river system of western Himalayan region i.e., Beas, Ganga, Ravi and Sutlej were selected as a case study The secondary data on physicochemical parameters of water such as WT (^{o}C), DO (mg l^{-1}), Cond. (µS cm^{-1}), Turbidity (NTU), TDS (mgl^{-1}), pH, Cl (mg l^{-1}), Alk (mg l^{-1}), Hard (mg l^{-1}), NTR (mg l^{-1}), PHP (mg l^{-1}), water current (cm sec^{-1}) and altitude of river sites (ms l^{-1}) and fish richness were utilized for study. Physicochemical parameters of water of rivers has been assumed as fixed effect and river specific effect has been considered as random effect for modelling on fish species richness. Factor analysis on physicochemical parameters of water showed that five factors together explain 72.54% variation in which factor 1 (35.36%) explained maximum variation. This factor is dominated by Cond., TDS, Alk and HRD; factor 2 (10.12%) is dominated by WC; factor 3 (9.31%) dominated by NTR, Factor4 (9.13%) representing DO and factor 5 (8.26%) dominated by Turbidity respectively (Table 19). GLMMs results showed that none of the physicochemical parameters were found to be significant excepting altitude (-0.29, $p < 0.05$) of the river system as fixed effects on fish richness (Table 19). The negative effect of altitude showed that at high altitude low fish richness were observed. River impact on fish richness was found to be maximum by Ganga (2.79) and minimum by Sutlej (1.92). The estimated variance of the random effect (0.133) determines the rivers specific effect on fish richness. It also suggests the high degree of variability of fish species richness across rivers. The R^2 value of 0.53 indicates good fitting of the model.

Table: 19. Factor score of different physicochemical parameters on derived five factors

Physicochemical parameters	Factor 1 (35.36%)	Factor 2 (10.12%)	Factor 3 (9.31%)	Factor 4 (9.13%)	Factor 5 (8.62%)
WT	0.52	-0.41	0.28	-0.30	-0.11
WC	-0.26	0.92	-0.07	0.20	0.17
DO	-0.16	0.21	-0.19	0.92	0.08
Cond.	0.94	-0.15	0.14	-0.07	0.00
Turb	0.05	0.14	0.00	0.07	0.98
TDS	0.94	-0.17	0.14	-0.09	0.00
pH	0.49	-0.03	-0.11	-0.01	0.04
Cl	0.40	-0.03	-0.19	0.14	0.10
ALK	0.83	-0.27	0.17	-0.18	0.08
HRD	0.96	-0.03	0.01	-0.06	0.03
NTR	0.21	-0.08	0.94	-0.19	0.00
PHP	-0.11	0.01	0.02	-0.09	0.01

Fisheries Socio-Economics

Project Title: Impact Assessment of CIFRI Technologies and Trainings

Project No: FSE/17-20/03

Project Staff : Arun Pandit, Ganesh Chandra, Aparna Roy, Anjana Ekka, Anil K. Yadav, Piyashi Deb Roy, Simanku Bora, Dipak Biswas, Loknath Chakrobarty

For evaluation of cage culture, data were collected from State Fisheries Departments and through field surveys in Chhattisgarh, Jharkhand, Odisha, Maharashtra, Manipur and Assam states. The ratio scale developed by Chattopadhyay, 1963 was modified for assessing the Adoption Quotient of the technology. The socio-economic impact of cage culture technologies on the livelihood and employment generation of beneficiaries was assessed through difference-in-difference (DID) and the propensity score matching (PSM) methods which are found suitable for this type of technology.

Status of cage culture in India

Case studies have been conducted in Chhattisgarh, Jharkhand, Maharashtra, Odisha, Assam and Manipur. Jharkhand is one of the early adopters of cage culture in India. In 2007, the cage fish farming started on a National Mission on Protein Supplement (NMPS) scheme. The goal of the cage culture was to fulfil the protein requirements of the people at a low cost and to create livelihood opportunities for the displaced farmers. The study revealed that the income of cage culture was shared between fishers and the society in 80-90:10-20 ratio. At present, there are 5768 (5046 GI and 722 Modular) cages installed in 22 reservoirs of Jharkhand. In Chhattisgarh, the cage culture in reservoir was started in the year 2011-12 from the financial assistance of NMPS.

Maharashtra has great potential of cage culture owing to its possession of huge reservoirs (around 1821 notable reservoirs) with around 4 lakh hectare area. Total number of cages in the state in operation is around 1500 out of which 8.75% of the cages are of GI cages (350 cages). The number of cages is proposed to be around 4000 soon. Gujarat is also one of the early adopters of cage culture technology in India where it was started with a group of 80 fishers in 2015 with 50 cages. At present 550 cages are operational in Ukai reservoir itself. The cage structure is made of Galvanized Iron and are manufactured by the fisher group themselves.

Economic analysis of cage fish production

The economic analysis was carried out for the fish production through cage culture. In Chhattisgarh the total cost of fish farming in High-density polyethylene (HDPE) cage was estimated to be ? 2, 04,500 and the gross return was ? 3,20,000 per cage to an entrepreneur who took the cages from the Fisheries Department on lease. Therefore, the net return was ? 1,15,500 per cage per year which was very remunerative. In Odisha, the analysis showed that the B:C ratio was 1.07 with a net return of ? 12,600 per HDPE cage annually for leased-in cages. The cage culture was done by entrepreneurs. The lease amount per cage was higher in Odisha @ ? 25,200 annually. The gross return was low as the farm gate price of Pangasius in Odisha was low, at @ ? 65/kg. The major challenge faced by fishers practicing cage culture in Odisha was marketing of Pangas. In Chandil reservoir of Jharkhand the B:C ratio was estimated to be 1.24 and the net return was ? 50,000 per cage.

In Maharashtra, the economic analysis of cage culture at Pench reservoir showed that, the gross return and the net return earned by the fishermen were ? 2,48,000 and ? 63,782 per cage, respectively. The Benefit cost ratio was estimated to be 1.34. In Gujarat the total cost and net return were estimated to be ?1,86,500 and ? 59,500, respectively. In all the cases the major cost item was feed followed by labour and seed. The individual cage size was 6x4x4 m^3 and the candidate fish species was *Pangasianodon hypophthalamus*.

Cage culture status in the country

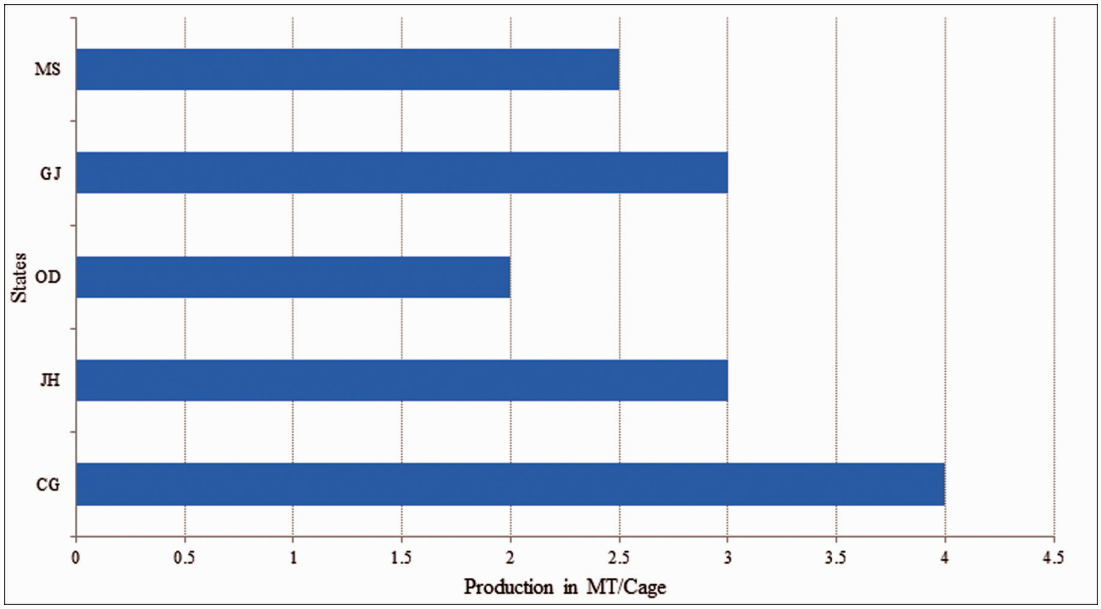
Cage culture was widely adopted in India through NMPS scheme in 2011-12. In last 3-4 years, there has been a phenomenal increase in cage culture in reservoirs across different states of India. Entrepreneurs also showed interest and many cages in different states are waiting to be operationalized. The interim estimate showed that around 14,018 cages have been installed all over India in different reservoirs of the country. Among them, the eastern regions comprising of Odisha and Jharkhand contributed around 6,000 (around 43%). The western region comprising Gujarat, Maharashtra and Goa contributed around 33% of the cages. The Galvanized Iron made cages constituted around 30% of the total cages. Pangasius (*Pangasianodon hypopthalmus*) was the most preferred species for cage culture in India. Tilapia was also cultured, however, to a lesser extent. State Fisheries Department, Fishers Cooperatives, Private Entrepreneurs were the major agencies involved in cage culture.

Table 20: Region-wise cage fish farming status (2016-17)

Region	No. of cages	GI cages	GI cages as % of total cages	% of total cages of India	Implementing agency
Northern	116	8	6.90	0.75	State Fisheries Dept. and ICAR-CIFRI
Central	1183	141	12.17	8.51	FishFed, F. Coop., Private
Western	4684	986	21.05	33.69	Private, F. Coop
Eastern	6011	2719	45.23	43.23	PFCS, Private.
Southern	718	90	12.53	5.12	State Fisheries Dept., F. Coop.
North- eastern	1318	216	16.39	9.48	State Dept., F. Coop., ICAR-CIFRI
Total	14018	4163	29.70	100.00	

Impact of cage culture

It has been observed that the fish yield in cages varied state to state. It depends upon the stocking density, candidate fish species, feeding intensity, management aspects and the reservoir ecosystems.The figure 2 shows that the per cage yield varied from 2 metric tones in Odisha to 4 metric tones in Chhattisgarh.



Note: CG = Chhattisgarh, JH = Jharkhand, OD = Odisha, GJ = Gujarat, MS = Maharashtra

Fig. 107. Average fish yield/cage

Table 21: Impact of cage culture on reservoir yield

No. of cages	14,018
Avg. production/cage (MT)	3.0
Total production from cages (MT)	42,054
Fish production from all reservoirs @ 82kg ha^{-1} (Jha *et al*, 2013) in lakh MT	2.58
Cage production as % of reservoir production	16.30

Therefore, assuming 3 metric tones per cage as the average yield the total fish production from cages in reservoirs was estimated at 42,054 metric tones. This figure was around 16% of the current reservoir production. There exists a scope to increase the contribution if we can harness the potential of cage culture in the country. Note: CG = Chhattisgarh, JH = Jharkhand, OD = Odisha, GJ = Gujarat, MS = Maharashtra.

As far as employment is concerned, it has been seen that, there were three types of manpower employed by the cage aquaculturist. Labour for daily maintenance, security personnel and supervisor/manager are the manpower employed in majority of the cases. In Chandil reservoir of Jharkhand and Ukai of Gujarat, cages were mainly operated by fishermen. On an average one fisher operated two cages in Chandil. He devoted 2-3 hours daily and all the operations were done by him. In Gujarat, six cages were being operated by 1-2 fishers. From the observations of the surveyed states, it was obtained that, on an average one cage operation requires around 53 mandays per year of employment. Cage fabrication, installation, fish breeding create additional employment. At this rate all the cages in the country employed 7.46 lakh mandays of labour in a year. The figure may increase substantially, if the full potential of cage culture in the reservoirs are achieved.

Constraints in Cage culture

At present, lack of trained staff is the major constraint in adoption and promotion of cage culture. The line department officials as well as the people involved in cage culture do not have training or skills in installing and managing cages. Entrepreneurs found that, initial cost for installation of cage is very high. Therefore, fish farmers or their groups are unable to adopt the technology without government support. High expense on feed and requirement of frequent maintenance are the other constraints of cage culture. However, the ICAR-CIFRI provides capacity building trainings to the State Fisheries Department Officials regularly on cage culture of fishes in reservoirs. The State Fisheries Departments are expected to popularize the technology in their respective states for realizing the potential of cage culture in the reservoirs of India.

ICAR Outreach Projects

ICAR Outreach Activity - 1

Project Title : Carp culture in cages and pens using feed

Projet No : OR/ER/08/09/01

Project Staff : M. A. Hassan, M. Aftabuddin, D. K. Meena and Mishal P.

A. Research

- Formulated feeds for *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* using locally available agricultural by-products and tested their efficacy in cages installed in wetlands. Catla performed best, compared to other two species and better growth was observed in fish groups fed with groundnut cake based feed.
- Standardized forms of feed for carp culture in pens in wetlands: Better growth rate (2.7 times) and Food Conservation Ratio (FCR) was observed with floating pellets (weight gain: 195.7%) in pens compared to moist ball of traditional feed (weight gain: 70.5%) after 15 day experimental trial.
- Screened feed additives for better feed intake and growth in *Labeo rohita*: Combined use of an herbal attractant (*Kaempferia galanga*) and probiotic (yeast), in the diet resulted in highest percent live weight gain (105.30%) compared to the individual inclusion of attractant (60.88%) and probiotic (72.63%) in cage experiments in reservoir.
- Developed feeding protocols for cage culture of carp in reservoir: Thrice feeding at 08 hrs, 12 hrs, 15 hrs maximized feed consumption, yielded better growth (water temp. 27-28°C.) in *L. rohita* fingerlings
- Performance of feed in response to species and environmental temperature: At varying temperature regime (19-24° C and 24-36° C), growth performance of *C. carpio* was better during low temperature compared to *C. catla* when fed with experimental diet (34% Crude Protein).
- Successful use of brewery waste as alternate feed ingredient for preparing extruded pellet: Using brewery waste as principal source of protein, floating feed was prepared that showed desirable physical stability (18-24 hours) and floatation efficiency (96% for 3 hours) in both indoor and outdoor environment. Efficacy of brewery based feed was tested in *Labeo bata*, *Pangasianodon hypophthalmus*, *Catla catla*, *Labeo rohita* in cages installed in reservoir.
- In *Labeo bata*, survival, growth parameters and feed conversion efficiency did not differ significantly ($p>0.05$) despite complete replacement of soybean meal by brewery waste after 60 day feeding trial. The cost estimate revealed marked reduction of feed cost per kg fish production (41.5%) using test diet as compared to the reference diet.
- The average weight gain (%), Specific Growth Rate (SGR), Feed Conservation Efficiency (FCE) and Protein Efficiency Rate (PER) of Pangas fed with brewery waste based floating feed was significantly higher ($p<0.05$) compared to those group of fishes fed with brewery waste based sinking feed. There was no significant difference ($p>0.05$) in average weight gain (%), SGR, FCE and PER between fish groups fed with floating feeds based on soybean oilcake and brewery waste after 60 days of feeding trial.
- Improved feed efficiency by changing environment: Creating flow in rearing environment in indoor trial improved feed consumption, growth and carcass composition of *L. rohita*.
- Proved the hypothesis of beneficial impact of flowing water in improving growth and feed conversion of Jayanti rohu and rohu in outdoor trials. The growth of Jayanti rohu (% weight gain) was 2.7 times higher in cages installed in flowing water compared to stagnant water after 90 day experimental feeding trial. The growth of normal rohu in terms of weight gain % was 2.15 times higher in flowing water as compared to stagnant water.

- Optimized cage environment for better performance of feed: Among the different dimension of cages, all the IMC species performed better in 5m long cages. Increased cage length (10m and 20m long) did not influence growth in *C. catla*, *L. rohita* and *C. mrigala*.
- Assessed growth performance of carps in different dimensions of cages in polyculture system using sinking pellet: There was significant difference ($p<0.05$) between species; *C. catla* performed best and least by rohu. There were no significant difference between hybrid (catla-rohu) and mrigal.
- Tested the synergistic role of developed feed with natural food in cages in reservoir for three major carps. Only *L. rohita* showed significant difference between the treatments and recorded highest growth when provided with both formulated feed and natural food.
- Evaluated leather meal (CP: 65.9%; CL: 0.88%) as a novel cost effective, protein rich ingredient for fish feed preparation: No significant difference ($p>0.05$) in growth, FCR and PER was observed between leather meal based feed & brewery waste based feed in *P. hypophthalmus* in indoor trial. Significantly better ($p<0.05$) growth, FCR and PER was observed in control group fed with soybean based feed. However, the cost of per unit weight of fish production was found economical with leather meal or brewery waste incorporated feed.
- Identified species specific feed supplements for *L. rohita* and *C. mrigala* for their culture in confinements. Incorporation of these supplements improved growth significantly in confinements under experimental set up.
- Infrastructure for low cost farm made feed has been created at ICAR-CIFRI.
- Installed extruder feed mill and standardized preparation of floating feed: A semi-automatic extruder pellet mill has been successfully installed at CIFRI, Barrackpore, with production capacity of 10-15 kg hr^{-1} and standardized feed preparation using local ingredients for feeding trials in cages.

B. Products

- Registered CIFRI made extruded feed '*CIFRI CAGEGROW*' for trademark
- The product '*CIFRI CAGEGROW*' has been commercialized after testing of its performance in farmer's cage at Chandil reservoir where the feed indicated better growth and feed conversion efficiency in comparison to available commercial feed.
- Designed Fish Feed maker (Fermenter cum steam cooker cum drier):

  Nutrients from plant origin feed ingredients can be made more available to fish by simplifying the complex macromolecules through the process of soaking/fermentation, steaming and cooking. In the process, the anti-nutritional substance present in plant origin ingredients that hamper growth and affects health will also get deactivated / de-natured. Steam treatment helps starch component of the feed mixture to gelatinize and enhance binding capacity leading to better feed stability. Keeping all these in mind a device has been conceptualized and a design of equipment has been developed to fulfil the objective of fermentation, cooking and drying in the same system.
- Feed additives/supplements for growth enhancement in carp culture in confinement:

  Farming of filter feeder carp species in confinements is a big challenge to obtain its growth potentials. Nutritionally balanced artificial feed failed to achieve desired growth when fed to fishes in confinement where natural food was nil or deficient. It is therefore presumed that some crucial natural substances responsible for growth that fishes collect along with their natural food during the feeding process are missing in the formulated feed. The issue of growth of carps in cages becomes more critical despite feeding balanced feed, if the ecosystem is poor in natural productivity. In order to realize growth potential of carps in cages, two natural substances were supplemented in the diet of *L. rohita* and *C. mrigala*

C. Consultancy

- Signed MoU with Geetanjali, a private party for technical guidance and consultancy for setting up fish feed mill in West Bengal.

ICAR Outreach Activity - 2

Project Title: Genetic stock characterization of the Indian Major Carps from major rivers of India
Project code: OR/ER/08/09/02
Project Staff : B. K. Behera, P. K. Parida, D. K. Meena, P. Das and A. K. Jana

The comparative population structure, genetic diversity and historical demographics of IMCs, *L. rohita*, *G. catla*, *C. mrigala* were characterized by analyzing partial 307 bp sequences of Cytochrome *b* gene of 357 individuals collected from seven geographically isolated sites from Indian river basins (Ganga, Brahmaputra, Narmada and Teesta) and two culture zones (24 Praganas North and Midnapur). The DNA sequences alignment among three species revealed comparative divergence and evolution in these heterogeneous species in terms of over transition to transversion (TS:TV) ratio as 6.25. The study implicated the occurrence of 35 haplotypes with haplotype diversity (Hd) of 0.7333 in *L. rohita* at Brahmaputra basin showing allelic richness, while no nucleotide diversity (π) 0.000 was observed in *G. catla* of two geographically isolated locations at river Ganga and Narmada. The analysis of molecular variance (AMOVA) revealed the genetic diversity of IMCs is to be very low (9.40%) within the species, as compared to the among the three species (80.76%). The Fst scores ranged between 0.000 to 0.996 indicating low to high genetic structure of IMCs. The Haplotype-1, Haplotype-13 and Haplotype-19 in *L. rohita*, *G. catla* and *C. mrigala* were considered as ancestral haplotypes, respectively. The expansion factor was found to be 0.45000 and 0.90000 for *L. rohita* at Farakka-Ganga and Allahabad-Ganga stocks respectively.

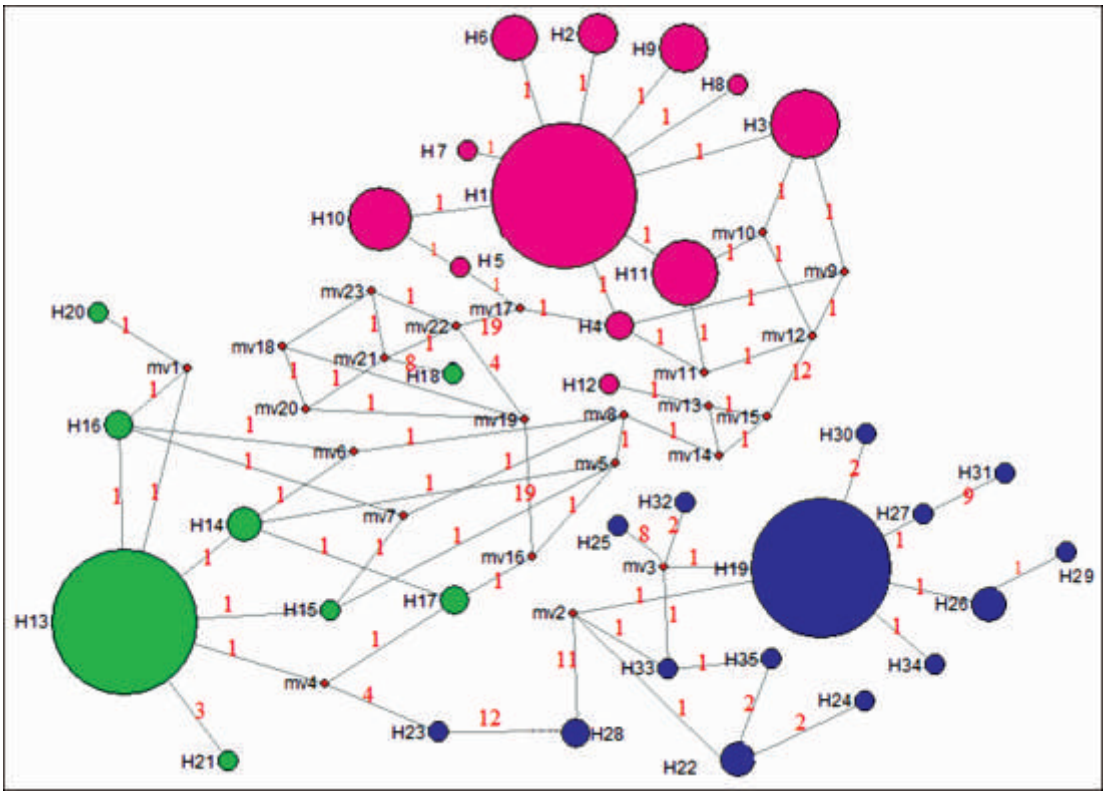


Fig.108. Median-joining network of 35 haplotype of three Indian Major Carps (Red color = *L. rohita*, Green color = *G. catla* and Blue color = *C. mrigala*). Each circle represented haplotypes and circle size is proportional to haplotype frequency. Numerals indicate Number of mutations.

Outreach Activity - 3

Project Title: Nutrient Profiling and Evaluation of Fish as a Dietary Component

Project code : OR/ER/07/003

Project staff: B.P. Mohanty (Coordinator & PI), D. Karunakaran, D. Debnath, R. K. Raman, P. K. Parida, A. Sinha, Sona Yengkokpam, Prajna R. Behera, Sanjay Bhaumik, L. R. Mahaver, Sk. Rabiul, S. K. Paul and Asim Jana

Nutrient profiling and evaluation of fish as a dietary component

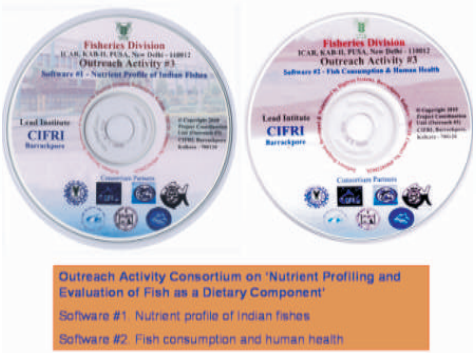
Fish is a health food; rich in quality animal proteins, polyunsaturated fatty acids and micronutrients; besides, availability and consumer affordability are far much better for fish as compared to other sources of animal proteins. Aquaculture, one of the fastest growing food production sector would play a big role in eradicating hunger, malnutrition and nutrient-deprivation globally. However, nutritional information on the fish species is necessary to harness the potential of fish to its fullest extent. Keeping in view the important role of fish on human health and nutrition, Fisheries Science Division, ICAR has undertaken the Outreach Activity on 'Nutrient profiling on fishes' with the objective of generating and documenting comprehensive scientific information on nutrient profile of commercially important food fishes.

Fig.109. Some of the important food fishes studied under the project

Output (2008-2018)

1. Nutrient profile of >100 species of food fishes from India have been studied and important nutrient data on proximate composition, amino acid, fatty acid and micronutrient profile have been generated. Some of the fishes studied are shown in Fig.109.

2. Software developed for data collection and compilation.



3. A database named '**NutriFishIN**' has been developed (http://www.cifri.res.in/nutrifishin/index.php). The database has an in-built knowledge base which provides information on the richness of different fish species in different food components which could be useful for their inclusion in dietary counselling by physicians. Besides the nutritional data, information on standard international protocols followed to generate the information and other technical aspects are also available (*Current Science*, 2015). The nutritional composition data generated has also been reviewed to explore the implications of such nutritional information in consumer guidance, dietary counselling, food-policy planning and prioritization of species for aquaculture to fight hunger, malnutrition and micronutrient deficiency; ultimately contributing to food and nutritional security (*Food Chemistry* 2018).

Homepage of NutriFishIN Database (http://www.cifri.res.in/nutrifishin/index.php).

Table 22 : Gross chemical composition of important food fishes from India (Mohanty et al., *Food Chemistry*, 2018)

Species	Habitat	Moisture	Crude Protein	Crude Fat	Ash
Ailia coila	Freshwater	82.8±0.2	12.9–0.5	1.8±0.0	2.0±0.0
Amblypharyngodon mola	Freshwater	76.2±1.1	16.3=0.8	4.3±0.0	4.0±0.9
Anabas testudineus	Freshwater	68.0±0.7	16.9=0.5	6.9±0.6	5.3±0.2
Catla catla	Freshwater	76.2±0.3	16.2_0.5	2.8±0.3	2.5±0.1
Cirrhinus mrigala	Freshwater	75.3±0.6	15.5=0.5	2.8±0.3	2.5±0.1
Cheetala cheetala	Freshwater	74.2±1.2	22.2=0.7	4.0±0.7	1.7±0.1
Clarius batrachus	Freshwater	75.9±0.7	16.4_0.3	3.7±0.4	2.3±0.0
Crassostrea madrasensis	Marine	80.1±0.7	16.8=0.1	2.7±0.2	1.3±0.1
Cyprinus carpio	Coldwater	77.2=0.3	17.9=0.8	3.0±0.0	1.3=0.1
Epinephelus Sp.	Marine	78.5±1.5	18.1_1.1	0.9±0.5	1.5±0.5
Etroplus suratensis	Brackishwater	74.2 0.5	20.4 0.8	4.7±0.8	1.4 0.1
Euthynnus affinis	Marine	75.7±0.1	20.9=0.1	1.9±0.0	1.5±0.0
Fenneropenaeus indicus	Brackishwater	82.2=0.9	16.4=0.3	0.7±0.4	1.4=0.1
Gadusia chapra	Freshwater	76.7±0.3	14.1=0.1	5.7±0.0	2.9±0.0
Harpodon nehereus	Marine	87.5±2.0	8.2±0.9	2.2±0.2	1.1±0.2
Heteropneustes fossilis	Freshwater	76.7±1.1	16.3=0.4	2.7±0.5	2.6±0.1
Johnius coitor	Freshwater	78.8±1.9	20.6_1.9	0.6±0.2	1.0±0.0
Katsuwonus pelamis	Marine	70.6±7.4	22.4=2.9	1.2±1.1	1.9±0.8
Labeo rohita	Freshwater	75.6±0.5	15.9=0.4	2.7±0.2	2.6±0.2
Lates calcarifer	Brackishwater	72.8±0.6	21.1_0.9	2.6±0.5	1.6±0.1
Leiognathus splendens	Marine	74.7±3.7	17.2=1.6	3.8±3.7	3.1±0.7
Liza parsia	Freshwater	76.4±0.4	22.3=0.8	0.9±0.0	1.6±0.0
Macrobrachium rosenbergii	Marine	73.5±0.6	16.9=0.4	4.4±0.2	4.9±0.2
Mugil cephalus	Brackishwater	75.6±0.6	20.0 0.9	3.3±0.7	1.3±0.1
Nemipterus japonicus	Marine	78.5±0.1	15.4=0.2	5.1±0.0	1.0±0.0
Neolissochilus hexagonolepis	Coldwater	75.3±0.1	18.25±0.3	3.3±0.1	1.4±0.0
Notopterus notopterus	Freshwater	74.2_1.2	22.2_0.7	4.0±0.7	1.7±0.1
Oncorhynchus mykiss	Coldwater	74.7±0.3	17.9=0.0	3.8±0.1	1.8±0.0
Pampus argentius	Freshwater	76.2=0.7	19.6=0.6	4.0±0.6	0.9=0.2
Penaeus monodon	Brackishwater	76.3_0.5	19.4_0.2	0.7±0.2	3.1±0.1
Perna viridis	Marine	83.5±0.5	11.0±0.1	1.7±0.0	1.4±0.0
Puntius sophore	Freshwater	75.7±1.9	16.3=0.9	4.9±0.5	3.4±0.1
Rastrelliger kanagurta	Marine	78.2±0.1	19.2_0.1	1.7±0.0	1.2±0.0
Rita rita	Freshwater	77.7±4.3	19.55±1.2	1.6±0.0	1.04–0.1
Sardinella longiceps	Marine	71.3±7.1	17.1=1.4	9.2±5.8	2.3±0.6
Schizothorax richardsonii	Coldwater	77.3 ±0.0	16.4 ± 0.1	2.5±0.0	1.2 =0.0
Sperata seenghala	Freshwater	79.4±1.2	19.0 1.3	0.8±0.4	0.9±0.2
Stolephorus commersonii	Marine	79.4±0.1	16.4=0.1	1.2±0.0	3.2±0.2
Stolephorus waitei	Marine	79.9±0.1	20.3=0.1	1.1±0.0	3.3±0.3
Tenualosa ilisha	Freshwater	66.9±4.2	20.7_2.7	10.5_4.6	1.1±0.5
Thunnus albacares	Marine	74.1±0.1	23.9–0.1	0.6±0.0	1.4±0.0
Tor putitora	Coldwater	74.9=0.1	17.9=0.5	4.3±0.1	1.5±0.1
Trichiurus lepturus	Marine	75.5±3.6	17.9_1.5	3.4±4.1	1.6±0.4
Xenentodon cancila	Freshwater	78.2±0.7	15.7 0.3	0.7±0.0	3.6±0.1

4. Based on the nutritional information, species have been prescribed for possible dietary counselling by physician, dietician for their health and nutritional value. For example:

- **Amino acid:** Amino acid composition of food fishes from different habitats viz. freshwater, coldwater, brackishwater and marine environments were generated (*Journal of Amino Acids* 2014). In general, the cold water species are rich in lysine and aspartic acid, marine fishes in leucine, small indigenous fishes in histidine, and the carps and catfishes in glutamic acid and glycine. In addition to this amino acid composition > 70 food fishes from different habitats has also been generated under the project.

Table 23: Fish species rich in different amino acids among the 27 food species studied.

Amino acids	Species richness in the amino acid
Essential amino acids	
Arg[a]	*Onchorhynchus mykiss, Tor putitora, Neolissochilus hexagonolepis*
His	*Rastrelliger kanagurta, Catla catla, Stoleophorus waitei, Amblypharyngodon mola, Puntius sophore*
Iso	*Onchorhynchus mykiss, Labeo rohita, Stoleophorus commersoni*
Leu[a]	*Stoleophorus waitei, Rastrelliger kanagurta, Labeo rohita*
Lys	*Stoleophorus commersoni, Thunnus albacores, Tor putitora*
Met[a]	*Stoleophorus waitei, Tor putitora, Rastrelliger kanagurta*
Phe	*Cirrhus mrigala, Catla catla, Labeo rohita*
Thr	*Thunnus albacores, Nemipterus japonicas, Stoleophorus waitei, Stoleophorus commersoni*
Tyr[a]	*Onchorhynchus mykiss, Tor putitora*
Val	*Nemipterus japonicas, Cirrhus mrigala, Rastrelliger kanagurta*
Trp[a]	*Tor putitora*
Glu[a,c]	*Cirrhus mrigala, Catla catla, Labeo rohita*
Gly[a,c]	*Cirrhus mrigala, Catla catla, Labeo rohita*
Pro[a,c]	*Onchorhynchus mykiss, Tor putitora*
Non-essential amino acids	
Ala	*Nemipterus japonicus, Labeo rohita, Catla catla*
Asp	*Stoleophorus commersoni, Heteropneustes fossilis, Clarias batrachus*
Ser	*Stoleophorus commersoni, Nemipterus japonicas, Thunnus albacares*

[a]Conditionally essential amino acids; [c]Functional amino acids as per human nutrition

- **Fatty acid:** Fatty acid composition of thirty-nine food fishes from different habitats viz. freshwater, coldwater, brackishwater and marine environments were generated (*Biomed Research International* 2016). The fishes *Tenualosa ilisha*, *Sardinella longiceps*, *Nemipterus japonicus*, and *Anabas testudineus* were found to be rich sources of DHA and EPA. In addition to this >50 food fishes are also studied under the project from different habitats.

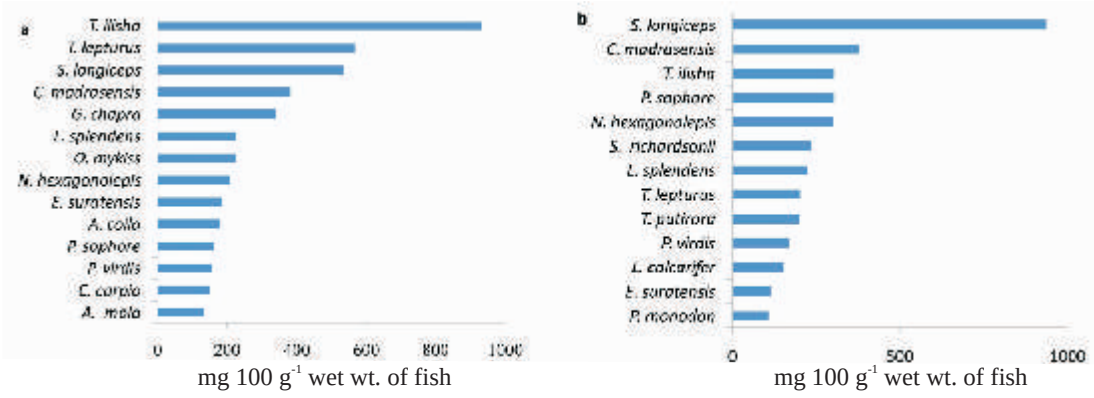


Fig.110. Top Species of food fishes from India for DHA (a) and EPA (b)

- **Minerals:** The macro minerals **(**Na, K, Ca, Mg and P) and micro minerals (Fe, Cu, Zn, Mn and Se) composition of food fishes from different habitats viz. freshwater, coldwater, brackishwater and marine environments were generated (*Biological Trace Element Research*, 2016). In general, the marine fishes were rich in sodium and potassium; small indigenous fishes (SIFs) in calcium, iron, and manganese; coldwater fishes in selenium; and the brackishwater fishes in phosphorous.

- **Fat soluble vitamins**: The fat soluble vitamin profile (A, D, E and K) of food fishes from different habitats viz. freshwater, coldwater, brackishwater and marine environments were generated (*Biological Trace Element Research*, 2016). Among them, the marine fishes *Sardinella longiceps* and *Epinephelus* spp. and the SIFs were rich in all fat-soluble vitamins.

5. Nutrigenomic studies on hilsa from the rivers Hooghly and Padma: *Tenualosa ilisha*, rich in oils, enjoys high consumer preference in the South Asian countries owing to its unique flavour and culinary properties. This study reported different flesh quality attributes of hilsa in terms of nutritive

Table 24. Fish rich in specific minerals and fat soluble vitamins among the species studied.

Micro nutrients	Species rich in particular micronutrient
Macro mineral	
Sodium	*Perna viridis, Penaeus monodon, Fenneropenaeus indicus*
Potassium	*Rastrelliger kanagurta, Stolephorus commersoni, Nemipterus japonicus*
Calcium	*Xenentodon cancila, Gudusia chapra, Ailia coila, Neolissochilus hexagonolepsis Puntius sophore*
Magnesium	*Penaeus monodon, Fenneropenaeus indicus, Perna viridis*
Phosphorous	*Xenentodon cancila, Gudusia chapra, Epinephelus* Sp.
Micro mineral	
Iron	*Gudusia chapra, Amblypharyngodon mola, Puntius sophore*
Copper	*Thunnus albacores, Xenentodon cancila*
Zinc	*Stolephorus waiti, Xenentodon cancila, Stolephorus commersoni*
Manganese	*Gudisia chapra, Crassostrea madrasensis. Xenentodon cancila*
Selenium	*Neolissochilus hexagonolepsis. Labeo rohita. Clarias batrachus*
Fat soluble vitamins	
Vitamin A	*Amblypharyngodon mola, Epinephelus* Sp., *Sardinella longiceps*
Vitamin D	*Amblypharyngodon mola, Puntius sophore, Epinephelus* Sp.
Vitamin E	*Epinephelus* Sp., *Sardinella longiceps. Tenualosa ilisha*
Vitamin K	*Amblypharyngodon mola. Puntius sophore. Epinephelus* Sp.

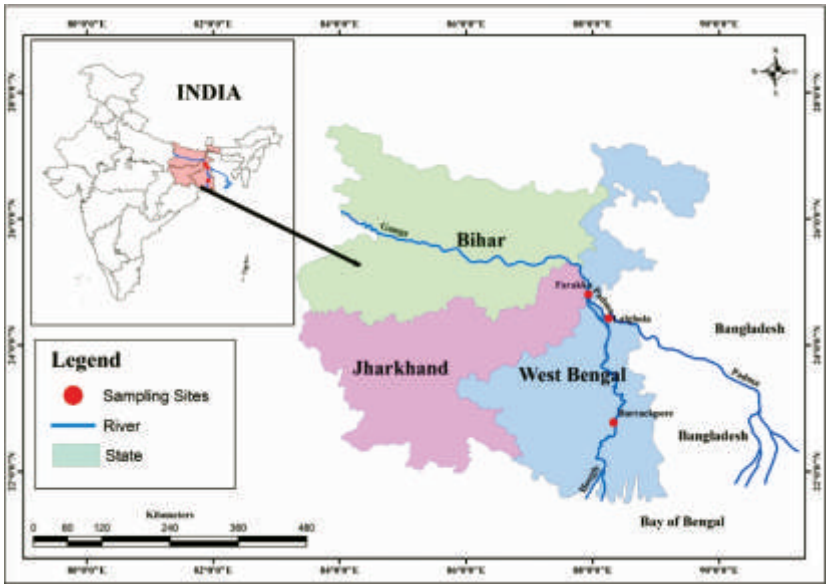


Fig.111. Map showing hilsa sampling sites along river Hooghly and Padma

value, pH, water holding capacity and expression of genes associated with fatty acid metabolism and flesh quality assessment. Additionally, comparative studies on the flesh quality attributes in hilsa from rivers Hooghly and Padma were also reported (Fig.111). The protein content, essential amino acid and functional amino acids were significantly higher in Hooghly hilsa ($P<0.05$). The predominance of umami taste and sweet taste amino acids in hilsa from both the rivers could be the contributing factors to its unique flavour. The concentration of flavouring fatty acids like saturated fatty acids and omega (ω)-3 polyunsaturated fatty acids were significantly higher in Hooghly hilsa ($P < 0.05$). Among the genes associated with fatty acid metabolism studied, expression of some genes was significantly higher in Padma hilsa ($P < 0.05$), however, comparative gene expression profiling of flesh quality related genes showed similar levels of expression in hilsa from both the rivers ($P < 0.05$). It was concluded that Hooghly hilsa (medium size category, 500-700 g size) is superior in terms of oil content, ω-3 PUFAs EPA and DHA and essential amino acids than Padma hilsa; however, the expression profile of genes associated with flesh quality were found to be similar.

6. Whole liver transcriptome of *Tenualosa ilisha* was generated and submitted to NCBI, Sequence Read Archive, SRA (SRA Accession No SRR5936610).

7. Partial gene sequence information of different genes related to fatty acid metabolism and flesh quality of *Tenualosa ilisha* submitted to GenBank NCBI: *Elongase*: KT634298; *Desaturase*: KT634297; *Enolase*: KJ028078; *β – actin*: KJ028079; *18S rRNA*: KX572358; *Fatty acid synthase*: KX572356; *Glyceraldehyde 3 phosphate dehydrogenase*: KX572357; *Actin*: MF611871; *Triose phosphate isomerase*: MF611870; *Adeenylate kinase*: MF611872; *Phosphotidyl etanolamine binding protein*: MF611874; *Apolipoprotein AI*: MF611873; *Lactate dehydrogenase*: Mf593460.

8. *Tenualosa ilisha* fatty acyl desaturase, mRNA, partial cds (1305 bp) has been generated (GenBank Accession No. Mh004275) and given below :

9. Developed an Android App: An Android App named "NutriFishApp" has been developed. The app contains nutritional information on commercially important food fishes of India, from varying habitats like freshwater, coldwater, brackish water and marine systems. The main feature of the app is information on food fishes in terms of gross chemical composition, amino acid, fatty acid and micro nutrients. The app has an in-built knowledge base which provides information on the richness of different fish species in different food components which could be useful for their inclusion in dietary counselling by physicians. Besides the nutritional data, information on standard international protocols followed to generate the information and other technical aspects are also available.

10. More than 10 mass awareness campaigns have been carried out in a number of places to bring awareness on the 'Health benefit of eating fish'.

11. Clinico-epidemiological survey was carried out at different locations (Farakka, West Bengal and Cochin, Kerala) to correlate 'Fish Consumption with Human Health'

Fig. 112. NutrifishApp Homepage

Madanganj, Sundarban, West Bengal, 2014

Hajilur, Baishali, Bihar, 10Feb, 2016

Sagar Island, 22 Sep, 2016

Documentation: Some important publications from Outreach Activity #3

NEH Activities

Project Staff : B. K. Bhattacharjya, S.Yengkokpam, D.Debnath, A. K.Yadav, P. Das,N. Sharma, Simanku Borah, N. Samarendra Singh, K. K. Sarma, B. C. Ray and A. Kakati

Impact of fish stock enhancement through in-situ raising of stunted carp fingerling in pen on fish production in Mer beel, Assam

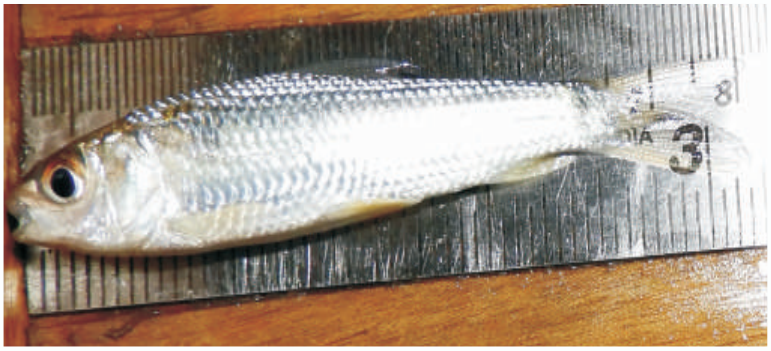
ICAR-CIFRI Regional Centre, Guwahati in collaboration with AFDC Ltd., Guwahati carried out fish stock enhancement in Mer beel (seasonally open, water spread area 20 ha), Morigaon district of Assam under the NEH component of the Institute. Stunted fish fingerlings were raised in rectangular pens (4 nos., each having 2500 m^2 area) installed in marginal areas of the beel. Six species of carps *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, *L. gonius*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* were stocked @ 5 nos. m^{-2}. After rearing for 5 months in the pen stunted carp fingerlings were released to the beel proper for fish stock enhancement @ 2000 nos. ha^{-1} towards partial restocking of the beel following the first major part-harvest in the beel during January. The average fish production of the beel during 2007-11 was 507 kg ha^{-1} following intermittent stock enhancement. During 2011-16, stock enhancement was adopted as per ICAR-CIFRI guidelines by supplementary stocking with carp fingerlings, which gave an average fish production of 1326 kg ha^{-1} showing an increase of 188.95%. The fish yield rate during 2016-17 was recorded as 1465 kg ha^{-1} yr^{-1} showing that stock enhancement using stunted carp fingerlings resulted in 12.6% increase in production. The result suggests that fish production from the beels can be further enhanced by stocking stunted carp fingerlings reared in pens.

Pen installed in Mer beel, Morigaon district, Assam

Fish harvest in Mer beel

Rearing of *Labeo bata* in CIFRI-GI Cages as a winter crop in Samaguri beel, Assam

A series of ICAR-CIFRI GI-cages (individual cage dimension of 5 x 5 x 2m) were installed in Samuguri beel, Nagaon district of Assam under the NEH component of the Institute. During the winter months, fish reared in enclosures were usually affected with disease and had low survival in addition to low growth rates. In the present experiment *Labeo bata* was selected as it is hardy species and has high demand in local market. The cages were stocked with fingerlings of *L. bata* at five stocking densities, i.e., 25 (S1), 50 (S2), 75 (S3), 100 (S4) and 150 fingerlings m^{-3} (S5)in triplicates on 25.09.17. The average length and weight of the stocked fish were 8.2 cm and 4.82 g, respectively. Fish were fed with pelleted feed containing 30.04% CP @ 5% body weight. Plastic tray (2 nos. in each cage) with sinker attached was used for feeding. Results from the present study indicated that the survival was high (range : from 85.5-94.07%) during the rearing period. The growth performance parameters such as body weight, specific growth rate and weight gain percent were found to be significantly higher in the lowest stocking density group, followed by those stocked at 50 and 75 fingerlings m^{-3} and lowest in the highest stocking density group.



Labeo bata fingerling stocked in cages at Samaguri beel, Nagaon district, Assam

ICAR-CIFRI GI cages installed in Samaguri beel

Event organized

Regional Consultation on 'Open Water Fisheries Development in NE Region'

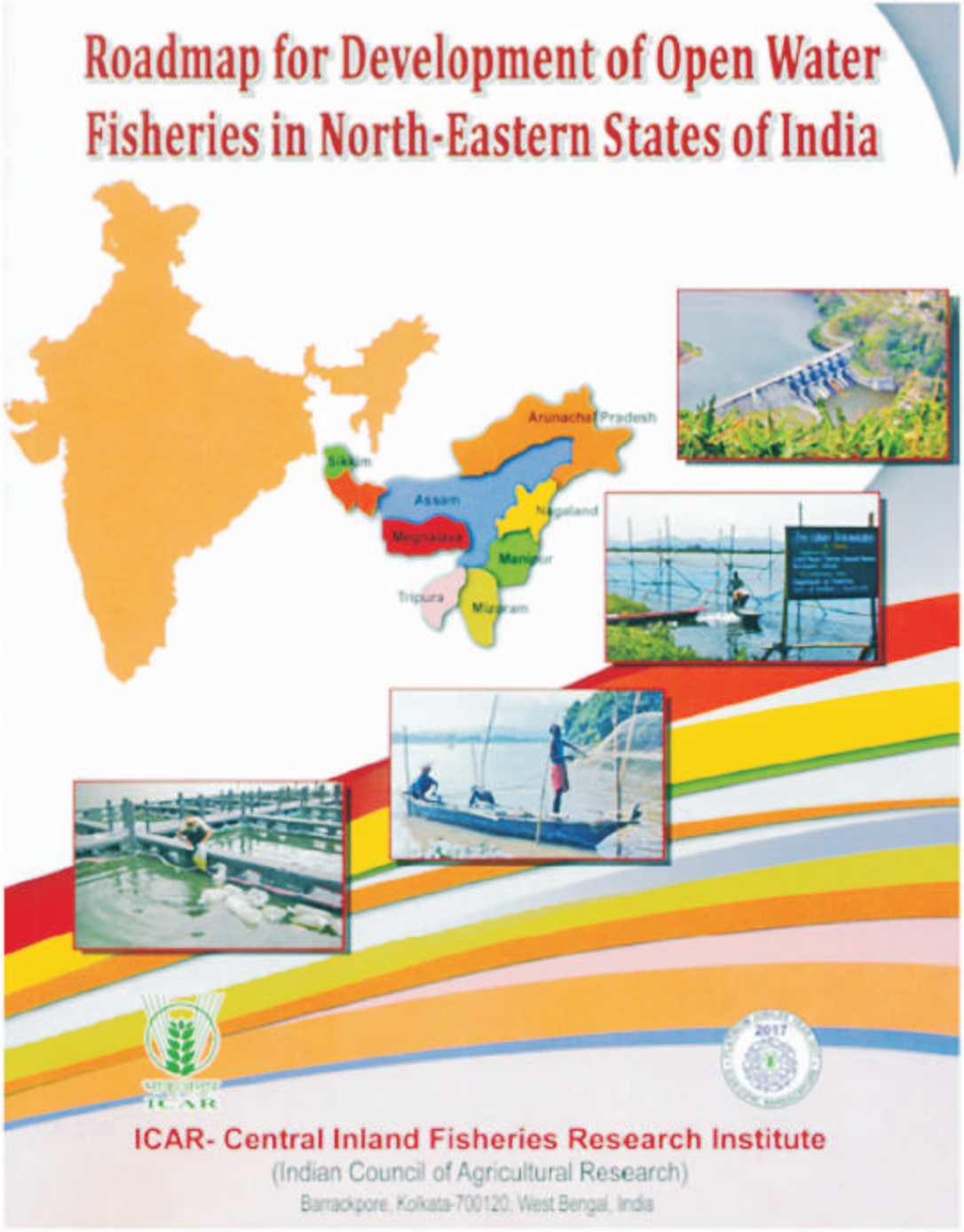
ICAR-Central Inland Fisheries Research Institute organized the Regional Consultation on *"Open Water Fisheries Development in NE Region"* at Guwahati on 29.04.2017. Total 40 delegates including Director, ICAR-CIFRI; Director of Fisheries from Assam, Manipur and Mizoram; Dean, College of Fisheries (CAU), Lembuchera; Prof. K. K. Saharia, GB Member of ICAR; Dr. J. Chauhan, National Convener for Extension Education, Ministry of Agriculture and Farmers' Welfare, Govt. of India; Dr. S.K. Das, Principal Scientist and I/C, ICAR Research Complex for NEH Region, Umiam, Meghalaya; Mr. P. K. Hazarika, Technical Manager, AFDC Ltd., Guwahati; officials from fisheries departments of North-eastern (NE) states; Mr. B. Phukan, Asst. Professor, College of Fisheries (AAU), Raha; officials from National Fisheries Development Board, Regional Centre, Guwahati and Scientists of ICAR-CIFRI participated in the Regional Consultation. Dr. B. K. Bhattacharjya, Head (Acting), ICAR-CIFRI Regional Centre, Guwahati welcomed the participants and sought scientific inputs from the delegates. Dr. B. K. Das, Director, ICAR-CIFRI emphasized on the need for developing open water fisheries in the region on priority basis and assured providing research support to the state fisheries departments. Shri Parimal Suklabaidya, Hon'ble Minister of Fisheries, Govt. of Assam stressed on the need for making the NE region self-sufficient in fish production. In the technical session, scientists from ICAR-CIFRI Regional Centre presented the proposed state-specific road maps for open water fisheries development. The delegates provided useful inputs and suggestions regarding state-specific road maps. The organizers agreed to revise the roadmap in the light of discussions in the technical session.

Participants and delegates at the Regional Consultation at Guwahati on 29.04.17

Inauguration session of Regional Consultation on
'Open Water Fisheries Development in NE Region'.

Shri Parimal Suklabaidya, Hon'ble Minister of Fisheries, Govt. of Assam,
addressing the audience.

As an output of the Consultation, the 'Roadmap for development of open water fisheries in North-eastern states of India' (a policy document) was prepared and distributed to all the concerned states fisheries departments for implementation.



Externally Funded Projects

Project Title: Impact of climate change in inland fisheries and development of adaptation strategies

Project Staff : U. K. Sarkar, M. Naskar, S. K. Nag, B. K. Bhattacharjya, P. Pannikar, A. Pandit, D. Debnath, S. Yengkokpam, S. Das Sarkar, T. T. Paul, Lianthuamluaia, G. Karnatak, Mishal P, K. Kumari, T. N. Chanu, Sibina Mol S., N. S. Singh

Demonstration of climate resilient pen system

Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in Mathura and Bhomra beel in West Bengal, 47-Morakolong beel in Assam and Vembanad lake in Kerala. The regionally important fish and shellfish species evaluated in CRPS are *Amblypharyngodon mola*, *Labeo bata*, *Puntius sarana*, *Nandus nandus*, *Ompok pabda*, *Gudusia chapra*, *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Etroplus suratensis*, *Macrobrachium rosenbergii* and *Villorita cyprinoides*.

Stocking of fish fingerlings in pen in Mathura beel

Estimation of primary productivity and associated microflora of the Wetlands

Present study showed plankton abundance of 0.56×10^5 to 1.02×10^5 ind. l^{-1} during post monsoon season in Bhomra, Mathura, Chandania wetlands. Analysis of samples revealed 40 genera and plankton density @ 744 ind. l^{-1}; 42 genera and plankton density @ 1878 ind. l^{-1}; 30 genera and plankton density @ 1667 ind. l^{-1} during the study in Mathura, Bhomra and Chandania wetlands respectively. *Microcystis* colonies containing 110-385 cells. colony^{-1} were observed in Mathura. The Gross Primary Production (GPP) rates ranged from 150 to 1000 mgCm^{-3}hr^{-1}. Community Respiration (CR) rates ranged from 0 to 812.5 (mgCm^{-3}hr^{-1}). CR also followed similar trend with GPP in all the wetlands which indicated higher rate of carbon assimilation during metabolic activities by phytoplankton cells. The estimation of Carlson's Trophic State Index (TSI) showed that the selected wetlands are oligotrophic to mesotrophic in nature.

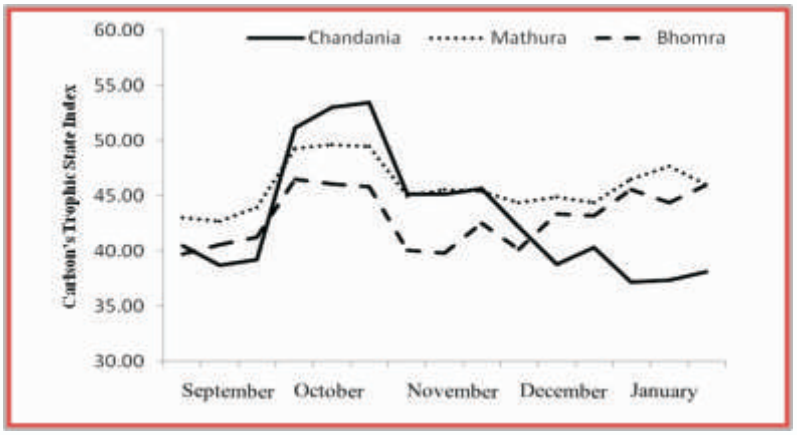


Fig. 114. Trends in TSI values of three wetlands in West Bengal

Vulnerability assessment of wetland fisheries to climate change

Fifteen years of fish production data (2000-2015) of Bhomra wetland, West Bengal when collated with downscaled climatic grid data of the area (1985-2015) and fish stocking data (1999-2014) which indicated that, if better management protocols are consistently maintained, fish production from the wetland may likely to increase in future without much detrimental impact by the local trends of changing climate (0.18°C rise in mean air temperature and 185 mm decrease in total rainfall). Results revealed a positive relationship between fish yield and stocking ($r= 0.589$, $p<0.05$), fish yield and mean air temperature ($r=+0.517$, $p<0.05$), while harvesting efficiency had an inverse relationship with rainfall ($r= -0.543$, $p<0.05$). Taking the relative importance of management intervention (stocking) and climatic factor (mean air temperature) on dictating fish production, it was found that climate (t^2 value= 0.001) have much lesser impact on fish production than management decisions like stocking (t^2 value= 2.397). Based on a recent SWOT analysis carried out through rapid survey of some floodplain wetlands in West Bengal, it has been observed that the open wetlands support richer fish diversity and bear more resilience in terms of diversity even under climatic variability. Fish diversity in closed wetlands on the other hand is more sensitive to changes in regional thermal-precipitation patterns manifested quickly through water stress.

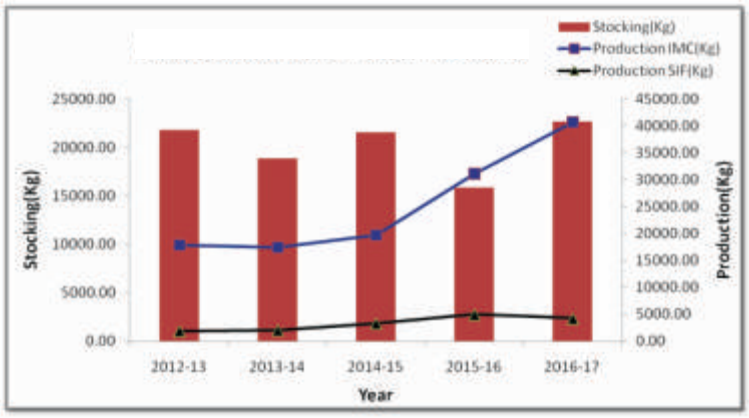


Fig.115. Fish production trend in Bhomra wetland

Geomorphologic vulnerability of floodplain wetlands

Preliminary efforts have been made to find the connection of climatic variability on shrinking of the wetlands. The average climatic variability scenario of the studied districts showed three general trends - (i) reduction in total annual rainfall; (ii) concentration of majority rainfall within monsoon proper with reduction in rainfall distribution during pre-monsoon and post-monsoon; (iii) warming climate.

Historical (1970-80s) eco-geomorphology data of selected wetlands from three districts of West Bengal (North 24 Parganas, Nadia and Murshidabad) were acquired from the toposheets. The historical dimensions of the selected wetlands have been compared in GIS software with their time series satellite images including the most recent satellite image (1984-2017). The percentage change in total water spread area have been quantified for some wetlands and collated with (a) CIFIRI's published historical data, and (b) real-time local fisher folk perceptions. Almost half of the surveyed wetlands till now (n=6) have demonstrated 15-40% reduction in water area of wetlands.

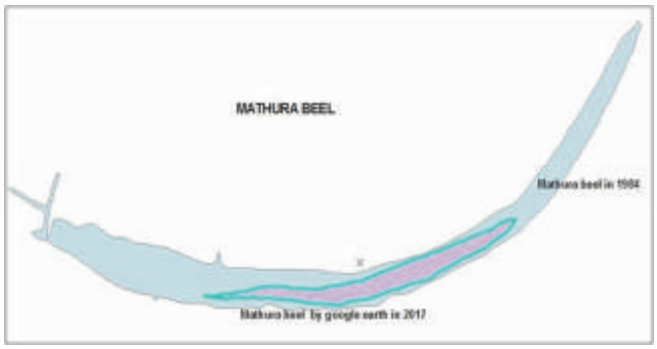


Fig. 116. Geomorphologic vulnerability of Mathura beel

Ecosystem vulnerability mapping of Gangetic floodplain wetlands of West Bengal

Trophic State Index (TSI) of floodplain wetlands in West Bengal was estimated based on secondary data (1985-2017) from 52 wetlands and it ranged between 29.76-51.77 units that cover oligotrophic to mildly-eutrophic. Out of 52 wetlands mapped, majority (~75%) of the wetlands in West Bengal found to be under 'mesotrophic' category (40-50 units TSI). Inter-annual variability of trophic state index values among wetlands of West Bengal seemed to be significant ($p<0.01$). Both linear and non linear trends of TSI have revealed that the wetlands in West Bengal are showing signs of progressive eutrophication : change over the last decade (2008-09 onwards) being more intense, as evident from the non-linear model.

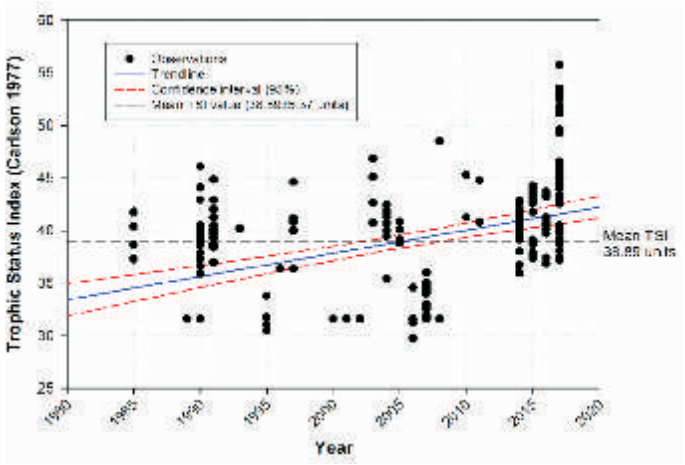


Fig. 117. Trends in TSI values of selected wetlands of West Bengal

Reproductive vulnerability assessment of *Puntius sophore*

Information on various aspects of reproductive traits of *P. sophore* from middle-lower stretches of River Ganga was generated for the first time in relation to climate change. Rainfall followed by water temperature found to be the key drivers regulating gonadal maturation and breeding. Availability of a threshold rainfall of >50 mm within a wide temperature range (20-30 °C) found to be necessary for threshold breeding GSI (>10.5 units) in the species. Fish seem to maintain requisite pre-spawning fitness

(1.61-1.67 units Fulton condition factor) both during low-mild rainfall (50-150 mm) and high rainfall (400-700 mm) conditions across a broad thermal window (15-35 °C) during which mere availability of breeding cues may induce successful spawning decisions.

Carbon sinking and trading capabilities of wetland fisheries

Experiments were being conducted to find out potential of primary Carbon (C) capture and ultimate C accumulation in the sediments of Bhomra, Mathura and sewage-fed East Kolkata wetlands (Jhagrasisa of West Bengal). The net primary productivity (NPP) of Jhagrasisa was much higher (312.5 $mgCm^{-3}hr^{-1}$) than that of Bhomra (181.25 $mgCm^{-3}hr^{-1}$) and Mathura beel (225 $mgCm^{-3}hr^{-1}$). Measurement of algal biomass indicated that the phytoplankton population was much more in Jhagrasisa than in Bhomra and Mathura beels. Aquatic macrophytes in wetlands also play a vital role in C accumulation since a substantial part of undecomposed carbonaceous material, most of macrophyte origin is deposited and accumulated in the sediments. In the wetlands being studied, Jhgarasisa has lowest (10%) macrophyte coverage, followed by Mathura beel (20%) and highest in Bhomra beel (40%). The C accumulation in 0-15cm layer in wetland sediments were estimated to be above 30.54 Mg C ha^{-1} (1Mg=1tonne) in Jhagrasisa, 40.09 Mg C ha^{-1} in Bhomra and 74.7Mg C ha^{-1} Mathura wetland.

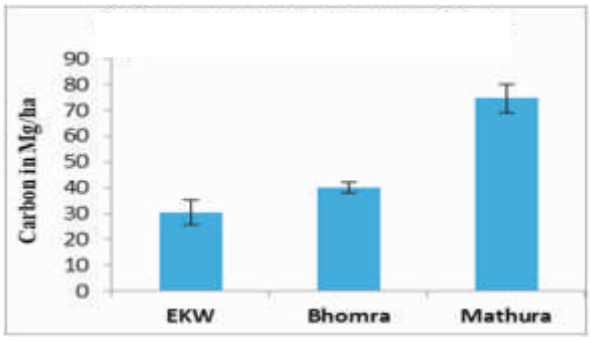


Fig. 118. Carbon accumulation in sediment of different wetlands

Farmers' sensitization workshop on climate resilient fisheries in wetlands

Under the project, Farmers sensitization workshop on "Climate resilient fisheries in wetlands" was organized and MoUs were signed with Fishermen's Co-operative Society Ltd. for demonstration of climate resilient adaptation strategies in Mathura and Bhomra beel in West Bengal, 47-Morakolong beel in Assam and Vembanad lake in Kerala.

Signing of MoU with KRFCS Ltd, West Bengal

Farmers sensitization workshop in Kerala

Project Title : Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan

Project Staff : B. K. Das, V R Suresh, R. K. Manna, R. S. Shrivastava, D.N Jha, Absar Alam, S. C. S. Das, J. Kumar, Manas H. M., Raju Baitha, T. N. Chanu, H. S. Swain, M. H. Ramteke, R. Naik, S. K. Paul, A. Roychowdhury, S. Mandal, L. Chakraborty, K. Shrivastava, S. Shrivastava, V. Kumar

Assessment of fish and fisheries of river Ganga

Quarterly field surveys were carried out at 18 selected stations of River Ganga for ecology and fisheries of the river.

Fig.119. Sampling sites in river Ganga

A total of 175 fish species belonging to 124 genera, 51 families and 19 orders.have been identified and recorded from upper stretch to lower estuarine stretch of River Ganga

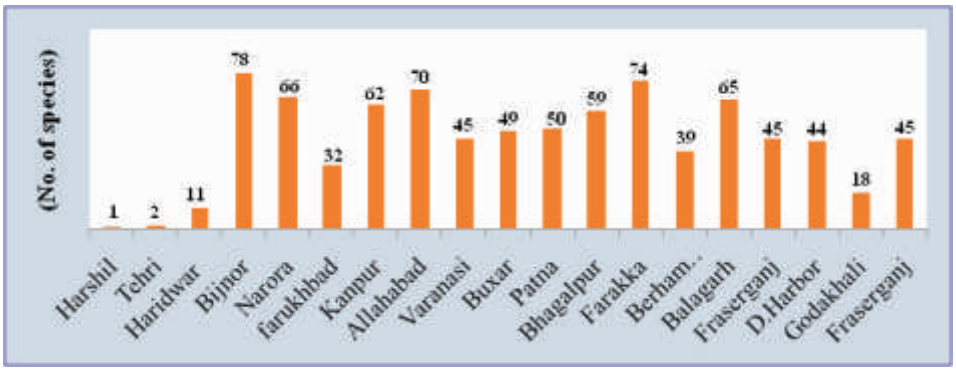


Fig. 120. Number of fish species recorded along the River Ganga

Exotic fish in river Ganga

Seven exotic fish species, namely, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Ctenopharyngodon idella*, *Cyprinus carpio*, *Clarias gariepinus*, *Salmo trutta fario* and *Oreochromis niloticus* were recorded.

Distribution of exotic fishes in different stretches of the river are given below

Exotics	Harsil	Tehri	Haridwar	Bijnor	Narora	Farrukhabad	Kanpur	Allahabad	Varanasi	Buxar	Bhagalpur	Farakka
Salmo trutta fario												
Cyprinus carpio												
Ctenopharyngodon idella												
Hypophthalmichthys nobilis												
Hypophthalmichthys molitrix												
Oreochromis niloticus												
Clarias gariepinus												

Indian Major Carp landings at Allahabad

The total Indian Major Carp (IMC) landings at Allahabad stretch of Ganga River system during April 2017 to March 2018 has been estimated to be 19.28 t. Among IMCs, *Cirrhinus mrigala* (40.45%) was recorded maximum, followed by *Catla catla* (29.5%), *Labeo rohita* (20.31%) and *Labeo calbasu* (9.74) (Table 25).

Table 25. Species-wise IMC landings at Allahabad

IMCs	Quantity (t)	% Contribution
Catla catla	5.69	29.5
Labeo rohita	3.92	20.31
Cirrhinus mrigala	7.81	40.45
Labeo calbasu	1.88	9.74

Dissolved oxygen status of river Ganga

Decreasing trend of dissolved oxygen (mg l^{-1})was observed from upstream to downstream of the river (Fig. 121). Significantly lower dissolved oxygen was recorded from estuarine stations of Diamond harbor and Fraserganj.

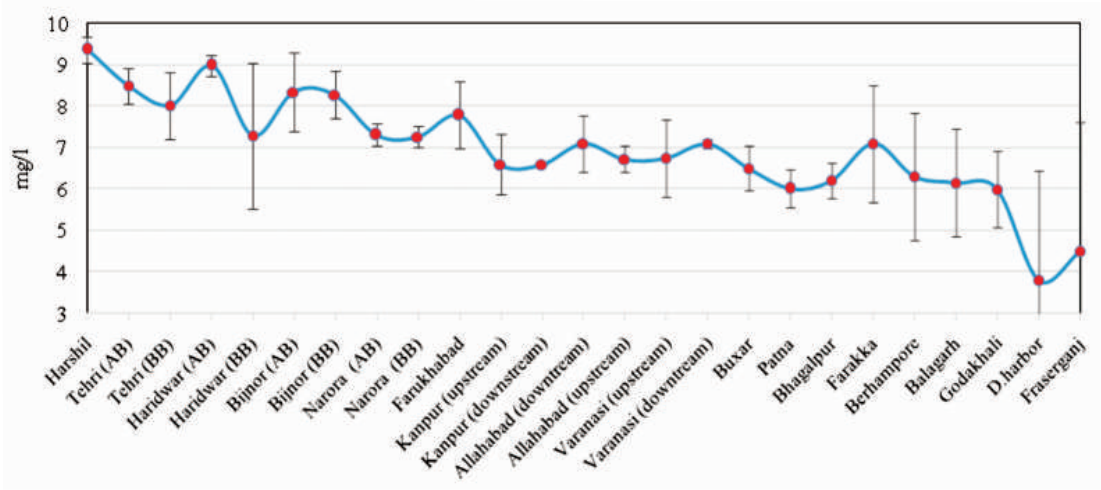


Fig. 121. Dissolved oxygen in water of river Ganga (AB: Above barrage; BB: Below barrage)

Water specific conductivity status of river Ganga

Varanasi stretch of River Ganga observed significantly higher specific conductivity as compared to nearby stations indicating high load of local anthropogenic pollutants. Attention is required for Varanasi stretch of river Ganga to improve its aquatic habitat.

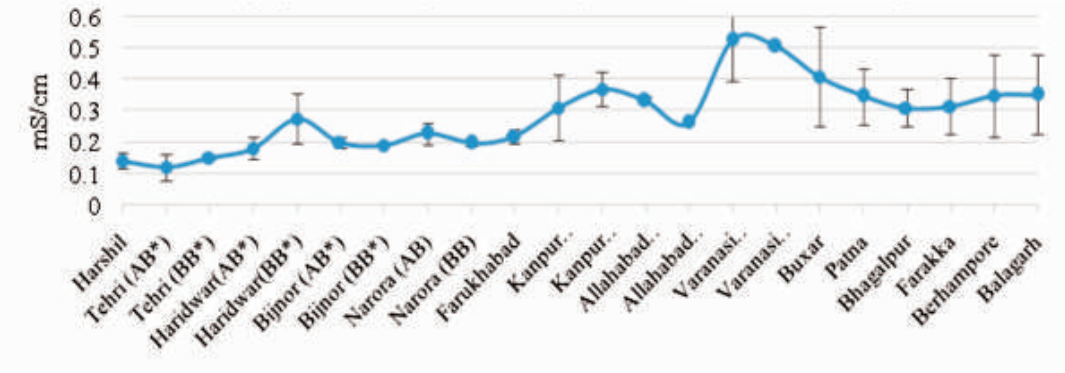
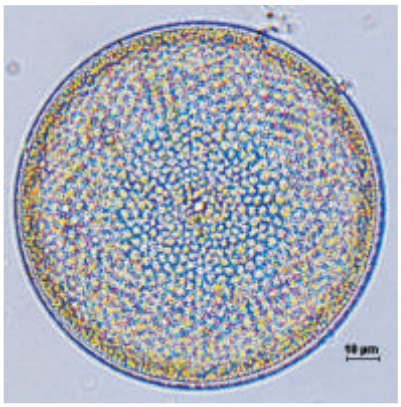


Fig. 122. Water specific conductivity of river Ganga (AB: Above barrage; BB: Below barrage)

Plankton and periphyton status in river Ganga

A total of 119 phytoplankton species and 20 zooplankton species were recorded from 18 sampling stations from Harshil to Fraserganj. Phytoplankton dominated over zooplankton. Highest value was found in Haridwar may be due to the partial lentic character of water above Bhimgoda Barrage.

Average periphyton abundance ranged from 313 cells cm^{-2} in Fraserganj to 11030 cells cm^{-2} in Allahabad. Highest abundance of periphyton in Allahabad might be due to sluggish nature of river or pollution load in that particular stretch. Highest average Myxophyceae population was observed in Kanpur (5735 cells cm^{-2}) which indicates this stretch may be maximally polluted compared to other stretches.



Coscinodiscus sp.

Concentration of metals in water and fish from River Ganga

In upper stretch up to Varanasi, maximum concentration of heavy metals like Zinc (0.24 mgl^{-1}) in water was recorded from Farukhabad followed by Tehri below barrage (0.141 mgl^{-1}) and Allahabad upstream (0.124 mgl^{-1}) respectively. Concentrations of copper was recorded to be maximum from Kanpur below barrage (0.037 mgl^{-1}) followed by Farukhabad (0.026 mgl^{-1}) and Allahabad downstream (0.017 mgl^{-1}). Heavy metal like Mn was observed to be highest at Farukhabad (0.103 mg/l) followed by Allahabad upstream (0.090 mgl^{-1}) and Allahabad downstream (0.076 mgl^{-1}). In lower stretch, the average concentrations of copper (0.045 mgl^{-1}), zinc (0.038 mgl^{-1}), lead (0.103 mgl^{-1}), cadmium (0.065 mgl^{-1}) and chromium (0.128 mgl^{-1}) were recorded to be maximum at Fraserganj (West Bengal). The average concentration of Mn (0.221 mgl^{-1}) was recorded highest from Diamond Harbour.

Fish species such as *Rita rita*, *Systomus sarana*, *Labeo calbasu*, *Mystus cavassius*, and *Odontamblyopus rubicundus* from river Ganga were analysed for possible contamination of heavy metals. In flesh *of R. rita*, Cu (0.18 mg kg^{-1}), Zn (2.178 mg kg^{-1}), Pb (5.439 mg kg^{-1}), Cr (0.676 mg kg^{-1}) are found and Mn, Cd are not found. In flesh of freshwater fish *M. cavassius* and brackish water fish *O. rubicundus*, Zn was found 55.42 mg kg^{-1} and 22.53 mg kg^{-1} respectively. No toxic heavy metals are found in the flesh of freshwater fish species like *P. sarana*, *E. vacha* and *L. calbasu.*

Fishing gears used in River Ganga and associated sustainability issues

As many as 5 varieties of drag net, 16 varieties of gill net, 1 type of set barrier net, 2 types of bag net, 8 types of traps and 27 different types of fish baits in hook & line have been recorded from river Ganga. Based on analysis of data, few immediate recommendations are (i) Control of destructive fishing gears like seine net, bag net, set barrier net, shooting net (targeting prawn juveniles) etc. especially during post breeding return journey of migratory species like hilsa (*Tenualosa ilisha*), (ii) Mesh size regulation of gill nets like hilsa net, drag net etc, (iii) Banning of zero mesh nylon net in all types of fishing gear, (iv) Scientific use of baits in case of hook & line fisheries to avoid non-targeted aquatic animal of river Ganga and (v) Implementation of ban period with provision of alternative livelihood of the fishers.

Zero mesh drag net, a highly destructive gear in river Ganga

Importance of wetlands in fisheries of river Ganga

An open and a closed wetland in Nabadwip, West Bengal in lower stretch of river Ganga were studied to understand the role of wetlands in fisheries of river Ganga. Higher dissolved oxygen and pH in open wetland indicated better environment; higher free CO_2 in closed wetland highlighted more detrital decomposition at bottom. A significantly higher fish species diversity (37 species) was found in open wetland in comparison to close wetland (8 species). This is mainly due to river connectivity with the wetland. Open wetland with its high biodiversity inhabits many riverine fishes like *Gudusia chapra*,*Nandus nandus*, IMC species, *Botia lohachata* etc. which migrate to the river to enrich riverine biodiversity.

Nandus nandus from River Ganga

Seed production (*in-situ*) of selected fish species for ranching in the depleted river stretches

Brooders of Indian Major Carps were collected from Nabadwip to Balagarh stretch of river Ganga for *in-situ* production of fish seeds to be used for ranching. Brooders of IMC (wild) having average weight of 0.3 to 3 kg have been collected and stocked in a pond at Balagarh in West Bengal. By adoption of Better Management Practice, the riverine brooders were matured in stocking pond by the month of July and breeding program was conducted on 18th July, 2017. About 12 lakhs eggs were produced with a fertilization rate of 98% and 10 lakh spawns were produced at a hatching rate of 85%. Produced IMC spawn were reared in a nursery pond at Balagarh up to advance fingerling sizes which are being used for ranching in different depleted stretches in river Ganga. Total nine ranching programs were conducted during the Year 2017-18.

Induced breeding of wild stock of IMC

Ranching vis-à-vis cleaning of river Ganga

Under NMCG project, out of six major species selected, *Cirrhinus mrigala* and *Labeo calbasu* mainly

feed on detrital organic matter. About 44% of the gut content of *L. calbasu* is detrital organic matter; whereas in case of *Cirrhinus mrigala* it is about 40%. Restoration of fishery of IMC, Mahseer and trout will significantly remove the detrital organic load from the river and thus helping in making a 'cleaner Ganga'. More than 2.03 lakhs IMC fish seed have already been ranched at different stretches of river Ganga during 2017-18.

Project Titile : Metagenomic profiling for assessing microbial biodiversity in river Ganga for ecosystem health monitoring

Project Staff: B. K. Behera, B. K. Das, P. K. Parida, D. Sarkar, R. Raman and A. K. Jana

Nine environmental sediment samples were collected from six different sites of river Ganga *viz.* Ganga Barrage (N 26^{0}30.858$^{//}$E 80^{0}19.114$^{//}$), Jajmau (N 26^{0}25.301$^{//}$E 80^{0}25.282$^{//}$), Jana Village (N 26^{0}24.495$^{//}$E 80^{0}26.904$^{//}$) near Kanpur, UttarPradesh, Farakka Barrage (N 24^{0}47.804$^{//}$E 87^{0}55.417$^{//}$), Dhulian (N 24^{0}47.804$^{//}$E 87^{0}55.417$^{//}$), Lalbagh (N 29^{0}11.087$^{//}$E 88^{0}16.079$^{//}$) near Farakka, West Bengal and three different sites of river Yamuna *viz.* Wazaribad (N 28^{0}42.39$^{//}$E 77^{0}13.57$^{//}$), Okhla barrage (N 28^{0}32.51$^{//}$E 77^{0}18.30$^{//}$), Faizupur Khaddar (N 28^{0}18.43$^{//}$E 77^{0}27.52$^{//}$) near New Delhi, India. Metagenomic sequencing were carried out for the nine river sediment samples. The metagenomes were analyzed for the identification of probiotic bacteria from these environmental samples. Several lactobacillus species have been identified, most of which showed a similar proportion in all nine locations, however *Lactobacillus casei* showed statistically significant differences with relatively higher proportion in Farakka stretches of river Ganga. *Bacillus subtilis* and *Bacillus mycoides* were found significantly in higher proportion at Kanpur stretch, however *Bacillus clausii* and *Bacillus coagulans* found significantly in higher proportion at Farakka stretch of river Ganga. The metagenomic data showed two species of *Vibrio* displayed differences in relative abundance between Kanpur and Farakka stretch of river Ganga and New Delhi stretch of river Yamuna. *Vibrio mediterranei* and *Vibrio fluvialis* have significant differences in occurrence between three stretches of two rivers and relatively lower proportion in Kanpur stretch compared to Farakka stretches. *Shewanella colwelliana* demonstrated a statistically significant quantitative difference among three locations and found higher proportion at Kanpur stretches. *Enterococcus faecium* found in higher proportion at New Delhi stretches of river Yamuna showed significant a quantitative difference among three locations. *Pediococcus acidilactici* was significantly higher at Kanpur stretch of river Ganga, however, *Pediococcus pentosaceus, Pediococcus ethanolidurans* have significantly more abundance at Farakka stretches of river Ganga and New Delhi stretches of river Yamuna.

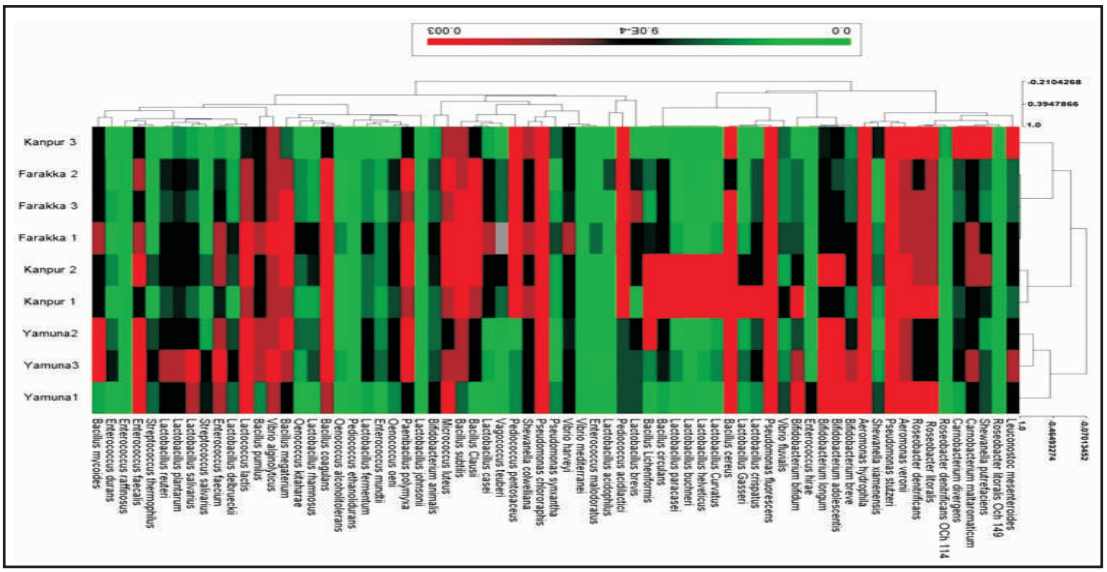


Fig. 123. Probiotic species label Heatmap analysis from nine different sediment metagenomes

Project Title : National surveillance program for aquatic animal diseases

Project Staff: B. K. Behera, B. K. Das, A. K. Sahoo, P. Das and B. K. Bhattacharya, P. K. Parida, T. Abdulla, S. Bhowmick and A. K. Jana

Identification of Tilapia Lake Virus (TiLV) in West Bengal

The Tilapia Lake Virus (TiLV) associated with mortalities of farmed Nile Tilapia, *Oreochromis niloticus* (Linnaeus 1758) in West Bengal was identified first time in India. Diseased fish exhibited lethargy, inappetance and skin erosions with> 85% mortality. TiLV infection was confirmed on the basis of PCR amplification and sequencing of segment 3 of TiLV, histopathology. In histopathology, typical syncytial giant cells in liver and congestion of the blood vessels along with haemorrhages in sections of brain tissue were observed. The disease was successfully reproduced in tilapia following injection of tissue homogenate filtered through 0.2µm and TiLV was successfully re-isolated from experimentally infected tilapia.

Discoloration of skin along with erosions and loss of scales in a moribund Tilapia.

Identification of *Klebsiella pneumoniae* in diseased *Labeo rohita* in West Bengal

Diseased fish samples having hemorrhages near the tail and peritonial region was collected from culture ponds of Burdwan, West Bengal for the isolation of the pathogenic bacteria. Primarily the bacterium was characterized using biochemical and antibiogram studies. The 16S rRNA gene sequence of the isolated bacteria revealed that the isolate was having 100% homology with *Klebsiella pneumoniae* (NCBI Accession Number- KY003130). Intraperitoneal injection with 1.05×10^6 CFU per fish causes 50%

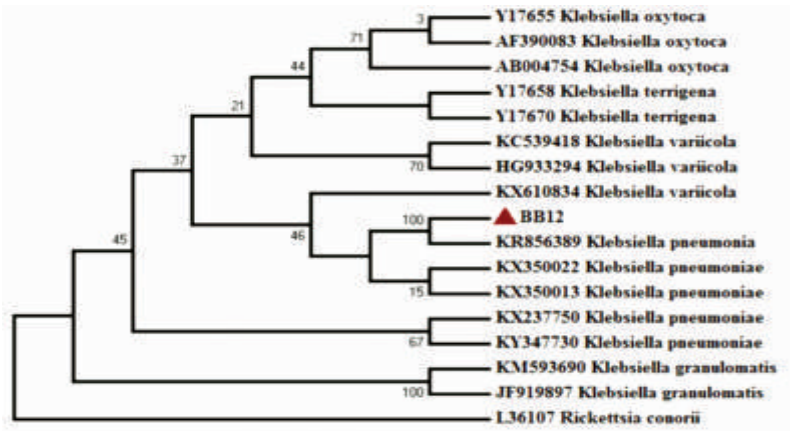


Fig. 124. Phylogenetic analysis of *Klebsiella* sp. based on 16S rRNA nucleotide sequences. Phylogenetic tree was generated using Maximum-likelihood method by the MEGA 6 software.The numbers next to the branches indicate percentage values for 10,000 bootstrap replicates. Bootstrap values are shown at the nodes. The isolate BB12 identified in this study are indicated by the shaded triangle.

mortality. The challenged fish showed hemorrhages in the intraperitonial region. The histopathology of the challenged fish liver showed vacuolation, necrosis and disruption of hepatocytes. However, focal necrosis and vacuolation was observed in kidney tissue. This study highlights the first time involvement of *Klebsiella pneumoniae* in the disease outbreak of cultured *Labeo rohita*.

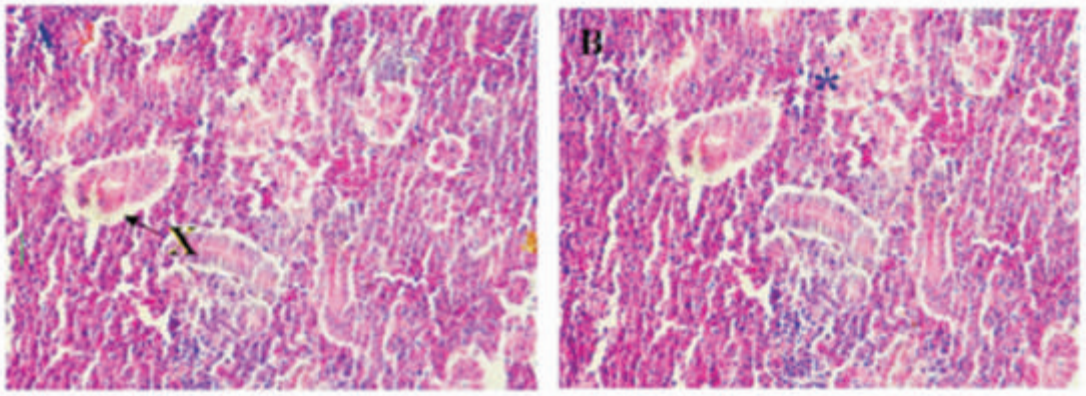


Fig.125. A–B. Photomicrograph of Kidney of BB12 challenged *Labeo rohita* showing [A]: Focal necrosis, ultrastuctural changes in the glomeruli and renal tubules (*) (H & E staining; 60×); [B]: vacuolation in kidney (X)(H & E staining; 60×).

Project Title : Development of standard protocols and molecular tools for fish food authentication for food safety and quality assurance

Project Staff: B.P. Mohanty and P. K. Parida

Formaldehyde (FA) is classified as a known human carcinogen. Because of this detrimental health effects, the application of FA in food products is prohibited worldwide. However, due to low cost and high bactericidal activity, it is being illegally applied to increase shelf life of food products like fish and milk. Therefore, it is necessary to develop easy detection methods for detection of formaldehyde adulteration in fish and fish products.

Endogenous formaldehyde content in commercially important Indian food fishes

In spite of the available reports on intentional application of FA in fish and fish products, it can also be present naturally (endogenous) in fish and fish products as a breakdown product of trimethyl amine N-oxide (TMAO). Therefore, information on the endogenous formaldehyde contents of food fishes are important. Endogenous formaldehyde contents were estimated in six important Indian food fishes *Tenualosa ilisha, Harpodon nehereus, Labeo rohita, Catla catla, Cirrhinus mrigala, Orechromis niloticus* using HPLC with UV-VIS detector. FA contents in all the fish species studied ranged between 1.10- 3.83 mg Kg^{-1} except *Harpodon nehereus*, which is well within the limit set by the Malaysian Food Regulation.

Development of CIFLIN - a Kit for detection of formaldehyde adulteration in fish

A Kit for detection of formaldehyde adulteration in fish (CIFLIN) has been developed. This kit can detect if formaldehyde has been used in preservation of fish or not. It requires about 0.1 g of tissue for the testing and the test is completed in 5 minutes. Field testing has been carried out in some of the markets of West Bengal, Odisha and Tripura. Demonstration of the kit has been provided to officials of the Department of fisheries, Govt. of Odisha.

Hand holding support provided to the state fisheries officials of Odisha to detect the formalin adulteration by using the kit "CIFLIN"

Field testing of the CIFLIN kit at Tripura

Project Title: All India network project on fish health

Project Staff : S.K. Manna, S.K. Nag, A.K. Bera, P. Panikkar, A. Ekka, D. Debnath and R. Baitha

Evaluation of safety of oxytetracycline in *Pangasianodon hypophthalmus*

Use of antibiotics in aquaculture sector is highly restricted and only a limited number of antibiotics are permitted for use in aquatic systems. Oxytetracycline is one of the permitted antibiotics for use in aquaculture. However, its safety in *P. hypophthalmus*, a widely cultured fish species in cage, is unknown. In this study, safety of oxytetracycline in *Pangasianodon hypophthalmus* has been evaluated. Following acclimatization, fishes were daily fed with oxytetracycline @ 80mg (1x), 240 mg (3x), 400 mg (5x) and 800 mg/kg b.w. (10x) for 10 days (10 days trial), 20 days (20 days trial), and 30 days (30 days trial), followed by 10 days post-drug observation in every case. All the experiments have shown no marked toxic effects in terms of fish behavior, mortality, gross and histological changes and clinical profiles. There were reduction in feed intake and changes in liver function in 3x-10x concentration; the changes were,

however, reversible after drug withdrawal. The study established safe nature of the antibiotic oxytetracycline in *P. hypophthalmus*.

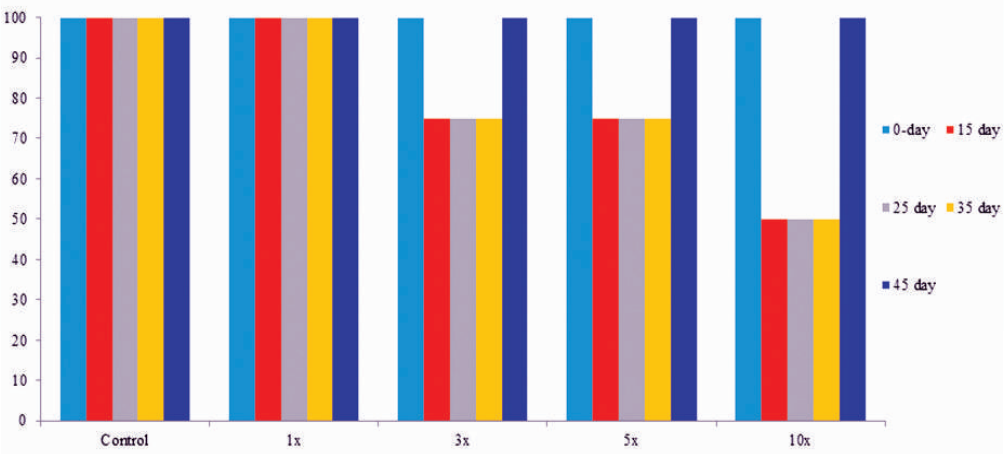


Fig.126. Feeding behavior score (%) of fish treated with oxytetracycline hydrochloride for 30 days

Study of drug use pattern in aquaculture systems of Assam

Information on usage pattern of drugs, chemicals, antibiotics etc. including their consumption pattern, in aquaculture system of Assam is not available. Hence, survey was conducted, through structured questionnaire, in 132 fish farms, spread over 10 districts, namely Dhubri, Borpeta, Nagaon, Cachar, Karimganj, Hailakandi, Kamrup, nalbari, Baksa and Darrong of Assam. The study has identified, among about 90 preparations available in market, a few commercial preparations such as Giolime, CIFAX, Clinar, Toximar, Sokrena, Decis, Endectin, Ammokil, Endokil, Metasil, Watrmin, Agrimin, Aquamix etc. that are commonly used in aquaculture sector of Assam. Average consumption of drugs and chemicals was low in Assam; use of antibiotic was not recorded.

Project Title : Wetland fisheries development projects in Bihar under CSS blue revolution

Project Staff: M. A. Hassan, Ganesh Chandra, Sandhya K.M., Suman Kumari, Mishal P., Lianthuamluaia, Gunjan karnatak, Raju Baitha, H. S. Swain

Implementation of package of practices for scientific fisheries development sponsored by National Fisheries Development Board (NFDB) in 4 ox-bow lakes (maun) of east Champaran District of Bihar in need based manner is under way. The four different projects sponsored are:

1. Fisheries development in Rulhi wetland of Bihar through stakeholders' participatory fisheries management model (Co-management) in a sustainable manner- An Innovative project
2. Fisheries development in Sirsa wetland of Bihar through *in-situ* fish seed rearing and fisheries enhancement techniques for tapping fish production potential - An Innovative project
3. Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholders participation for capacity building and improved livelihood – An Innovative project
4. Fisheries development in Majharia maun of Bihar through refinement of site specific fisheries enhancement technology- An Innovative project

Baseline survey on morpho-hydrographic, ecology, fisheries and socio-economic status of fishers

The selected 4 ox-bow lakes from East Champaran district of Bihar, namely Kararia, Sirsa, Rulhi and Majharia *mauns* were surveyed to generate basic information on socio-economic status of fishers, institutional arrangements and existing fisheries management practices. These *mauns* are presently under

the ownership of Department of Fisheries, Govt. of Bihar under the Bihar Jalkar Act 2006. These *mauns* are leased out to a fishermen cooperative society for a period of 7 years from 2012-13. A total of 640 fishermen households are dependent on these 4 wetlands for their livelihood. The survey revealed that around 10-40% of the total annual income of fisher's household comes from these wetlands. The monthly income from fisheries ranges between Rs 4000 in Rulhi *maun* to Rs 10000 in Kararia *maun*. Average family size of the household was 5 members. Most of the active fishermen belong to the age group of 22-45 years. The average literacy rate among fisher's community was around 45%, of which male members comprised 55% and female members was less than 40%.

Fish catch composition revealed these wetlands harbour rich diversity of indigenous self recruiting fish species that contributed approximately 15-23% of the total fish catch. Some of the indigenous commercially important species, specially catfishes, such as, *Wallago attu, Ompok pabda , Mystus tengra* and *M. bleekeri* were dominant in the catches.

The culture based fisheries is being practiced in these wetlands and the present fish yield from Majharia, Kararia, Sirsa and Rulhi Maun are 244-300 kg $ha^{-1}yr^{-1}$, 600-700 kg $ha^{-1}yr^{-1}$, 250-350 kg $ha^{-1}yr^{-1}$ and 75-110 kg $ha^{-1}yr^{-1}$ respectively.

Table.26. Basic features of wetlands with their coordinates, present yield and beneficiaries

Wetland	GPS Co-ordinates	Area (ha)	Depth (m)	Present yield (kg $ha^{-1}yr^{-1}$)	Fishers (no.)
Majharia	N26°33'23.8" E 84°56'01.6"	120	2-7	244-300	240
Kararia	N26°37'05.4" E 84°55'57.8"	120	2.5-5	600-700	120
Sirsa	N26°36'29.8" E84°59'38.9"	70	3.2-8.5	250-350	125
Rulhi	N26°35'42.8" E84°57'07.9"	80	1.5-6.5	75-110	150

Stakeholders meet and orientation of fishers

All the stakeholders including scientists from ICAR-CIFRI, Executives of funding agency, Chief of Line Department and Fishers of all wetlands met, discussed and finalised the action programme for each wetland. The priorities identified were macrophyte clearance, training of fishers on culture based fishery and enclosure culture, installation of cage and pens in wetlands and stocking of fish seeds. The stakeholder meeting was held to orient fishers towards principles of scientific fisheries management and garner benefit from the enhanced fish production as a partner in the co-management.

Stakeholders meetings at project sites

Installation of CIFRI-HDPE pen in progress

CIFRI-HDPE pen installed

Fabrication and installation of pens:

The pre-fabricated "CIFRI pen HDPE" were procured and installed in the marginal area of Sirsa, Kararia and Majaharia maun. The fishers actively participated in the activity and understood the advantages of the new pen material and ease of installation.

CIFRI GI cage in Sirsa maun

A haul of *P. hypophthalmus* in cages

Installation of cages:

The CIFRI GI Cages were installed in Sirsa, Rulhi and Majharia maun at a suitable site where water depth was more than 5 meter. The standard dimensions of cage frame remained unchanged while dimensions of hapa was suitably modified to suit wetland ecosystem.

Implementation of fisheries eanhancement programme:

Based on the need of the each wetland, species enhancement and stoking enhancement activities were

implemented following standard norms. Selection of species and their stocking was based on the ecosystem characterstics. Stocking enhancement activity with advanced fingerlings (Weight:25-50g ; Length: 12- 230cm) was undertaken in a staggerd manner at a time interval of 50-60 days. So far 50% of the stocking need has been met and rest will follow as per norms.

Seed conditioning in progress for stocking in maun

Training

A 3 day off campus training programme on "*Sahbhagita ke madhyam se adrabhoomi matsy palan vikas par Bihar ke matsysjeevyon ke liye prashikchan karykram*" was organized during 6-8 October, 2017 at KVK, Piprakothi, Motihari (Rajendra Kendriya Krishi Vishvavidyalay, Samastipur), Bihar for fishers of Majharia and Sirsa maun of East Champaran district. Dr. B. K. Das, the Director, ICAR-CIFRI inaugurated the training in presence of dignitaries like District Fisheries Officer, Motihari and Mukhiya (Gram Pradhan), Vir Chapra, Piprakothi. The valedictory session was chaired by Honourable Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh, and the Director, ICAR-CIFRI, Barrackpore welcomed honourable minister and briefed him about the NFDB sponsored project and training programme. He emphasized that this training programme in four wetlands namely Kararia, Rulhi, Majharia and Sirsa will help understanding of technologoical interventions for enhancing fish productions and increasing their income through implementation of project programmes in these natural water bodies.

Hon'ble Agricultre Minister distributing certificates to successful trainee fishers

A section of trainee fishers

Shri Radha Mohan Singh, Honourable Union Minister of Agriculture and Farmers Welfare, Government of India in his speech said that a large number of fishers livelihood depends on the fisheries in 4 lakh hectare wetlands in eastern and north eastern part of India. This project for development of four selected wetlands of East Champaran district of Bihar under central sector scheme on Blue revolution will double the production of these wetlands and help in doubling the income of wetland fishers. Six hundred and fifty fishers family will be benefitted from this project. He said that under this project, cage culture, pen culture will be installed and advanced fingerlings will be produced at the maun site for stocking in the maun. The 78 fishers of Majharia and Sirsa maun participated in the training programme and got hands on training on different aspects of wetland fisheries management and development and participation certificates to the participating trainees were distributed by Honourable Minister.

Project Title : Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)

Project Staff : V. R. Suresh, B. K. Behera, R. K. Manna, Sajina A. M. and Sandhya K. M.

The project aimed to unravel the dynamics of natural populations of hilsa, its ecology, biology, stock characters, genetic structure, physiology, reproduction and artificial propagation as well as culture along with feed development and attempts to chemo attractants. Achievement of the project, besides adding to the scientific knowledge about the fish, would help develop technologies for aquaculture along with identification of genetic stocks and conservation of natural stocks. The project has been concluded on 30 November 2017.

Lead Center : ICAR-Central Inland Fisheries Research Institute

Project partners : ICAR-Central Institute of Fisheries Education, ICAR-Central Institute of Brackish water Aquaculture, ICAR-Central Institute of Freshwater Aquaculture, ICAR-Central Marine Fisheries Research Institute, ICAR-National Bureau of Fish Genetic Resources, Visva-Bharati University

Objectives:

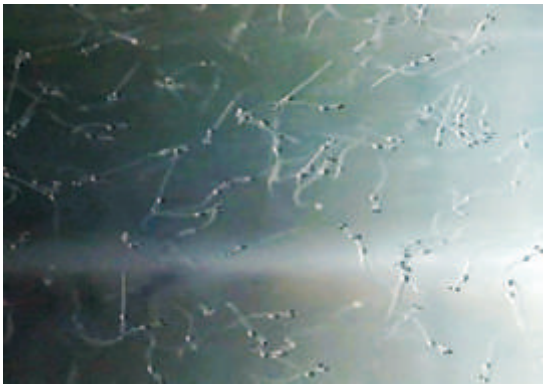
1. Assessment of natural stock of hilsa and their habitat preference, biology and biochemical composition in different ecosystems.
2. To develop knowledge base on genome-wide variation and population structure of hilsa to support aquaculture and natural stock management.
3. Evaluation of osmoregulatory and endocrine changes of hilsa in relation to ionic homeostasis and gonad maturation.
4. Development and standardization of captive breeding, seed production and culture systems
5. Development of feed and augmentation of homing through chemo-attractants.

The first objective was addressed by CIFRI, Barrackpore, the second objective was taken care of by NBFGR, Lucknow. The third objective was addressed by the Kolkata Centre of CIFE. The forth objective was addressed collectively by all the institutes in the respective areas of expertise with lead role by CIFA, CIBA and CMFRI involving development of culture technologies; captive breeding and seed production. The fifth objective was taken care of by CIBA for feed development and Visva-Bharati University for describing sensory mechanisms and developing chemo attractants.

Major achievements and outputs

- Database on feeding and breeding biology, which has been used in live feed production, collection of natural brooders, captive breeding and pond culture trials.
- Major breeding grounds of the fish along Hooghly estuary identified.
- Database on critical habitat parameters influencing hilsa, which have been used for culture pond management in experimental trials.
- Maximum sustainable Yield levels; Spawning Stock Biomass, Fishable limits estimated and recommended. MSY estimated at 32152 t and the catch has to be limited at this level for sustaining fisheries. The mean annual, catch is 35428 t, which exceeds MSY. Of this, 22395 t constitute SSB (23.66%). SSB to be maintained at least at 30%.
- Fishing gear (gill net) advisory and time series forecasting model developed for catch management.
- Based on the data generated, formulated recommendations for sustainable fisheries and natural stock management/ conservation of hilsa.
- Protocol for examining ion-transporters, Na^+/K^+-ATPase (NKA) and $Na^+/K^+/2Cl^-$ cotransporter (NKCC) proteins along with NKA enzyme activity as markers.
- Immuno-histochemical evidence generated on the role of NKA/NKCC-ir cells for osmoregulatory acclimation.
- Protocol for monitoring cellular changes in kidney as physiological indicator of fish acclimation under various salinities.
- Histological evidence of gonad growth and maturation generated for monitoring reproductive activity.
- Protocol for sex steroid estimation for monitoring and intervening in captive maturation.
- Method of confirming seaward migration and size range of fish performing such migration.
- Data base on gonad maturation for freshwater and brackish water culture systems.
- Data base on stock structure of natural populations of hilsa with evidence for different stocks in freshwater and marine environment.
- Established distinct genetic divergence in hilsa of Hooghly from that of Brahmaputra and Padma and existence of four distinct genetic stocks in the marine sector viz 1. (Digha, Kirtunia, Dhuleshwaram, Yanam, Kakinada) 2. Chudamani, 3. Badrak, 4. Vella estuary established.
- 6098 genetic sequences generated for five mitochondrial regions; 1011 genomic DNA isolated.
- Generated five mitochondrial DNA markers, 67 microsatellite markers and 653 COI as barcode markers.
- Genotyped 1021 individuals with 41 Polymorphic SSRs, generating 41861 genotypes.
- Modified existing method for artificial fecundation of natural brooders and production of fertilized eggs, which resulted in achieving 95% fertilization and 98% hatching compared to the earlier method where the rates were less than 50%.

- Achieved 90% larval survival up to 5th day of hatching; 60% survival achieved for 5 day old spawn (5mm/ 0.0005g) to fry stage (30 mm/ 0.27g) in 45 days and 70% survival of fry to fingerlings (110 mm/12 g) in 120 days achieved. Prior to this project, the survival reported was up to 15 to 30 days in most cases with 1 to 2% survival.
- A prototype hatchery design developed and tested, however it needs standardization and modification for better operation.
- Method for short term preservation of milt and long term cryopreservation protocol optimized.
- Developed data base on natural food items of the fish for different life history stages and standardized mass culture systems for important live feeds (Chlorella, Rotifers, Moina, Daphnia, Copepods).
- Indoor and outdoor mass live feed culture facility established.
- Data base on proximate composition, amino acid, fatty acid, vitamin and mineral composition of different size groups of hilsa collected from different ecosystems.
- Database on nutrient (Protein, lipid and amino acid) requirement and feeding behavior of hilsa fry established.
- Data base on digestive enzymes of hilsa and their concentration in gut and time of their first appearance.
- Micro particulate floating and slow sinking extruded feed 'Hilsa ^{plus}' *containing* 35% protein and 12 % lipid developed using twin screw extruder.



- Weaning method for artificial feeding of fry and above stages of the fish developed.
- Sensory cells on snout skin, olfactory cells, upper lip and tongue identified; their ultrastructure investigated and through immunohistochemistry confirmed localization of G-proteins related to odour reception on snout region.
- Molecular signaling in relation to microenvironment of hilsa established.
- First ever database of fish on epidermal cells exhibiting chemosensory transduction (Ectopic olfactory in nature).
- Database on response of sensory cells against pH, salinity, turbidity and poly amines.
- Information on odour receptor (OR) G-proteins and G-protein subunits have been generated.
- Chemo attractants prepared and tested for efficacy and found to be effective in pond reared hilsa.
- Table size hilsa produced through freshwater and brackish water pond culture. Management practice for grow out rearing with 20% survival in freshwater and 30% survival in brackish water ponds developed.
- Hilsa seeds (81.11 ± 1.88 mm/ 5.4 ± 0.4 g) stocked @ 20000 nos/ha in freshwater pond (0.1 ha area, 1.9 m depth) grew to 278 mm / 191 g in 26 months with 20% survival. Hilsa seeds (52.97±5.50 mm/1.37±0.18 g) stocked @ 8800 nos./ha in brackish water ponds grew to 360g/ 330 mm in 21 months with 30% overall survival. This has not been possible until this project and possibility of culture in freshwater and brackish water ponds successfully demonstrated. However, require further studies and standardization for faster growth and still higher survival for commercial viability.

- Under pond culture in brackish water, males reached milting stage in 1.5 years and females developed mature oocytes (Stage V) in 2 years (October-November and January- February). While in freshwater ponds the ovary grew up to stage IV, males started milting within the same period. However, the oocyte stages did not reach beyond this stage, which needs further trials for achieving brood stock maturation and consequent breeding of captive stocks.

- Cage design and structure developed for holding hilsa in still water. An average survival of 30% was achieved in grow-out culture with females reaching 222 mm total length in one year with development of oocytes. However, holding hilsa in cages in the highly fluvial environment of river Hooghly estuary was difficult and require design and size modifications through more trials.

Project Title : Ntional Agriculture innovation fund (NAIF) Component 1 (ITMU) of 2017-18

Project Staff : Ganesh Chandra (In-Charge ITMU)

Intellectual property generation:

Trademark: One Trademark application was filed for CIFRI "CAGEGROW" fish feed by application no.3625921 to Indian Patent office, Kolkata on 20-11-2017.

Registration of Designs: Two certificates of registration of Design awarded by the Patent Office, Government of India, Kolkata

1. Cage culture structure for fish production in the name of "Indian Council of Agriculture Research" on 1/1/2018 by Certificate number : 60962

2. Tissue Embedding Machine in the name of "Indian Council of Agriculture Research" on 10/1/2018 by Certificate number : 61327

Commercialization of Technologies:

Two ICAR-CIFRI technologies, namely, CIFRI Pen HDPE and CIFRI CAGEGROW fish feed was commercialized in the year 2017-18. The institute got one time development fee of ` 7 lakh and ` 6 lakh respectively from non-exclusive license of manufacturing of these two technologies. The Memorandum of Understanding was signed between ICAR-CIFRI and the licensee M/s M. R. Aquatech, Bhubaneshwar on 17th March 2018.


ORIGINAL

No. 61327

GOVERNMENT OF INDIA

THE PATENT OFFICE

CERTIFICATE OF REGISTRATION OF DESIGN


ORIGINAL

GOVERNMENT OF INDIA

THE PATENT OFFICE

CERTIFICATE OF REGISTRATION OF DESIGN

Consultancy Projects

Project Title : Investigation on present status of fish diversity with special focus on carps and small indigenous fish species in Ansupa Lake, Odisha

Project Staff : B. K. Das, A. K. Sahoo, Lianthuamluaia, R. K. Raman, Sanjay Bhowmick, Sucheta Majumder.

Funding Source: Chilika Development Authority, Odisha

Ansupa Lake is situated on the left bank of the Mahanadi River, Odisha. Geographically, it is in 20.26'28.43"to 28.28'34.44"latitude and 85.35'56.74"to 85.36'30.01"longitude. Due to the rich fauna and floral diversity, the wetland is famous for ecotourism. About 240 families are depending on the resources including fisheries and aquatic macrophytes for their livelihood.

In the present investigation, a total of 26 fish species belonging to 20 genera under 12 families and 4 orders were documented during the study period, March to July, 2017. The order Cypriniformes contributed the highest number of species (13 species) followed by the order Perciformes (10), Siluriformes (2) and Synbranchiformes (1). All the species observed were native to Mahanadi river. The fish community in Ansupa wetland was dominated by Small Indigenous Fishes (SIF) in terms of numerical abundance. A total of 15 SIFs were observed during the present investigation, which were contributing about 95 % of the total fish population in terms of numerical abundance. The most dominant SIFs were *Rasbora daniconius*, *Trichogaster faciata* and *Puntius sophore*. The Simpson's index (dominance), Pielou's evenness index and Shannon diversity index indicated for the need to improve and conserve the fish diversity in Ansupa lake. The IUCN conservation status indicated that two species *Ompok bimaculatus* and *Parambasis lala* were in the category of Near Threatened (NT), but most of the species were in the category of Least concern (LC). During the study period, it was observed that the maximum average daily catch of carps was recorded in the month of May (37.48±19.91 kg). The major reasons for depletion of fish catch and fish diversity in Ansupa lake were macrophytes infestation and poor fisheries management including habitat restoration, species enhancement through seed stocking etc. From the present investigation, important management options such as weed clearance, proper seed stocking, habitat protection, enclosure culture, human resource management and co-management were highlighted for improving the fish diversity and fish production in Ansupa lake.

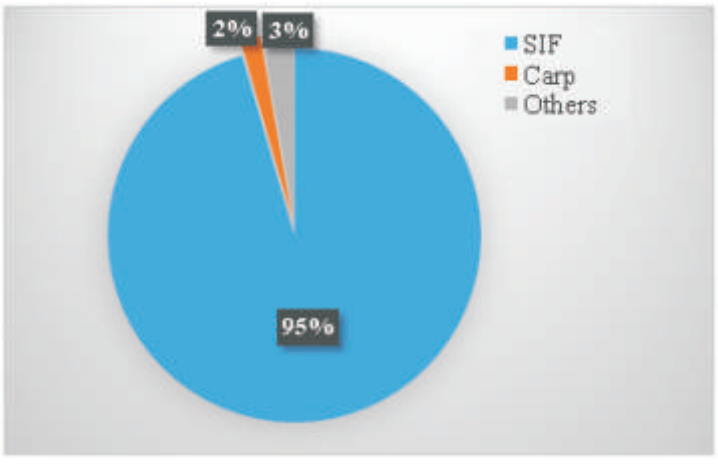


Fig.127. Group-wise numerical abundance of fish in Ansupa wetland

Fig.128. Average daily catch of carp during study period in Ansupa lake

Project Title : Exploratory survey on Hilsa (*Tenualosa ilisha*) catch and life stages availability along up / down stream of Farakka Barrage

Project Staff : B. K. Das, A. K. Sahoo, C. M Roshith, A. R. Chowdhury, D. Saha and D. K. De.

Funding Source: NMCG, Ministry of Water Resources, River Development & Ganga Rejuvenation

An exploratory survey on hilsa, *Tenualosa ilisha* catch and life stages availability in the vicinity of up and down streams of the Farakka barrage and feeder canal was carried out under National Mission for Clean Ganga (NMCG) project during March to June 2017. The estimated total catch of hilsa from the down-stream of Farakka and feeder canal was recorded to be 1,315 kg and 736 kg respectively, and the total being 2,078 kg during March to June 2017. While, hilsa catch in the upper stretches and navigational channel is majorly represented by juveniles, which was negligible in quantity. The reduced catch of hilsa in both down-stream and feeder canal was recorded during the period as compared to earlier years and could be attributed to the stray migratory run of the species.

The length frequency distribution of hilsa in the downstream and feeder canal indicated the presence of distinct size groups contributing to the respective fishery during each month. It was observed that in the downstream of barrage, fishes belonging to size range between 190 mm and 260 mm (1+ year age) and 261 mm and 345 mm (2+ year age) groups were found most dominant in the fishery during March to May (Fig. 129, 130). The contribution of 1+ and 2+ age groups varied from 47% to 62% and 18% to 46% in numbers respectively in the total fish population. While in the months of June the 2+ and 3+ (346 mm – 415 mm) age groups were found dominant contributing 45% and 27% in numbers respectively

Maturity of female hilsa was studied based on the samples belonging to length range from 179 mm to 450 mm during the period. Availability of very few female hilsa with developed gonads (high GSI values and higher range in size of ova diameter) clearly indicated stray breeding during post winter season. The attainment of fish maturity in downstream and feeder canal occurs at 227 mm (1+ year old) and 283 mm (2+ year old) respectively. The number of ova produced by a female from down-stream and feeder canal ranged from 52,032 to 3,35,828 and 87,670 to 6,60,560 respectively, and the number of ova increased with the age of the fish. At present, the recruitment of hilsa fishery is mostly dependant on smaller age groups due to absence of higher age group fishes in the population. Since the higher age groups are less found, the recruitment level of hilsa fishery has been drastically reduced. This is one of the major reasons of decline of hilsa fishery in and around Farakka barrage.

The survey observed availability of hilsa both in feeder canal and in downstream of Farakka barrage, and a small quantity of juvenile hilsa in the upstream of barrage. This indicates possible migration of hilsa

through the barrage or establishment of a native population in the upstream, which needs to be investigated. The same has been presented before Sushree Uma Bharati, Hon'ble Minister, Ministry of Water Resources, River Development and Ganga Rejuvenation.

Project Title : Study on assessment of efficacy of Fish Pass/ Fish Ladders in Teesta Low Dam III and

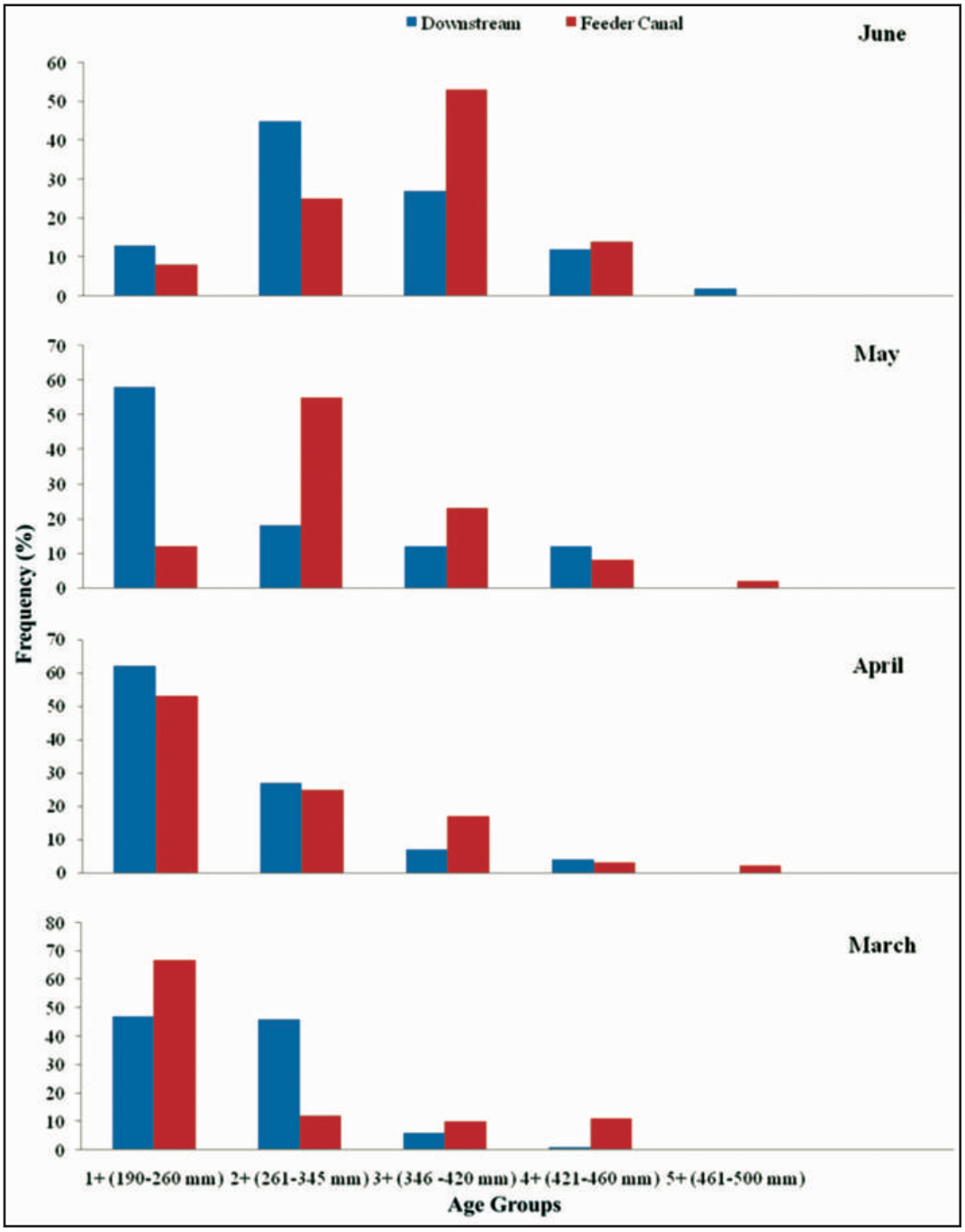


Fig.129. Hilsa, *Tenualosa ilisha* (450 gm) caught by gill net at Beniagram (Downstream of barrage)

Fig.130. Hilsa juveniles caught from Hosenpur (downstream of barrage)

Sushree Uma Bharati, Hon'ble Minister, Ministry of Water Resources, River Development and Ganga Rejuvenation; DG, NMCG and other senior officials of Central Water Commission (CWC) and Farakka Barrage Authority (FBA) at Farakka on 31st May 2017

IV Power Stations, West Bengal

Project Staff : B. K. Das, A. K. Sahoo, D.K. Meena, T. N. Chanu R.K. Raman, S. Prasad and A. R. Chowdhury

Funding Source: NHPC, New Delhi

An investigation on "Study on assessment of efficacy of Fish Pass/ Fish Ladders in Teesta Low Dam III and IV Power Stations, West Bengal" in river Teesta was carried out during the month of May 2017 representing pre-monsoon period and during October 2017 representing post–monsoon season with the following objectives: 1) to study the present migratory fish species and their period of migration in both upstream and downstream of the existing dams, 2) to study the efficacy of the exiting fish pass for these species during these periods through suitable methods. The entire river stretch of aprrox. 60km from Trevini to Teesta barrage was surveyed and five sampling sites representing free flowing stretch and reservoirs based on the fish species availability and Gauge and discharge (G/D) sites were selected. Major focus was given on the fish pass installed at TLDP III and TLDP IV. Standard methodologies were adopted to observe the fish species diversity and their migration across the fish pass.

During the study period, a total of 36 fish species belonging to 29 genera, 9 families and 6 orders were recorded in the entire stretch from Triveni to Barrage. Of the species recorded, fish belonging to family Cyprinidae dominated the catch composition contributing more than 60 % of total diversity in both the seasons. Seven fish species were recorded during pre-monsoon with dominance of *Barilius vagra*, *Garra* spp. in comparison to diversify in monsoon which is dominated by *Barilius vagra* among the total diversity of 35 fish species in all the catch. Migratory fish species such as *Schizothorax* sp. of size range 15±0.5 cm were caught by well designed gear, experimented at TLDP III during the month of October (Post-monsoon season), while no migratory fish was recorded at TLDP IV. The reproductive biology of this species indicated immature gonads. This clearly indicates that *Schizothorax* spp. is available in the reservoirs and in the down streams of the dam. The efficacy of fish pass was examined by fixing different nets/gears across the fish pass with different mode of operation like change in velocity through the fish pass, period of gate operation, and duration of net/gear operation. The result indicated that fish species such as *Schizothorax* sp., *Garra* sp. and *Neolissochilus hexagonolepis* are passing through the fish pass during operation. However, observation of these fish species across the fish ladder could be either due to accidental entry of fish during fish pass gate operation or finding fish pass as migratory path needs to be investigated through tagging experiment.

Fig.131. Conical shaped fishing net used in experimental fishing

Cast net operation at TLDP IV fish pass

Cast net operation in Teesta III reservoir

Fish species caught at TLDP IV

Project Title: Determination of environmental flow for non-lean and non-monsoon months in respect of Teesta Stage - IV HE Project, Sikkim

Project Staff : B. K. Das, A. K. Sahoo, H.S.Swain, P.K.Parida, S. Majumdar, and S. Prasad

Funding Source: NHPC, New Delhi

Environmental flow in the river Teesta at Teesta IV study stretch was estimated using the 10-daily flow values and considering the complex behavior i.e migration and feeding of the target fish, *Schizothorax* sp., its aquatic habitat, temporal variability of flow depth and velocity characterized by the irregular river cross-section. An integrated approach of both hydrological and hydraulic method viz. Flow-Duration Curve (FDC) method, Hydraulic rating method (MIKE11-HD) that solve the full dynamic wave equations using the de Saint Venant equations of continuity and momentum equations and the fish biology (adaptable water depth and velocity for its migration, spawning etc.) were adopted. It was estimated that a water release of 44.0 cumec during non-lean (Dec-Jan) period would support to maintain the river in Class B (Slightly Modified) category.

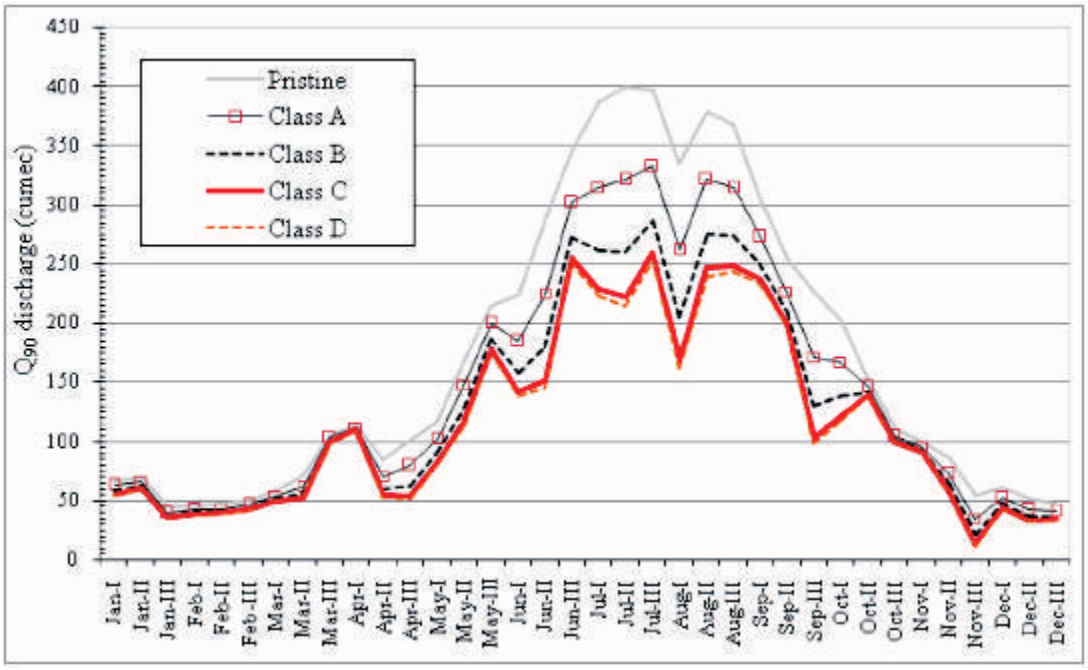


Fig. 132. Estimated E-flow at the Sanklang Gauge-Discharge site of the Teesta River using the FDC (Q90) analysis at 10-daily scale.

Project Title : Implementation of cage culture scheme in state reservoirs

Project Staff : B. K. Das, U. K. Sarkar, A. K. Das, P. Mishal, M. Ramteke, Tasso Tayung

Funding Agency: Department of Fisheries, Himachal Pradesh

ICAR-CIFRI was entrusted with the activities of cage culture for production of Pangas (*Pangasianodon hypophthalmus*) table fish in cages installed in Govindsagar reservoir near Bhakra Dam and Pong reservoir at Khatiyar through an MoU signed between ICAR-CIFRI and DoF, Himachal Pradesh (H.P.) a total of 48 nos. of cages (24 nos. in each site) were installed and stocked with fingerlings of Pangas in cages on 1 and 2 May, 2016 in G'sagr and Pong reservoirs respectively. During the production periods of six and a half months (May to mid Nov, 2016) the cage stocks at G'sagar reservoir were severely attacked with Ich and bacterial diseases which were overcome, while, the cage stocks of Pong showed moderate growth and survivality. A total of 46.711 t Pangas table fish was produced in 2016. Even though the project activities ended in Dec, 2016, ICAR-CIFRI was instrumental in conducting the developmental experiment for second year also i.e, in 2017 with the fund allocated to ICAR-CIFRI initially. In last week of April 2017, 3 lakhs advanced fry of Pangas were stocked in cages installed in Pong and G'sagar reservoirs. Because of low water temperature, prevailing even in end of April also, huge mortality took place, more in G'sagar than Pong. Even then, 45.816 t with 1.90 t/cage from Pong and 10.33 t with 0.43t/cage from G'sagar reservoir were harvested. It is worth mentioning here that the production target of Pong i.e, 48t is almost achieved, it would have been more had there been little higher water temperature during April-May. Study showed that Pangas production was shattered in G'sagar as this reservoir does not suit catfish because of low density of phytoplankton, low water alkalinity around 50 ppm, and disease problems due to low water level in most part of the year. Thus in two phases a total of 22.57 metric tonne Pangas table fish was produced in cages installed in Govindsagar reservoir during 2016 and 2017. So far a total of 102.857 metric tonne Pangas has been produced in cages in HP reservoirs by ICAR-CIFRI, during 2016 and 2017. So far, ? 73.82 lakh has been received by the Department of Fisheries, Himachal Pradesh as revenue by selling the produce of the cages.

Cage at Pong Reservoir

Cage at Govindsagar Reservoir

Pangas haul from cages

Project Title : Cage culture in reservoirs as collaborative programme between Department of fisheries, Telangana state and ICAR-CIFRI during 2018-2020

Project Staff : B. K. Das, U. K. Sarkar, A. K. Das, P. Mishal, Sajina A. M., M. Ramteke, Jesna P. K. and A. Saha

Funding Agency: Department of Fisheries, Telangana

A team of scientists in Dec. 2017 visited three reservoirs with senior state fisheries officials (Deputy Directors Dr. V. Srinivas and Dr. M. Krishna) and conducted a rapid survey for site selection of proposed cage battery installation in Singur reservoir (Medak District, Godavari River basin), Koilsagar reservoir (Mahabubnagar District, Krishna River Basin) and Lower Manair Dam (Karimnagar district, Godavari River basin). Telangana has reservoirs with an area of 1.91 lakh ha. The project aims to substantially increase fish production from inland open water resources of the state, provide employment opportunities and cater nutritional security to the rural population. Interactions with the associated fisheries stakeholders of the concerned reservoirs were held with successful sensitization of the fish farmers-fishermen regarding the benefits and principles of cage culture in reservoirs. Based on the discussions and SWOT analysis, two reservoirs were selected for the cage culture project, namely, Koilsagar reservoir (1035 ha, medium reservoir) and Lower Manair Dam (12,500 ha, large reservoir).

Accordingly, a two year MoU has been signed between ICAR-CIFRI and Govt. of Telangana for cage culture development in Telangana. ICAR-CIFRI will provide all sorts of technical inputs, advisories including the deployment of CIFRI model cages and diversified high value species mix for cage culture. The state fisheries department of Telangana will take care of the logistics and expenditure incurred. The cage aquaculture project in both the reservoirs will be jointly monitored by both the parties. This project is aimed to ensure sustainable reservoir fisheries development, culture fishery enhancement in inland waters and warrant livelihood-food security to the dependent stakeholders.

Signing MoU with DoF, Telangana

Survey of reservoirs for cage culture in Telangana

Species Description / New Records

First record of bull shark (*Carcharhinus leucas*) from the Mahanadi estuarine system

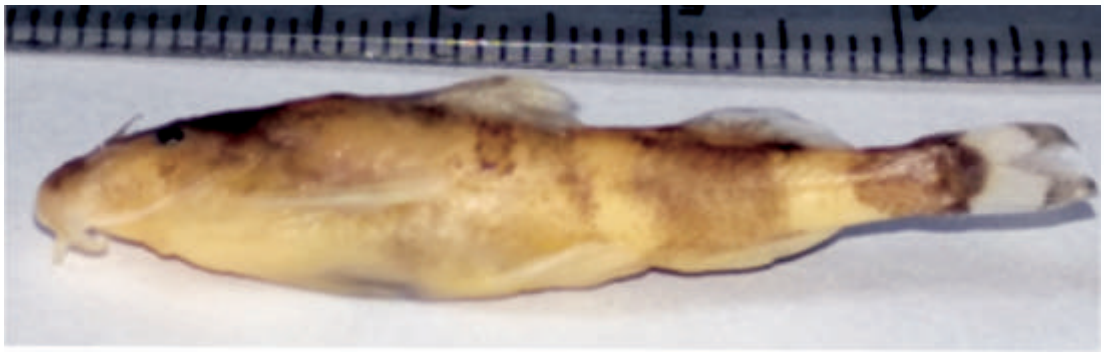
The bull shark, *Carcharhinus leucas* (Valenciennes, 1839) belonging to the order Carcharhiniformes, was recorded from the Devi estuary (a distributary of River Mahanadi) near Nuagarh area (20^0 01$^{'}$ 07.79? N; 86^{0}19' 54.28? E). The fish (total length of 840 mm) was captured in gill net operated in the estuary at about 12 km from the sea-mouth. It has been revealed from the previous literature that, among the elasmobranchs, only two species of rays (*Dasyatis zugei* and *Himantura walga*) were reported from the Mahanadi estuarine system earlier. The bull sharks are known for their ability to tolerate lowered salinity levels which makes them capable of ascending the estuaries and even freshwater reaches of rivers. These elusive sharks have been frequently recorded from the Chilika lagoon and are known to reside in deeper pools within the lagoon for more than 6 months. Our report is the first record of bull shark (*C. leucas*) from the Mahanadi estuarine system.

First record of white leg shrimp *Litopenaeus vannamei* from the Cauvery estuarine system

The occurrence of *L. vannamei* is reported for the first time from the wild along the lower estuary stretch of Cauvery river. The introduction of the species into the wild may have happened accidentally from the nearby aquaculture farms where culture of the species is carried out.

First record of *Pseudolaguvia foveolata* from Torsa River

New records of *Pseudolaguvia foveolata* are documented based on thirteen specimen for the Torsa River, Jaldapara, Alipurduar district, West Bengal, India; 26°43'44.66"N, 89°19'32.34"E, extending its distribution range in Brahmaputra drainage, India. The identity of the species has been confirmed by traditional and molecular taxonomy (COI: MF506828; Cytochrome b: MF506829; RAG2:MF506827). The species was earlier recorded from Teesta River only, which indicates its wider geographical distribution in Brahmaputra drainage



State-wise outreach of ICAR-CIFRI during 2017-18

State	Resource	Activities
Assam	River	• Investigation on habitat characterization, fisheries, estimation of environmental flow and socioeconomics of River Siang • Exploratory surveys were conducted in floodplain wetlands of Assam for ecological assessment in relation to climate change. • Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in 47-Morakolong beel in Assam • Arsenic contamination • Forecasting of Hilsa catch in River Brahmaputra
	Wetland	• Rearing of *Labeo bata* in CIFRI-GI Cages as a winter crop in Samaguri beel, Assam • Arsenic contamination
Arunachal Pradesh	River	• Investigation on habitat characterization, fisheries, environmental flow and socioeconomics of River Siang
Andaman & Nicobar Islands	Mud volcano	• Identification of bacterial diversity
Manipur	Wetland	• Evaluation of pen culture technology developed by ICAR-CIFRI
West Bengal	River	• Investigation on emerging contaminants in river Torsa and associated wetlands and their effect on selected biota • Nutrigenomic studies on hilsa from the rivers Hooghly and Padma • Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan • Breeding of wild fish germ plasm and ranching in depleted stretches of river Ganga • Assessment of efficacy of fish passes provided across Teesta Low Dam Stage III and IV power stations
	Canal	• Exploratory survey and study of Bishalakhi canal in Sagar Island and Bhetkimari canal in Madangunj in Sundarbans studied for fisheries development with local stake holders participation.
	Wetland	• Study of the emerging contaminants in East Kolkata Wetland and their effect on selected biota • Exploratory surveys in four floodplain wetlands for ecological assessment in relation to climate change. • Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in Mathura and Bhomra beels • Arsenic contamination in Khalsi and Chandania • Disease investigations in Khalsi, East Kolkata and Moyna wetlands
	Estuary	• Spatial characterization of commercial landings of Hilsa in Hooghly-Matlah
	Pond	• Arsenic contamination in 3 ponds of Nadia district
Bihar	River	• Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan
	Wetland	• Fisheries development in Kararia, Majharia, Rulhi and Sirsa wetlands of Motihari region through empowerment of communities and stake holders participation for improved livelihood opportunity and capacity building

State	Resource	Activities
Jharkhand	Reservoir	• Demonstration of Electronic Data Acquisition System (e-DAS) for fish catch data collection from reservoirs (at Patratu Dam site) • Evaluation of cage culture technology developed by ICAR-CIFRI • Efficacy of floating feed CIFRI-CAGEGROW was tested in a farmer's cage installed in Chandil reservoir. • Disease investigations in Patratu, Tenughat, Chandil and Getulsud reservoirs
UP	River	• Estimation of environmental flows in Rivers Tamas/Tons • Impact of major tributaries and wetlands on biodiversity and ecological function of river Ganga. • Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan • Breeding of wild fish germ plasm and ranching in depleted stretches of river Ganga • Study of fish landings at Allahabad
	Reservoir	• Assessment of ecological and fisheries status of Jargo reservoir
Odisha	River	• Assessment of pollution, water and sediment qualities and fisheries status in river Kathajodi • Estimation of environmental flows in river Kathajodi
	Reservoir	• Assessment of ecological and fisheries status and the trophic state index (TSI), fish production potential, and impact of fish seed stocking on yield were also assessed of Derjang, Salia, Kalo reservoirs • Evaluation of cage culture technology developed by ICAR-CIFRI • Technical guidance on cage culture in Salia dam • Tribal Sub plan activities including distribution of inputs. Trainings to the fishers in Kalo reservoir
	Wetland	• Fish diversity status in Ansupa lake
Madhya Pradesh	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Tapti
	Wetland	• Resource assessment and pen culture in Loni wetland situated in Rewa district, MP
Chhattisgarh	Reservoir	• Evaluation of cage culture technology developed by ICAR-CIFRI
Himachal Pradesh	Reservoir	• Demonstration of cage culture technologies in Pong and Govindsagar reservoirs
Punjab	Canal	• Exploratory survey of one canal in Srihind in Punjab for fisheries development for last one year
Gujarat	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Tapti
	Reservoir	• Cage culture activity in different reservoirs
Maharashtra	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	• Evaluation of cage culture technology developed by ICAR-CIFRI in Pench and Bor reservoirs • Disease investigations in Pench and Bor reservoirs
Telangana	Reservoir	• Collaborative cage culture programmes with DoF • Disease investigations in Sriramasagar reservoir

State	Resource	Activities
Tamil Nadu	Reservoir	• Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	River	• Assessment of ecological and fisheries status in Mettur reservoir, Krishnagiri. • Implementation of Electronic Data Acquisition System (e-DAS) for fish catch data acquisition
Karnataka	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	• Habitat characteristics and fish assemblage of Harangi reservoir • Study on Potential Fishery Zones in medium and large reservoirs using hydroacoustics in Krishnarajasagar (KRS) reservoir
	Wetland	• Exploratory surveys in wetlands of Karnataka for ecological assessment in relation to climate change
Kerala	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	• Assessment of ecological and fisheries status of Mangalam reservoir
	Wetland	• Study on impact of climate change in inland fisheries and development of adaptation strategies in Vemanand lake • Pen culture activities were initiated with the installation of three pens in Thycauttuserry and Muhamma in the Alleppy District • Exploratory surveys were conducted in coastal backwaters for ecological assessment in relation to climate change • Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in Vembanad lake

Commercialization of CIFRI Technologies
"CIFRI Cage Grow Feed"

Development of "CIFLIN Kit" for
formalin detection in fish flesh

New Initiatives

Commercialization of CIFRI Technologies
"CIFRI PEN HDPE"

- Breeding of wild fish germplasm (Indian Major Carps) of River Ganga and the produced fish seed was ranched in the depleted stretches of river through PFCS members under National Mission for Clean Ganga (NMCG).
- Exploratory survey of Hilsa (*Tenualosa ilisha*) catch and life stages availability along up/down stream of Farakka barrage
- Cage culture in reservoirs as collaborative programme between Department of Fisheries, Telangana state and ICAR-CIFRI during 2018-2020
- Policy recommendations developed from the FAO/ICAR-CIFRI workshop on "Fish passage design at cross-river obstacles-experience from different countries, with potential relevance to India" held during 29th Nov. to 01 Dec. 2017
- Fisheries development in Kararia, Rulhi, Majharia, Sirsa & Kotia wetland of Bihar (Motihari) through in-situ fish feed rearing and fisheries enhancement techniques for tapping fish production potential – an innovative project
- Dried fish matters: Mapping the social-economy of dried fish in South and South-east Asia for enhanced wellbeing and Nutrition.
- ICAR-CIFRI along with NOFIMA, Norway developed project on "Development of captive breeding and aquaculture of hilsa (*Tenualosa ilisha*) in West Bengal", India
- Up-scaling of eco-friendly pen aquaculture technology developed by ICAR-CIFRI for improved livelihoods, employment generation and enhanced income of wetland fishers in North-east India funded by National Mission on Himalayan Studies, MoEF.

Ranching-cum-awareness programmes for restoration of fish stock in River Ganga

The prized fishes of River Ganga like Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigel (*Cirrhinus mrigala*), Kalbasu (*Labeo calbasu*), commonly known as Indian Major Carp (IMC), have been declined sharply year after year. The population of mahseer is also dwindling. Thus, it is need of the hour to re-establish these highly demanding fishes of Ganga through river ranching and sensitizing the fishers. Several ranching cum awareness programmes were organized in several places of river Ganga under (National Mission for Clean Ganga), NMCG project to restore and conserve the depleting IMC fish stock of the river. The following table shows the ranching-cum-awareness programmes conducted under NMCG project during 2017-18.

Sl.	Date	Place of ranching –cum-awareness programme	No of seed ranched	Fish species
1	23.05.2017	Rishikesh, Uttarakhand	5,000	Mahseer
2	26.05.2017	Barrackpore, West Bengal	2,500	IMC (Catla, Rohu, Mrigal)
3	01.09.2017	Allahabad, Uttar Pradesh	3,000	IMC (Catla, Rohu, Mrigal)
4	03.11.2017	Balagarh, West Bengal	60,000	IMC (Rohu, Mrigal)
5	11.11.2017	Dasaswamedh Ghat, Varanasi, Uttar Pradesh	5,000	IMC (Catla, Rohu, Mrigal)
6	21.11.2017	Barrackpore, West Bengal	20,000	IMC (Rohu, Mrigal)
7	05.12.2017	Allahabad, Uttar Pradesh	7,500	IMC (Catla, Rohu, Mrigal)
8	21.0[illegible].2018	Nabadwip, West Bengal	50,000	IMC (Rohu, Mrigal)
9	15.03.2018	Barrackpore, West Bengal	50,000	IMC (Rohu, Mrigal)
10	27.3.2018	Fatehpur Ghat, Allahabad	20,000	IMC (Catla, Rohu, Mrigal)

Ranching program of IMC at Allahabad on 01 August 2017. The chief guest of program was Shri Jai Prakash Nishad, Minister of State, Animal Husbandry and Fishery, U.P.

Ranching programme of Mahseer seed in the Ganga river at Rishikesh near Lakshman Jhula on 23 May 2017

A total number of 2500 fingerlings of Rohu (*Labeo rohita*) and Catla (*Catla catla*) have been released by Hon'ble Minister, Sushri Uma Bharti ji in river Ganga at Barrackpore on 26 May 2017.

On 03 November 2017 around 60,000 seeds of Indian Major Carp was ranched at Milan Dwip, Balagarh, Dist-Hooghly, West Bengal

Ranching programme by the Allahabad centre of the Institute on 11 November 2017 at Dasaswamedh Ghat, Varanasi, Uttar Pradesh

On 21 Jan 2018 ranching of 50,000 seed of IMC was done at Nabadwip, West Bengal

On 21 Nov, 2017, 20,000 IMC seed has been released at Daspara Ghat, Barrackpore

Demonstration and Transfer of Technology

Demosntration on productive use of derelict water bodies at Sagar Island, Sundarbans

A demonstration was organized at Khansaheber Abad tribal village, Sagar Island with 100 villagers on 14 June 2017 to show tribal farmers the technical feasibility of converting derelict water bodies into productive resources under tribal sub plan (TSP) to support the livelihood of the tribal people, Sagar Island. A Fish harvest mela was organized where planners and policy makers graced the occasion. A public meeting was held after the mela which was presided over by Sri Bankim Chandra Hazra, MLA, Sagar Island. The chief guest pointed out that fish culture in derelict waters can be a source of alternative livelihood. The event was witnessed by Mrs. Anita Maity, Sabhpati, Sagar and Sri Pradip Baleswar, Karmadhaksya, Sagar Panchyat. Dr. B.K Das, Director, ICAR-CIFRI, Barrackpore congratulated the tribal people for accomplishment of such good production from the derelict water bodies.

Rearing of *Labeo bata* in CIFRI-GI Cages as a winter crop in Samaguri beel, Assam

A series of ICAR-CIFRI GI-cages (individual cage dimension of 5 x 5 x 2m^3) were installed in Samaguri beel, Nagaon district of Assam under the NEH component of the Institute. During the winter months, fish reared in enclosures were usually affected with diseases and had low survival in addition to low growth rates. In the present demonstration-cum-experiment *Labeo bata* was selected as it is hardy species and have high demand in local market. The cages were stocked with fingerlings at five stocking densities. Fishes were fed with pelleted feed containing 30.04% CP @ 5% body weight. Results from the present study indicated that the survival was high (ranging from 85.5-94.07%) during the rearing period. The growth performance parameters such as body weight, specific growth rate and weight gain percent was found to be significantly higher in the lowest stocking density group, followed by those stocked at 50 and 75 fingerlings m^{-3} and lowest in the highest stocking density group.

Field demonstration of Electronic Data Acquisition System (e-DAS) for fish catch data collection from Jharkhand reservoirs

ICAR-CIFRI has developed an Electronic Data Acquisition System (e-DAS) to capture fish catch data from reservoirs (through SMS from mobile phones) directly into a database in the computer system and successfully demonstrated in patratu reservoir on 06 Dec 2017. The programme was attended by around 25 fishers and State fisheries officials of Jharkhand state. The e-DAS application was installed in the mobile phones of key fishers identified from four major fishing villages and trained on recording and transmission of species wise fish catch on regular basis through e-DAS. Shri M. Karthikeyan, Dr. U.K. Sarkar and other staff from ICAR-CIFRI conducted the demonstration.

Formalin detection kit demonstrated

The consumption of formalin adulterated food can cause stomach pain, vomiting etc. Formalin is also a potential inducing chemical for cancer. So, formalin adulteration in fish is a serious issue and its detection is important. ICAR-CIFRI has developed a formalin detection kit "CIFLIN" to detect the formalin adulteration in fish. Dr. B. K. Das, Director, ICAR-CIFRI and Mr. J. B. Dash, Addl. Director, Directorate of Fisheries, Odisha inaugurated the hands-on demonstration on detection of formalin adulteration in fish for the state fisheries officials of Odisha at Directorate of Fisheries, Cuttack on 29 January 2018. Dr. B. P. Mohanty, Dr. P. K. Parida and Dr. A. Mahanty demonstrated the use of formalin detection kit of ICAR-CIFRI and also provided hand holding support to the state fisheries officials to detect the formalin adulteration by using the kit "CIFLIN". The formaldehyde detection kit was also demonstrated at National Conclave on Scientific Co-operations, FSSAI, New Delhi on 05 February 2018.

Demonstration of Climate Resilient Pen Systems (CRPS) in selected wetlands of India

The impact of climatic variability on wetland fisheries includes changes in habitat, aquatic biodiversity, fish yield, aquatic weed proliferation, dominance of exotic species etc. which has negatively impacted the livelihood of fishers. In this background, a novel programme was launched under NICRA project on developing model wetlands for increasing the adaptive capacity and livelihood security of fishers and restoration of indigenous fishes. In this connection, Climate Resilient Pen Systems (CRPS) for fish raising was demonstrated in Mathura and Bhomra beels of West Bengal, 47-Morakolong beel of Assam and in Vembanad lake of Kerala. The regionally important fish and shellfish species being evaluated in CRPS are *Amblypharyngodon mola*, *Labeo bata*, *Puntius sarana*, *Nandus*

nandus, Ompok pabda, Gudusia chapra, Catla catla, Labeo rohita, Cirrhinus mrigala, Etroplus suratensis, Macrobrachium rosenbergii and Villorita cyprinoides. Under the project, MoUs were also signed with Fishermen's Co-operative Society Ltd. for demonstration of climate resilient adaptation strategies in selected beels. CRPS shall open a new avenue for conservation based rearing and ranching of SIFs within the same wetland, which may be viewed as an '*insurance'* for both wetland fishers and SIFs facing adversities of climatic variability.

Awards and Recognitions

- During the 29th All India Congress of Zoology (AICZ) many ICAR-CIFRI staff were honoured with awards for their outstanding contribution in inland fisheries and allied Sciences. Dr. B. K. Das, Director was conferred with the Eminent Zoologist Award by the Zoological Society of India (ZSI), Bodhgaya. Dr. B. P. Mohanty and Dr. M. A. Hassan were conferred with the Fellowship of Inland Fisheries Society of India (FIFSI) and Zoological Society of India (FZSI), respectively. Dr. B. K. Behera and Dr. A. K. Das got Dr. B S Chauhan Gold Medal and Prof. Har Swarup award, respectively. Dr. A. K. Sahoo and Dr. P. K. Parida were conferred with the Congress of Zoology medal in the field of Fish and Fisheries 2017 while Drs. R. K. Raman, Kavita Kumari bagged Young Scientist and Dr. S. Samanta, D. K. Meena bagged Sr. Scientist medals.

Dr. B. P. Mohanty

Dr. M. A. Hassan

Dr. A. K. Das

Dr. B. K. Behera

Dr. A. K. Sahoo

Dr. P. Parida

Dr. R. K. Manna

- Best Poster Award in the 29th AICZ:
  - T. Mitra, A. Mahanty, S Ganguly, L. R. Mahaver, S. K. Paul, and Dr. B. P. Mohanty for the poster 'Next generation sequence analysis of pollution stress responsive transcriptome of gill tissues of *Rita rita*'
  - A. K. Rout, B. Dehury, J. Maharana, C. Nayak,V. S. Baisvar, A. K. Jana, B. K. Behera and Dr. B. K. Das for the poster 'Molecular dynamic simulation, principal component analysis and binding free energy calculation in probing the ATP binding mechanism in Zebra fish Cyclin-depentent Protein Kinase like 1 (zCDKL1)'.

- Dr. R. K. Manna, A. K. Das, S. Samanta, S. C. S. Das, A. Alam, B. K. Singh, K. D. Joshi, R. K. Raman, M. Naskar, U. Bhaumik and A. P. Sharma bagged the Best oral presentation award for their paper 'Time scale changes of water parameters of river Ganga in relation to fisheries' in the 29th AICZ.

- Dr. B. K. Bhattacharjya served as an Expert member of Assam State Biodiversity Board, Guwahati for his excellent work on fish diversity of River Brahmaputra in Assam. Dr. Bhattacharjya also served as a Member, Extension Advisory Committee for College of Fisheries, CAU, Lembucherra. He also acted as a Member, State Fish Seed Certification and Accreditation Committee and Member, Technical Expert Committee of Assam Fisheries Development Corporation Ltd., Guwahati.


Dr. A. K. Das


Dr. B. K. Das


Dr. B. P. Mohanty


Dr. B. P. Mohanty


Dr. B. P. Mohanty


Dr. A. Pandit


Mrs. K. Sucheta Majumdar


Dr. S. Samanta

- Dr. B. K. Das, Director, was conferred with Krishak Gaurav award and Dr. B. P. Mohanty, Head FREM Division and Dr. A. K. Das, Principal Scientist were conferred with Krishak Bandhu Awards by the Odisha Krishak Samaj on the occasion of World Food Day on 16 October 2017. Dr. Mohanty also received the Life Time Achievement Award in Biochemistry at 3rd Annual Research Meet by the Venus International Foundation, Chennai on 11 Nov 2017. He has also delivered invited lectures on

The Institute's scientists bagged various prizes in M. C. Nandeesha Photo Competition in GAF under the auspices of 11th Indian Fisheries & Aquaculture Forum held at Kochi during 21-24 November 2017.

The photograph entitled
"Women's participation in fish harvesting (from aquaculture pond, Tripura, India)"
- by Shri Vikash Kumar won 1st Prize

The photograph entitled
"Equal Contributor : Catching fish using gillnet from a river in Indian Sundarbans"
- by Dr. R. K. Manna won 2nd Prize

The photograph by Ms. Suvra Roy entitled
"Women participate in sorting and grading of fishes after Catch (from coastal region of Sundarbans)was highly commended

various topics in different fora at Bhubaneswar, Tirupati, Pune and Balasore. He also served as a Member, 15th Institute Management Committee of the ICAR-National Research Centre on Pig, Rani, Guwahati.

- Dr. U. K. Sarkar served as a Member of the Institute Management Committee (IMC) of the ICAR-NBFGR, Lucknow. He has also delivered guest lecture at Haringhata Degree College in the workshop on "Impact of climatic change on inland fisheries".

- Drs. Dipesh Debnath and Pronob Das served as Panellist in Doordarshan Kendra, Guwahati to discuss the prospects of inland fisheries and aquaculture in NE and Aquaculture and Fish Health in a Live-in phone programme, respectively.

- Sh. Dibakar Bhakta bagged the best oral presentation award at 1st Innovative Science Congress, 2018 and National Conference on “Innovative farming for food and livelihood security in changing climate” held at FACC, BCKV, Kalyani during 12-13 Jan 2018. The title of his paper was 'Impact of short term starvation on growth compensation and muscle composition in fingerlings of Oreochromis niloticus (Linnaeus, 1758)'.

- Drs. B.P. Mohanty, S. Samanta, A. K. Das, Arun Pandit (Principal Scientists), Dr. Aparna Roy, Sh. H.S. Swain, Sh. D.K. Meena (Scientists), Sh. Sudipto Gupta (AAO), Ms. Poushali Roy (AAO) were awarded CIFRI Platinum Jubilee Awards and appreciation certificates for their outstanding contributions in institute building activities, research and extension.

- Sh. D. K. Meena was awarded best oral presentation in National conference on empowerment of rural community through aquaculture during 09 to 10 Feb 2018 held at College of Fisheries Ratnagiri. He was awarded Fellowship of Society of Fisheries and Lab Science in 11th IFAF held at Cochin during 21 to 24 November 2017.

- Dr. Sandhya K. M. was awarded the best women athlete in ICAR Eastern Zonal sports tournament 2017 at ICAR complex Patna. She won a total of 3 medals including 2 gold & 1 silver. ICAR-CIFRI contingent also won gold in table tennis and javelin throw and bronze in women shotput in the tournament. In the Inter Zonal tournament held at ICAR-NAARM, Hyderabad, Dr. Sandhya K. M. again made CIFRI proud by winning 2 bronze medals.

Dr. K. M. Sandhya

Gold in Javelin throw

TT Team of CIFRI

Trainings and Capacity Building

Model Training Course on 'Enclosure Culture in Inland Open Water'

The Institute organized a Model Training Course (MTC) on 'Enclosure Culture in Inland Open waters' during 22-29 August 2017 at Barrackpore. The objective of this MTC was to sensitize the participants regarding importance of enclosure culture technology for the sustainable enhancement of fish production in inland open waters. In the inaugural session Prof. C.S Chakrobarty, Former Vice Chancellor of West Bengal University of Animal and Fishery Sciences was the Chief Guest. Dr. B. K Das, Director, CIFRI remarked that enclosure culture including cage and pen culture could be the best alternative to meet the increasing demand of animal protein in the country for food security and for the improvement of the livelihood of many people in a sustainable manner. Dr. B.C Jha, Former Head, Reservoir and Wetland Division was also present on the occasion. A total of twenty two trainees from Jammu & Kashmir, Kerala, Maharashtra, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, Jharkhand, Rajasthan, Arunachal Pradesh, Assam, Odisha and West Bengal participated in the training programme.

Model Training Course on Enclosure Culture in Inland Open Waters at ICAR-CIFRI, Barrackpore

Other Trainings organized

Farmers training

The institute conducted 23 on campus training programmes for fishers/fish farmers on Inland open water fisheries management & development at Barrackpore Hqs. The details are given below :

Sl. No.	Date	Participants
1.	15-21 June 2017	26 (25+1) from Buxar, Bihar (DoF)
2.	30 June -06 July 2017	30 (29+1) from Sitamarhi, Bihar (DoF)
3.	11-17 Aug 2017	31 (30+1) from Munger, Bihar (DoF)
4.	18-22 Aug 2017	22 (21+1) from Madhubani (ATMA)
5.	25-31 Aug 2017	28 (27+1) from Jamui, Bihar (DoF)
6.	07-13 Sept 2017	31 (30+1) from Khagaria, Bihar (DoF)
7.	12-16 Sept 2017	10 (9+1) from Subarnapur, Odisha (PD, ATMA)
8.	14-20 Sept 2017	31 (30+1) from Sheohar, Bihar (DoF)
9.	18-25 Sept 2017	25 (24+1) from Begusarai, Bihar (DoF)
10.	02-08 Oct 2017	23 (22+1) from Lakhisarai, Bihar (DoF)
11.	03-09 Nov 2017	29 (28+1) from Sheikhpura, Bihar (DoF)
12.	13-15 Nov 2017	19 (18+1) from Gangarampur, Dinajpur
13.	15-19 Nov 2017	30 (27+3) from Balasore, Odisha
14.	15-21 Dec 2017	29 (28+1) from Buxar, Bihar (DoF)
15.	23-29 Dec 2017	30 (29+1) from Sitamarhi, Bihar (DoF)
16.	02-08 Jan 2018	27 (26+1) from Munger, Bihar (DoF)
17.	12-18 Jan 2018	25 (24+1) from Jamui, Bihar (DoF)
18.	06-12 Feb 2018	31 (30+1) from Khagaria, Bihar (DoF)
19.	16-22 Feb 2018	26 (25+1) from Begusarai, Bihar
20.	23 Feb to 01 March 2018	31 (30+1) from Bhagalpur, Bihar (DoF)
21.	06-12 March 2018	31 (30+1) from Lakhisarai , Bihar (DoF)
22.	23-29 March 2018	30 (29+1) from Sheohar, Bihar
23.	31 March to 04 April 2018	(20+1) 21 from ATMA, Kumargram Block, Alipurduar

- The Institute organized a three days off-campus training programme on “Wetland fisheries development through participatory technological interventions” during 06-08 October 2017 at KVK, Piprakothi, Motihari, East Champaran, Bihar. The objective of this training programme was to create awareness about the NFDB sponsored projects in Rulhi, Sirsa, Kararia and Majharia maun for fisheries development. Hon'ble Union Minister of Agriculture and Farmer's welfare Shri Radhamohan Singh was present in the valedictory ceremony.

- Allahabad Centre organized 2 training programmes on Integrated fisheries management and wetland conservation for 45 Tribal fishers/fish farmers each of Bundelkhand region, MP under TSP during 14-16 Dec 2017 and 21-23 Feb, 2018, respectively.

- Guwahati Centre organized a training programme on Scientific fishery management of floodplain wetlands (beels) on 18-19 Dec 2017 in which Twenty nine field staff and two beel managers of AFDC Ltd., Guwahati participated.

Students Training at CIFRI, H.Q. Barrackpore

Sl. No.	Name of the training	Date	Participants
1	Inland Fisheries Management	10-13 April 2017	26 B.Sc. Students from S. K. Mahila College Begusarai, Bihar
2	Hands-on training on Collection, Preservation and Identification of Freshwater Plankton	11-14 July 2017	12 participants
3	Inland Fisheries Management	10-14 July 2017	10 B.Sc. (Ag) 2nd year Students of MBA College, Saharsa, under BAU, Sabour Bihar.
4	Inland Fisheries Management	17-26 Aug 2017	8 M.F.Sc. Students under FRM Division of ICAR-CIFE, Mumbai.
5	Lab exposure visit and Hands-on Training Course on 'Contemporary Techniques in Fish Biochemistry'	01-12 Sept 2017	M.F.Sc. students of ICAR-CIFE (FNBP Division)

Officials Training

Sl. No.	Name of the training	Date	Participants	Venue
1.	Inland Fisheries Management	25-27 Oct 2017	6 Officials from DoF, Kerala	Barrackpore Hqs.

Hands on Training on "Collection, Preservation and Identification of Freshwater Plankton"
11-14 July, 2017

Exhibitions participated

Sl. No.	Date	Particulars	Place
1.	10-13 Apr 2017	Fish Festival -2017	Bhubaneswar, Odisha
2.	13-19 Apr 2017	*Krishi Mela* - 2017	Motihari, Bihar
3.	20-21 Apr 2017	International Symposium on 'Aquatic Animal Health and Epidemiology for Sustainable Asian Aquaculture' (ISAAE), organised by Aquatic Biodiversity Conservation Society, Lucknow in collaboration with ICAR -NBFGR & National Surveillance Programme on Aquatic Animal Disease. ICAR-CIFRI Allahabad RRC has participated	NBFGR, Lucknow, UP
4.	15-19 May 2017	8th Krishi Fair - 2017, organised by Shree Shrikhetra Suochara, Puri	Puri, Odisha
5.	24-27 Aug 2017	'21st National Agriculture Exhibition' organised by Central Calcutta Science & Culture Organisation for Youth	Vivekananada Krirangan, New Barrackpore, Kolkata
6.	22-24 Sept 2017	National Seminar on 'Strategies, Innovations & Sustainable Management for Enhancing Coldwater Fisheries & Aquaculture' organised by ZSI, Bodhgaya & ICAR DCFR, Bhimtal	Bhumtal, U.K.
7.	16 Oct 2017	'World Food Day' organised by Orissa Krushak Samaj	Bhubaneswar
8.	15-19 Nov 2017	'*Sabuja Sabala Meloy Sunderban*' organised by Sunderban Dream	Gosaba, South 24 PGS, W. B.
9.	21-24 Nov 2017	'11th Indian Fisheries & Aquaculture Forum' (11th IFAF) organised by Asian Fisheries Society Indian Branch (AFSIB) & ICAR-CIFT, Cochin, Kerala	ICAR-CIFT, Cochin, Kerala
10.	07-10 Dec 2017	Aqua Goa Mega Fish Festival	SAG Ground, Directorate of Fisheries, Panjim, Goa
11.	14-17 Dec 2017	*Bajarpore Gramin Pradarshani-O-Mela* organised by Alukaranbarh Seba Sangha	Purba Mecinipur.
12.	20-29 Dec 2017	*Sundarban Krishi Mela -O-Loko Sanskriti Utsav* organised by Kultali Milan Tirtha Society	Kultali, South 24 PGS, W. B.
13.	22-31 Dec 2017	*Sundarban Tuba Mela*' organised by Taldi Baharupee Sangha	Taldi, South 24 PGS, W. B.
14	24-31 Dec 2017	Naihari Utsav – 2017 organised by Naihati Utsav Welfare Samity	Naihati Railway Ground
15.	15-17 Jan 2018	2nd International Symposium on Societal Applications in fisheries & Aquaculture using Remote Sensing Imagery' organised by ICAR-CMFRI	ICAR-CMFRI, Kochi, Kerala
16.	07-14 Jan 2018	*Monomohan Mela O Lokosanskriti Utsav* organised by Srijani Sanstha	Chotojagulia, North 24 PGS, W. B.
17.	12-13 Jan 2018	'1st Farm Innovation Congress (FIC-2018) & National Conference on Innovative Farming for Food & Livelihood Security in Changing Climate' organised by Innovative Farming & Society for Advancement of Agricultural Innovations	BCKV, Mohanpur
18.	7-12 Feb 2018	'Babpur Utsav' organised by Suchana Welfare Trust	Babpur, North 24 PGS, W. B.
19.	12-14 Feb 2018	'4th International Conference on Environment and Ecology (ICEE)' organised by department of Zoology, Gauhati University	Gauhati University Ground, Assam
20.	12-14 Feb 2018	6th AGRO PROTECH 2018	Science City, Kolkata, W. B.
21.	19-20 Feb 2018	"Interface programme on Doubling farmers' income through arecanut based cropping system and Field day on cocoa"	ICAR-CPCRI Regional Centre, Kahikuchi, Assam
22.	24 March 2018	'Kishan Mela-cum-Technology Demonstration' organised by ICAR-IVRI, ERS Kolkata	ICAR-NDRI, ERS Kalyani Campus, Kalyani, W. B.

Exposure / Educational Visits

Sl. No.	Particulars of visitors	Date of visit
1.	20 Progressive fish farmers & 3 FFOs from Karbi Anglong, Dhipa, Assam	05-07 April 2017
2.	7 M.Sc. Students & 1 Professor In charge from Department of Zoology, Pandu College, Guwahai University	05 April 2017
3.	28 M.Sc. Microbiology Students, 1 Research Scholar & 1 Assistant Professor from Vidyasagar University, Midnapore	08 May 2017
4.	13 M.Sc. Zoology Students & 2 Teachers from Vidyasagar College, Kolkata	17 May 2017
5.	20 Trainees from Inland Fishery Research Centre (IFRC), Imphal, DoF. Govt. of Manipur	21 June 2017
6.	40 Input Dealers in Agri & Aquaculture from KVK, 24 PGS (N) under DAESI program of MANAGE, Hyderabad	22 June 2017
7.	12 M.Sc. Botany Students & 1 Teacher from Vidyasagar University, Midnapore	24 June 2017
8.	15 Students & 1 Faculty member from Future Hope School, Kolkata	11 July 2017
9.	26 B. F. Sc. Students & 1 Teacher from College of Fisheries Science, Nellore, Andhra Pradesh	05 Aug 2017
10.	81 Students & 4 Teachers In-charge from Army Public School, Barrackpore	17 Aug 2017
11.	46 Students & 4 Teachers In-charge from Army Public School, Barrackpore	18 Aug 2017
12.	21 trainees (PGDIF & FM) from ICAR-CIFE, Kolkata centre	08 Sept 2017
13.	24 M.Sc. Zoology Students & 1 Teacher In-charge from Bodoland University, Assam	14 Sept 2017
14.	33 B.F.Sc. Students & One Teacher In-charge from TNFU, Tuticorin	18 Nov 2017
15.	33 B.F.Sc. Students from Mangalore Fisheries College, Karnataka.	27 Nov 2017
16.	38 B.F.Sc. (3rd yr) Students from Ratnagiri	04 Dec 2017
17.	25 Officials (Fishery Assistants) of Govt. Tripura	23 Dec 2017
18.	12 B.F. Sc. Students from Faculty of Fishery Sciences, WBUAFS, Kolkata	27 Dec 2017
19.	10 B.Sc. (Hons.)Students from Karimgunj, Assam	28 Dec 2017
20.	21 B. F. Sc. Students from CoF, Kamdhenu University, Chhattishgarh	01 Jan 2018
21.	12 B.F. Sc.(4th Yr) Students from CoF, GADVASU, Ludhiana, Punjab	01 Jan 2018
22.	13 B.F.Sc. (4th yr) Students from Nagpur College	03 Feb 2018
23.	15 M.Sc. Zoology Students & 3 Teacher In-Charges from Uday Pratap Autonomus College, Varanasi	13 Feb 2018
24.	18 students (M.Sc. Zoology with special paper on fishery) and 2 Teachers from Raja Narendralal Khan Women's College, Midnapore, West Bengal visited ICAR-CIFRI Regional Centre, Guwahati	17 Feb 2018
25.	63 farmers from ATMA Katwa, Purba Medinipur	27 Feb 2018
26.	10 B.Sc. Students from Sonamukhi College, Bankura	09 Mar 2018
27.	6 Students & One Teacher In-Charge from Pandu College, Assam	16 Mar 2018
28.	46 Students & 4 Teacher In-Charges from Panagad College, Kerala	24 Mar 2018

Mass awareness camps

Camps	Place	Date
'Conservation of fishes of river Ganga' under ICAR-CIFRI-NMCG	M.Ian Dwip, Balagarh, Hooghly, W.B.	22 Apr 2017
Wetland management for upliftment of Tribal people	Rewa, M.P.	04 Apr 2017
Hilsa conservation and Restoration of Hilsa Juveniles at	Fresurgunj, W.B.	12 Oct 2017
Fisheries development in Sundarbans including canal fisheries	*'Sahaje Sahala Melay Sundarban'* Amtali, Gosaba, Sundarbans, South 24 Parganas, W.B.	16-17 Nov 2017
Pollution monitoring and Management in river Kathajodi-Dev:	SikharGhat, Naugaon, Jagatsinghpur, Odisha	19 Nov 2017
Contribution of Loni wetland in livelihood and food security of tribal fishers	Loni wetland, Bundelkhand	16 Dec 2017
Contribution of Loni wetland in livelihood and food security of tribal fishers	Loni wetland, Bundelkhand	21-23 Feb 2018
Fisheries development in Sundarbans	Kultali, Sundarbans, South 24 Parganas, W.B.	28 Dec 2017
Canal fisheries development in West Bengal during Mati Utsav, Burdwan	ATC, DoAg, West Bengal, Burdwan in Baluka Khal, W.B.	04 Jan 2018
Fisheries development in Burdwan district of West Bengal	Krishi Mela, Purba Burdwan, W.B.	17 Jan 2018
Wise-use of recommended chemicals in fish drying process	Namkhana & Fresergunj of South 24 PGS, West Bengal	18-19 Jan 2018
Mass awareness programme at Maghmela ground	Sangam, Allahabad	20 Jan 2018
Conservation of fishes of rives Ganga	Nabadwip, Nadia, West Bengal	21 Jan 2018
Impact of climatic variability on fish and wetland ecosystem	Nidaya Ghat, Kobla wetland (Purbasthali, Burdwan district, West Bengal	21 Jan 2018
Fisheries development with special reference to floodplain wetlands and pen culture on World Wetland Day	Mathura Beel, North 24 Parganas, W.B.	02 Feb 2018
Fisheries development including shrimp farming at Bengal Aqua Expo	Nachinda, Contai, Purba Medinipur, W.B.	05 Feb 2018
Fisheries development including shrimp farming	Haldia, Sutahata Block, Purba Medinipur, W.B.	05 Feb 2018
Fisheries development in Ariala, North 24 Parganas	Babpur, North 24 Parganas, W.B.	06 Feb 2018
Fisheries in livelihood development of tribal fishers	Kol tribe dominated area in Rewa district of M.P	08 Feb, 2018
Fisheries development including shrimp farming at Matsya Utsav	Haldia, Purba Medinipur, W.B.	12 Feb 2018
Fisheries development in Sundarbans including canal fisheries	Amtali, Gosaba, Sundarbans and Kalitala, Hingalgunj, Sundarbans	18 Feb and 19 Feb 2018
Fisheries development of N 24 Parganas district	Ula, Barasat Block, North 24 Parganas, W.B.	20 Feb 2018
Acute Hepatopancreatic Necrosis Disease" (AHPND)/ Early Mortality Syndrome (EMS) (in collaboration with Department of Fisheries, Govt. of West Bengal and West Bengal University of Animal and Fisheries Sciences)	Hasnabad, North 24 Parganas, W.B.	03 March 2018

Ongoing Projects

Institute funded research projects during 2017-18 :

S. No.	Project Code	Project Title
1.	REF/17-20/07	Habitat characterization, fisheries and socio-economics of rivers Cauvery, Tapti, Siang and Chaliyar
2.	REF/17-20/08	Exploration of canal resources of Punjab and Sundarbans (WB) for fisheries development
3.	REF/17-20/09	Investigation on environmental flows in rivers Kathajodi, Siang and selected tributary of Ganga
4.	REF/17-20/10	Impact of major tributaries and wetlands on biodiversity and ecological function of river Ganga
5.	RWF/17-20/05	Resource assessment and refinement of fisheries management plans through co-management in selected floodplain wetlands of different eco-regions
6.	RWF/17-20/06	Fisheries resource assessment and refinement of enhancement protocol through participatory mode in selected reservoirs of India
7.	RWF/17-20/07	Assessment and validation of potential fishery zones in medium and large reservoirs using hydro-acoustics
8.	RWF/17-20/08	Studies on exploitation of insects as feed and food
9.	RWF/17-20/09	Diversification of enclosure culture in reservoir and wetlands
10.	FREM/17-20/11	Pollution benchmarking and monitoring of selected rivers Ganga, Cauvery, Kathajori and East Kolkata wetlands
11.	FREM/17-20/12	Emerging contaminants in rivers (Teesta, Tons, Godavari) and East Kolkata Wetland and their effect on selected biota
12.	FREM/17-20/13	EIA and mitigation of Arsenicosis as a serious environmental challenge with special reference to fish and fishery resources
13.	FREM/17-20/14	Fish health management and antimicrobial resistance in inland open waters
14.	FREM/17-20/15	Statistical innovations for assessing inland fishery resources
15.	ESE/17-20/03	Impact assessment of CIFRI technologies and training

Outreach research projects during 2017-18 :

S. No.	Project Code	Project Title
1.	OR/ER/08/09/01	Carp culture in cages and pens using feed
2.	OR/ER/08/09/02	Fish genetic stocks
3.	OR/ER/08/09/03	Nutrient profiling and evaluation of fish as a dietary component

Externally funded research projects during 2017-18:

Sl. No	Project Title	Funding Agency
1.	Impact of climate change in inland fisheries and development of adaptation strategies (NICRA)	DARE, Ministry of Agriculture
2.	Stock characterisation, captive breeding, seed production and culture of Hilsa (*Tenualosa ilisha*)	NASF
3.	National surveillance programme for aquatic animal diseases	NFDB
4.	All India Network Project on Fish Health	ICAR
5.	Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan	NMCG
6.	Network project for Agricultural bioinformatics and computational biology	ICAR
7.	Development of standard protocols and molecular tools for fish food authentication for food safety and quality assurance	FSSAI
8.	National Agriculture Innovation Fund (NAIF) Component-I	ICAR
9.	Fisheries development in Majhariamaun of Bihar through refinement of site specific fisheries enhancement technology – an innovative project	DAHD&F
10.	Fisheries development in Sirsa wetland of Bihar through in-situ fish feed rearing and fisheries enhancement techniques for tapping fish production potential – an innovative project	DAHD&F
11.	Fisheries development in Kacaria wetland of Bihar through empowerment of communities and stakeholder participation for capacity building and improved livelihood – an innovative project	DAHD&F
12.	Fisheries development in Rulhi wetland of Bihar through Stakeholders' participatory fisheries management model (Co-management) in a sustainable manner – an innovative project	DAHD&F

Consultancy research projects during 2017-18:

Sl. No.	Title of the Project	Funding Agency	Budget (Rs. in Lakh)
1.	Investigation on present status of fish diversity with special focus on carps and small indigenous fish species in Ansupa Lake, Odisha	CDA	1.0
2.	Implementation of cage culture scheme in State Reservoirs	DoF, HP	334
3.	Assessment on efficacy of Fish Pass/ Fish Ladders provided across Teesta Low Dam Stage III and IV Power Stations in West Bengal	NHPC Ltd.	79.66
4.	Determination of e-flow for non-lean and non-monsoon months in respect of Teesta Stage-IV HE Project, Sikkim	NHPC Ltd.	17.227
5.	Exploratory survey of Hilsa (*Tenualosa ilisha*) catch and life stages availability along up/down stream of Farakka barrage	NMCG	24.506
6.	Cage culture in reservoirs as collaborative programme between Department of Fisheries, Telangana state and ICAR-CIFRI during 2018-2020	DoF, Telangana	15.53

Meetings

Institute Research Committee Meeting for 2016-17

The Institute Research Committee Meeting for 2016-17 was held at the Institute headquarters during 10-12 April 2017. Dr. B. K. Das, Director chaired the meeting. All the Scientists of the institute attained the meeting. The Chairman motivated the scientists to publish their work in high impact factor journals. He also stressed upon value addition in research work and requested the scientists to be innovative in their approaches and stressed that the research should have relevance to the farmers, policy makers and other stakeholders. A interface meeting among Scientists, Technical officers and Administrative staff was also held and different issues were discussed. The Principal Investigators of the projects presented their research and other achievements made during 2016-17. Many new projects have been presented and discussed in the house.

Regional Consultation at Guwahti RRC

A Regional Consultation on 'Open water fisheries development in NE region' was organized by the institute at Guwahati on 29 April 2017. A total of 40 delegates attended the consultation. Shri Parimal Suklabaidya, Hon'ble Minister Fisheries, Assam was the Chief Guest. Dr. B. K. Das, Director, ICAR-CIFRI emphasized on the need for developing open water fisheries in the region and assured providing research support to the State Fisheries Department. Dr. P. K. Pandey, Dean, College of Fisheries (CAU), Lembucherra; Prof. K. K. Saharia, GB Member of ICAR and Dr. J. Chauhan, National Convener for Extension Education, Ministry of Agriculture and Farmer's Welfare, Govt. of India; The Directors of Fisheries, Govt. of Assam, Mizoram and Manipur also addressed the gathering. Scientists of the Guwahati RRC presented the road maps in the technical sessions on which the delegates provided inputs and suggestions.

Stakeholders Consultation on National Inland Fisheries and Aquaculture Policy

A stakeholders consultation on 'Formulation of National Inland Fisheries and Aquaculture Policy' was organized by the National Fisheries Development Board, Regional Centre, Guwahati in collaboration with ICAR-CIFRI and ICAR-Central Institute of Fisheries Education (ICAR-CIFE), Mumbai at NIRD & PR, NERC, Guwahati on 16 June 2017. A total of 50 delegates including Shri A. K. Joshi, IFS, Joint Secretary, DAHD&F, New Delhi; Shri M. Chaudhury, Fisheries Advisor, NITI Ayog, Govt. of India; Dr. Dilip Kumar, Ex.

VC, ICAR-CIFE, Mumbai; Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore; Dr. Gopal Krishna, Director, ICAR-CIFE, Mumbai; Shri S. K. Das, Director of Fisheries, Govt. of Assam was present. A policy document prepared by ICAR-CIFRI, Barrackpore entitled "Roadmap for development of openwater fisheries resources in Northeastern Region" was released on the occasion.

Workshop on 'Assessment of water and soil quality parameters'

This workshop was organized at the Institute Headquarters on 14 August, 2017. A total of 21 candidates, including technical persons and research fellows of various externally funded projects both from headquarters and regional centres / research stations of ICAR-CIFRI attended the workshop. The Director stressed on the standardization of methods suitable for covering different locations, both at micro and macro level, for different sizes of water body and seasonal variations. Dr. S. Samanta and Dr. S. K. Das were the coordinators of this workshop.

46th Meeting of Institute Management Committee

The 46th Institute Management Committee meeting was held at the Institute Headquarters on 05 September 2017 under the chairmanship of the Director. The Chairman briefed the members about activities carried out by the Institute since last meeting. The members appreciated progress of research work at the Institute and complemented the Director and Scientists. Dr. A. K. Das, Principal Scientist of the institute delivered a presentation on enclosure culture of fishes in the IMC meeting.

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Mid-term Institute Research Committee Meeting

The mid-term Institute Research Committee meeting for the year 2017-18 was held at the Institute Headquarters, Barrackpore on 18-19 September 2017. The objective of the meeting was to assess the achievements made so far and mid-course correction, if any. Dr. B. K. Das, Director, ICAR-CIFRI chaired the meeting. Scientists from the CIFRI Headquarters, Kolkata Research Station and Project Principal Investigators from Regional Centers/Stations attended the meeting. The Chairman informed the house about new international research collaborations including Norway, Canada and Japan. The house was also informed about the achievement of patent on low cost GI cage design and application for patent on Tissue embedding machine and fish feed. Research achievements were discussed and recommendations were made.

Sensitizing Workshop on J-gate

J-Gate is an electronic gateway to global e-journal literature. It provides seamless access to millions of journal articles available online offered by 13,243 Publishers. It presently has a massive database of journal literature, indexed from 48,055 e-journals with links to full text at publisher sites. A sensitizing workshop on J-gate as one stop platform for discovering scholarly journal articles was held on 19 September 2017 at the Institute headquarter.

Workshop on 'Hilsa breeding and management: Way forward'

ICAR-NASF Workshop on "Hilsa breeding and management: Way forward" was held at the Institute Hqs., Barrackpore on 24-26 Oct, 2017. The workshop was inaugurated by Dr. Panjab Singh, Former Secretary, DARE & DG ICAR. The achievements of the project were discussed in details and the ways forward were formulated. Dr B. K. Das, Director of the Institute; Dr P. K. Agarwal, ADG, NASF; Dr. S. Raizada ADG, Inland Fisheries and Dr. V. R. Suresh were among the dignitaries attended the meeting.

Mid-term Regional Committee meeting

The institute organized mid-term review meeting of Regional Committee (Region II) on 13 November, 2017 at Barrackpore. The ICAR Region II, comprises the States of Andhra Pradesh, Telangana, Odisha, West Bengal and Union Territory of Andaman & Nicobar Islands. This meeting was conducted to review the progress of the action taken reports of the 23rd meeting held at ICAR-NAARM, Hyderabad on 24-25 June 2016.

Dr. J.K Jena, Deputy Director General (Fisheries Sc; Animal Sc.) chaired the meeting. A total 26 ICAR-Institutes/RRCs, eight universities participated in the meeting. Representatives from the State Departments of West Bengal, Telangana, Odisha, Andaman and Nicobar Island were also present in the meeting.

Stakeholder meeting on 'Validation of pen culture as a climate resilient technology for beel fishers'

This stakeholder meeting under NICRA project was organized by the Guwahati Regional Centre of the institute in collaboration with Assam Fisheries Development Corporation Ltd. (AFDC) at 47-Morakolong beel, Morigaon district, Assam on 16 November 2017. In the meeting Dr. U. K. Sarkar, Principal Investigator, NICRA project emphasized on judicious utilization of the vast beel fisheries resources of the state by adopting scientific methods of fisheries enhancement to substantially enhance fish production and income generation under the changing climate. Dr. B. K. Bhattacharjya, Incharge of the Guwahati Centre emphasized on the need of adoption of pen culture as a climate resilient production system for increasing adaptive capacity of the fishers. The field officials of AFDC Ltd., fishermen of the beel including the President and Secretary of the Fishers' Cooperative Society also attended the meeting.

Workshop on 'Strategies on fish disease prevention in Assam'

This workshop was organized by ICAR-CIFRI Regional Centre, Guwahati in collaboration with Assam Fisheries Development Corporation (AFDC) Ltd., Guwahati under the All India Network Project on Fish Health on 18 December 2017 at Guwahati. The main objective of this workshop was to generate awareness about various fish diseases in Assam and their control measures. The workshop was graced by Shri S. K. Das, ACS, Managing Director; Shri P. K. Hazarika, Technical Manager, Dr. Dhruba Jyoti Sarma, Liaison Officer, Mr. D. Pame from AFDC Ltd., Guwahati; Dr. B. K. Bhattacharjya, Head (Acting), ICAR-CIFRI Regional Centre, Guwahati; Dr. S. K. Manna, Principal Scientist & PI, All India Network Project on Fish Health, scientists and technical officers of the centre. A total of 30 field assistants from AFDC Ltd. participated in the workshop.

Sensitization workshop on 'Climate resilient technologies developed by ICAR-CIFRI for beels'

Guwahati regional centre of the institute conducted this workshop at 47-Morakolong beel, Morigaon district, Assam on 9 Jan 2018 under the NICRA project for validation of pen culture as a climate resilient technology for beel fisheries. Five pens of 10 m x 10 m area were installed in the beel periphery and stocked with small indigenous fishes such as *Amblypharyngodon mola* and *Gudusia*

chapra along with IMCs *Catla catla, Labeo rohita* and *Cirrhinus mrigala*. Dr. B. K. Bhattacharjya, Head (Acting), of Guwahati RRC, Dr. U. K. Sarkar, PI of NICRA project; Dr. S. Borthakur, Mr. Bipul Phukan, AAU, Raha; Shri Hemanta Baruah, DGM, NABARD, Morigaon; Scientists of Guwahati RRC; President, Secretary and more than 30 active members of the co-operative society participated in the programme.

Another sensitization workshop and demonstration of Climate Resilient Pen Systems (CRPS) for fish raising was organized at Mathura Beel, Kachrapara, North 24 Parganas, West Bengal on 2 Feb 2018 on the occasion of World Wetland Day. Dr. Bipul Kumar Das, Dean, CoF, WBUAFS graced the occasion as Chief Guest and the programme was attended by more than 200 fishers of Kanchrapara Refugee Fishermen's Co-operative Society, Ltd (KRFCS). Officials of Department of Fisheries, Scientists and other staff of NICRA project were also present. Dr. B. K. Das, Director inaugurated the model CRPS in Mathura Beel and released fish seed of IMCs, *Labeo bata, A. mola, Puntious* sp. and *Gudusia chapra* in the pens. On the occasion ICAR-CIFRI signed a MoU with KRFCS Ltd. for demonstration of climate resilient adaptation strategies in Mathura beel.

Community based knowledge sharing meeting at Sagar Island under Mera Gaon Mera Gaurav

A meeting was arranged on 15 Feb 2018 at Swami Vivakanad Cultural Youth Society, Krishnnagar, Sagar Island to discuss the agricultural problems under Mera Gaon Mera Gaurav programme. A total of 200 people from the five adopted villages attended the meeting. The farmers shared their experiences on different aspects of agriculture, horticulture and fish culture. Availability of quality fish seed in time was found to be a major problem. As the Island is not connected with roads, the cost of bringing seed for stocking the ponds is very expensive. Establishment of fish hatchery was the demand of the group. Some common diseases and their treatments were also discussed. The women fishers demanded training on ornamental fish culture. Literature on nutrient value of small indigenous fish to incorporate in daily diet, pen culture in open water and success story of canal culture during TSP at Khansaebar Abad village were distributed.

Launched programme on model wetland development for livelihood security and restoration of indigenous fishes

A programme was launched on developing model wetland for livelihood security and restoration of indigenous fishes under NICRA project on 16 February 2018 at Bhomra Beel, Haringhata, West Bengal. State fishery official, fishers and other stakeholders were also present on the occasion. Dr. U. K. Sarkar Principal Investigator, NICRA remarked that through climate resilient technologies and adaptation strategies, the fishers can cope up with adverse impact of climatic variability. Dr. B. K. Das, Director suggested for creation of value chain for local level processing and marketing of fish to ensure higher returns. He inaugurated the Climate Resilient Pen Culture System in Bhomra Beel and released fish seed of IMCs, Puti, Folui, Singhi and Pabda, in the pens. The demonstration of the technology aims to serve as a model wetland for this region. On the occasion, a fishers-scientist interaction meet was also organized. The Institute also signed a MoU with BFCS Ltd. for pen culture demonstration in Bhomra beel.

Interface meeting of ICAR institutes/centres

The Institute organized one-day interface meeting for developing multi-disciplinary approach in project formulations and innovations in agriculture and allied sectors involving all the Kolkata-based ICAR-Institutes/Centres on 17 February 2018 at the Institute Hqs., Barrackpore. Nine ICAR-Institutes viz. ICAR-CRIJAF, ICAR-NIRJAFT, ICAR-IVRI regional centre, ICAR-NDRI ERS regional centre, ICAR-CIFE Kolkata Centre, ICAR-CSSRI Canning centre, ICAR-CIFA Kalyani Centre, ICAR-CIBA, Kakdwip Research Centre, ICAR-NBSS & LUP, Regional Centre, Kolkata and five KVKs viz. KVK, Burdwan, KVK, Ashoknagar, KVK, Nilganj, KVK, Hooghly, KVK, Sasyashamala, participated in the interface meeting. Dr. A. E Eknath, Former DG, NACA, Bangkok graced the occasion as the Chief Guest. He told that the meeting is an excellent opportunity for the researchers as experts from almost all subjects are present in the meeting. An open house discussion was held to deliberate on various issues related to networking in disadvantageous areas through Tribal Sub Plan (TSP); smart village concept; Mera Gaon Mera Gaurav programme; sharing lab facilities, sharing knowledge etc.

Research Advisory Committee meeting

The Meeting of the Research Advisory Committee of the Institute was held at Barrackpore during 5-6 March 2018. Prof. Dr. B. Madhusoodana Kurup, Former Vice-Chancellor, Kerala University of Fisheries and Ocean Studies, Kochi, presided over the meeting. The Chairman urged the Scientists to focus on the research for knowledge based management of inland open waters and to formulate strategic action plans and highlighted the necessity of sustainable development of inland open water fisheries. The RAC advocated for action oriented research and research for societal gain and livelihood improvement.

Workshop on "Biodiversity of River Ganga and its conservation for sustainable fisheries"

The Institute organized this workshop on 15 March 2018 at its HQs, Barrackpore under the 'Namami Gange' programme. The workshop is a part of the series of activities to commemorate the Platinum Jubilee year of the Institute. As a part of the programme 50,000 Rohu, Catla, Mrigal fingerlings have been ranched in river Ganga at Barrackpore towards restoring the prized Major Carp fisheries in river Ganga . The workshop was chaired by Dr. J. K. Jena, the DDG (Fishery Science), ICAR. Dr. Jena urged for immediate integrated approach to clean the river system and restore the fisheries. Padmashree Prof. Ravindra Kumar Sinha, Hon'ble VC of Nalanda Open University was the chief guest in the inauguration. He said that proper policy and suitable action are necessary to restore river Ganga. Dr. Sandeep

Behera (Biodiversity consultant, NMCG); Prof. Amalesh Choudhury, Ecologist; Dr. B. K. Das, Director, CIFRI were among the other dignitaries attended the workshop. More than 150 eminent scientists, professors and delegates from different states of the country joined in discussion.

Brain storming on cage culture

In the series of events for commemorating the platinum jubilee celebrations, the institute organized a brainstorming session on "Cage culture in inland open waters" on 16 March 2018 at ICAR-CIFRI, Barrackpore. Officials from Public Sector Undertakings (NHPC, NEPCCO), Entrepreneurs (ABIS, GROWELL, GARWARE, SHALIMAR, AQUATICA etc.), progressive farmers, State Fisheries Departments, Universities, NGOs and different Water Resource Departments attended the meeting. Mr. M. S. Dhakad, MD, MP Fisheries Federation was the Chief Guest and Dr. N. P. Singh, Director, ICAR-NIASM, Baramati and Madhumita Mukherjee, Additional Director, Department of Fisheries, Government of West Bengal were the Guests of Honour. In his remarks, Dr. B. K. Das, Director gave an overview of the status of cage culture in inland open waters of India and highlighted the role of ICAR-CIFRI in pioneering and developing the cage culture technology. Mr. M. S. Dhakad highlighted the potential of cage culture in achieving the second blue revolution in the country. He stressed upon making cage culture technology economically feasible and viable for small scale farmers of the country. A series of publications on cage culture were released on this occasion. A Farmers-Entrepreneurs- Scientist Interface meet was also organised where progressive cage farmers from Odisha and Jharkhand shared their experiences.

Institute Research Committee Meeting 2017-18

The Institute Research Committee Meeting 2017-18 was held at the Institute Headquarters during 18-20 March 2018. Dr. B. K Das, Director chaired the meeting in which all the Scientists of the Institute participated. The Chairman encouraged the scientists to be innovative in their approaches and stressed that the research should have relevance to the farmers, policy makers and other stakeholders. An interface meeting among Scientists and Administrative staff was also held and different issues were discussed. Following this individual scientists presented their research and other achievements made during 2017-18. Dr. B. K. Behera, Principal Scientist presented the work done at RMIT University, Australia under foreign deputation programme.

Events

Exploratory Survey of Inland Fishery Resources of A&N Islands

A team of Scientists from the institute visited A&N Islands during 2-6 May 2017 with a view to explore the feasibility of fisheries development in the inland open waters of the islands. The team was led by Dr. B. K. Das, Director; Dr. B. P. Mohanty and Dr. A. K. Das were the other members. The team interacted with Deptt Officials and visited most part of the main islands of Andaman and interacted with the progressive farmers. The team had an overall assessment of the fisheries resources, fish species including exotics and found ample scope of fisheries development and enhancement both in freshwater sector and coastal zone. The team has identified several areas of intervention including delineation of inland water resources using GIS platform, feasibility of cage culture and simplifying quarantine procedure for easy access of good quality seeds in the Islands from the main lands etc.

Ranching Programmes for Conservation and Restoration of Ganga Fishery

Ranching programme of Mahseer seed in river Ganga at Rishikesh near Lakshman Jhula was organized by the Institute under NMCG (National Mission for Clean Ganga), Ministry of Water Resources, River Development and Ganga Rejuvenation to restore and conserve the depleting and endangered fish species like Mahseer on, 23 May 2017. Dr B. K. Das, Director and Dr. R. S. Srivastava, Head of Allahabad RRC were present on the occasion. Shri Sunil Kumar, a nominee of NMCG, Delhi; Professor, Scientists and officials from Gurukul Kangri University, Haridwar, WII, FRI, Dehradun, Forest Dept. Uttrakhand, Fisheries Dept. Uttrakhand, NIH, Haridwar, Central Pollution Control Board, Central Pollution Research Institute, Haridwar, Ganga Action Plan, Shiv Yog Peeth, Directorate of Coldwater Fisheries Research, Bhimtal, NGOs, Scientists of Directorate of Coldwater etc. were also present.

Another ranching program of IMC was done at Allahabad on 1 August 2017 in collaboration with Directorate of Fishery, Govt. of U. P. and other stakeholders. The seed of Indian Major Carp like Catla, Rohu, Nain in the Ganga River were released under NMCG (National Mission for Clean Ganga). The chief guest of programme, Shri Jai Prakash Nishad, Minister of State, Animal Husbandry and Fishery, U.P. inaugurated the function with lighting the lamp. An awareness programme has also been organized on restoration and conservation of the depleting fish species.

Hon'ble Union Minister Sushri Uma Bharti visited at ICAR-CIFRI, Barrackpore

Hon'ble Union Minister of Water Resources, River Development and Ganga Rejuvenation Sushri Uma Bharti visited ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore, Kolkata on 26 May 2017. Honourable Minister acknowledged the contribution made by the Institute in National Mission on Clean Ganga. She stressed that 'Nirmal Dhara' of river Ganga can be achieved only when original aqualife (fish, dolphin, etc.) of river Ganga can be restored in their own habitats. She released a poster on fishes of River Ganga. Shri U. P. Singh, IAS, Director General of National Mission on Clean Ganga, Shri B. K. Biswas, Chairman, Ground Water Board and Shri Madhusudan Ghosh, Local MLA were also present on this occasion. Fingerlings of Rohu (*Labeo rohita*) and Catla (*Catla catla*) have been released by her in river Ganga at Barrackpore, West Bengal. The Honourable Minister also interacted with the fishers of South 24 Parganas (Sagar Island), Hooghly and Nadia districts of W. B. She appealed all to contribute towards making the Ganga clean and incessant. On behalf of ICAR-CIFRI, she distributed fishing nets to fishers of Sagar Island.

World Environment Day

The Institute celebrated World Environment Day on 5 June 2017 to generate awareness regarding importance of environment in our lives. The theme for world Environment Day 2017 was "Connecting people to nature". A cruise was organized in the Hooghly River under the leadership of Dr. B. K. Das. He urged all for protecting environment and explained that ecosystems are essential to human life as it provides goods and services upon which human welfare depends. Saplings were planted in the Institute residential and office campuses. Rangoli was made by institute staff depicting the role of organisms and their interaction in the ecosystem.

International Yoga Day

The Institute celebrated International Yoga Day on 21 June 2017. The Yoga Session was conducted under the guidance of eminent Yoga experts, Mr. Sujit Ghorei and his group of Yoga Kendra, Barrackpore. The session was conducted based on the Common Yoga Protocol provided by Ministry of AYUSH, Government of India. Around 150 staff members of ICAR-CIFRI and their family attended the program in the morning of 21 June 2017. Earlier, on 20 June 2017 a lecture on "Health benefits of Yoga" was organized for the staff. Other Centres of the Institute also celebrated the day.

National Fish Farmers' Day

The Institute celebrated National Fish Farmers' Day on 10 July 2017 at its Headquarters. The day

commemorates the revolutionary induced breeding technology developed by Dr. Hiralal Choudhury of this Institute. Mr. Ronald Sapa Tlau MP, Rajya Sabha, Mizoram and Chief Guest of the function addressed the farmers and congratulated the team ICAR-CIFRI for immensely contributing in production enhancement and conservation of natural resources. Dr. P. Das, Former Director ICAR-NBFGR was also present. A Farmer-Scientist interaction meeting was organized and it was chaired by Swami Visvamayananda ji, Maharaj, Sargachi Ramakrishna Mission. A bilingual bulletin on awareness and sensitization initiative by ICAR-CIFRI, a bulletin on "Fisheries enhancement in reservoirs of MP with special emphasis on MSY" and an extension pamphlet on canal fisheries were released on this special occasion. Around 100 fish farmers from West Bengal, Bihar, Odisha, Jharkhand and Assam participated in the event. Eight fish farmers from different parts of India were awarded at the function. Nets were distributed to the tribal farmers from Burdwan district of West Bengal.

Independence Day

The institute celebrated 71st Independence Day on 15 August 2017. Dr. B. K. Das, Director unfurled the tricolor and paid rich tribute to the nation. He recalled achievements made in the last year, including sanctioning of new projects and highlights of the existing projects. He congratulated all the staff for the great achievements. Some of the security staff were decorated for their outstanding services. A cultural programme was also organized. A friendly football match was played in which the trainees from Bihar also participated.

Vigilance awareness week

The Vigilance Awareness Week-2017 with the theme “My Vision – Corruption Free India” was observed at the Institute during 30 October – 4 November, 2017. On the first day, Integrity pledge was administered by the Director to the staff members of the Institute. The celebration was marked by competition on slogans/posters, essay writing etc. Students of Class XI and XII from different schools participated in essay writing, cartoon and poster drawing competitions. On 2 Nov 2017 the staff of the institute formed a human chain symbolising togetherness in fighting corruption. A road march and a gram sabha were also organised in Ariala village at Barasat-1 block of North 24 Parganas district for awareness generation on corruption. Shri K. Jayaraman, IPS and Director of Swami Vivekananda State police Academy (SVSPA), West Bengal was the Chief Guest of the concluding ceremony.

Vigilance officers meeting

The Review meeting of Vigilance Officers, Administrative Officers and Finance and Account Officers of 19 ICAR Institutes of Eastern and North Eastern region was held at the Institute Headquarters, Barrackpore on 10 October 2017. Additional Secretary, DARE and Secretary, ICAR Shri Chhabilendra Roul, IAS, presided over the meeting. Sh. Rajan Agrawal, Director, DARE and Chief Vigilance Officer, ICAR; Sh. V. P. Kotyal, Director Works; Sh S. K. Sinha, Under Secretary Vigilance, senior officials of CPWD from Eastern region were present in the meeting. The pending Audit paras, purchase of major equipments and proprietory items and Institute vigilance matters were the focal points for discussion.

Quami Ekta (National integration) week

The staff members of ICAR-CIFRI, Barrackpore observed Quami Ekta (National integration) Week during 19-25 November 2017. A pledge on the theme of secularism, anti communalism and non-violence was taken by all the staff members on 19 November under the guidance of the Dr. B. K. Das, Director of the Institute. An awareness meeting was organised on 22 November in order to foster and reinforce the spirit of communal harmony and national integration. Displaying relevant posters in different locations, the Institute observed Communal harmony Flag Day on 24 November. A fund raising campaign was also organized on the occasion for support of the orphan or destitute children. Concluding programme was organised on 25 November.

World Fisheries day

The Institute celebrated world fisheries day at its Hqs, Barrackpore on 21 November 2017. The celebration was started by ranching 20,000 Indian major carp seed in the River Ganga at Daspara Ghat, Barrackpore under ICAR-CIFRI- NMCG project. The ranching program was followed by an in-house program in which local fishers were sensitized about the various factors behind declining fish biodiversity as well as total fish catch from river Ganga. The fishers pledged their active cooperation towards success of river ranching program for restoration of fishery of Indian major carps in Barrackpore stretch of River Ganga. Dr. B. K. Das, Director, Dr. D. K. De, renowned expert in hilsa fisheries, Dr. Utpal Bhaumik, former HoD of the institute and Dr. M. L. Bhaumik, noted aquaculturist also spoke on issues on sustainable fishery and fishers livelihood.

Agricultural Education day

The Institute celebrated 'Agricultural education day' during 3-5 December 2017 to highlight the importance of agricultural education in nation building. The Day is celebrated all over the country in the memory of our first agriculture minister Dr Rajendra Prasad. Dr. H. S. Sen, Former Director of ICAR-CRIJAF, Barrackore, was the Chief Guest of the programme. About fifty students of B.Sc. (Industrial Fish and Fisheries) from APC College, New Barrackpore participated in the programme of Agricultural Education Day. Lectures followed by laboratory, field visits and demonstrations were organized for them. Thirty students from the College of Fisheries, Ratnagiri visited the institute. In his address, Dr. B. K Das, Director emphasized on the need of quality agricultural education to serve the farming community of the country.

World Soil Day

The Institute celebrated 'World soil day' on 5 December 2017 to generate awareness among the farmers on importance of soil in our life. The theme of this year's World soil day was 'Caring for the planet starts from the ground'. Dr. H. S. Sen, former Director of ICAR-CRIJAF, Barrackore, and an eminent Soil Scientist chaired the programme as Chief Guest. He highlighted soil as the main resource for sustainable agricultural production and the problems associated with maintenance of soil fertility and soil health. He emphasized that increasing production calls for caring for soil health. Fifty farmers from Barasat Block–I, West Bengal attended the programme and soil health cards were distributed to the farmers.

World Wetland Day

A sensitization workshop and demonstration of Climate Resilient Pen Systems (CRPS) for fish raising were organized at Mathura Beel, Kachrapara, North 24 Parganas, West Bengal on 02 Feb 2018 on the occasion of World Wetland day. Dr. Bipul Kumar Das, Dean, CoF, WBUAFS graced the occasion as Chief Guest and the programme was attended by more than 200 fishers of Kanchrapara Refugee Fishermen's Co-operative Society, Ltd (KRFCS). Officials of Department of Fisheries, Scientists and other staff of NICRA project were also present. Dr. B. K. Das, Director inaugurated the model CRPS in Mathura Beel and released fish seed of IMCs, Labeo bata, A. mola, Puntious and Gudusia chapra in the pens. On the occasion ICAR-CIFRI signed a MoU with KRFCS Ltd. for demonstration of climate resilient adaptation strategies in Mathura beel.

Republic Day

The Institute celebrated the Republic Day with great enthusiasm and fanfare on 26th January, 2018. Dr. B. K. Das, Director of the Institute hoisted the tri-colour and paid rich tribute to the nation. In his speech, the Director recounted the achievements of CIFRI during the last one year and also recalled the golden journey of CIFRI. He remarked that a good working atmosphere and team spirit are the key to success. All the CIFRI staff and members of the family were present on the occasion. Activities under Swachh Bharat Abhiyan was organized in the campus.

International Women's Day

International Women's Day was celebrated at the institute Hqs, Barrackpore on 8 March 2018. Dr. V. R. Suresh, Director-in- charge, Heads of Divisions, Chairperson, Women Cell, Member Secretary-Women Cell and Member Secretary-Women Complaint Cell spoke about the importance of International Women's Day and the role of women especially in fisheries sector. A brain storming session on 'Women in fisheries' was organized in which all the staff of the institute actively participated and discussed various issues like safety, drudgery reduction, cleanliness, improving knowledge and skills, participation in development of fisheries policies and decision making etc.

ICAR-CIFRI Foundation Day

The Institute celebrated the 72nd Foundation Day on 17 March 2018 at its Hqs. Barrackpore. The celebration was the culmination of year-long platinum jubilee celebrations of the institute. Dr. D. D. Patra, Vice Chancellor, Bidhan Chandra Krishi Vishwavidyalaya graced the occasion as Chief Guest. Dr. N. P. Singh, Director, ICAR-NIASM, Baramati; Dr. P. Das, Former Director, ICAR-NBFGR, Lucknow; Dr. M. Mukherjee, Additional Director, DOF, West Bengal; Shri Saumyajit Das, MD, SFDC, West Bengal; and Shri Malay Ghosh, Chairman of North Barrackpopre Municipality graced the occasion as Guests of Honour. Retired and present staff of the institute, state department officials, 100 fish farmers, fisherwomen and entrepreneurs from West Bengal, Jharkhand and Odisha were also present.

Various conferences, workshops, seminars and ranching programme in river Ganga, and brainstorming session on different aspects of inland fisheries were organized during the year to commemorate the

platinum jubilee year. On this momentous occasion, two Memoranda of Understanding were signed between the institute and M/s M. R. Aquatech, Bhubaneshwar for 5 year manufacturing license of two CIFRI technologies namely CIFRI PEN HDPE and CIFRI CAGEGROW feed. The audience also watched the live speech of Hon'ble Prime Minister Shri Narendra Modi from Krishi Unnati Mela 2018 at IARI Mela Ground. Progressive fishers and fish farmers of West Bengal, Odisha and Jharkhand were felicitated for their contribution in the development of inland fisheries in India. Meritorious wards of the staff and some institute staff were also felicitated for their excellent contributions.

Other Important Events

- Dr. J. K. Jena, DDG (FS), ICAR, New Delhi visited the ICAR-CIFRI Vadodara centre and had a talk with the Scientists and other staff of the centre on 12 May 2017.
- The institute signed a Memorandum of Understanding with M/s Gitanjali for consultancy on establishment of Fish Feed Mill. The Fish Feed Mill will be contructed at Kalian tala, PO. Bajitpur, PS: Karimpur, District Nadia, West Bengal. Dr B. K. Das, Director from ICAR-CIFRI side and Mr. Giren Vairagya from M/s Gitanjali signed the MOU on 19 Sep 2017.
- Dr. J. Jena, DDG (FS) inaugurated the recirculatory system at Barrackpore.
- *Sankalp Se Siddhi* : The institute observed Sankalp se siddhi shapath for making a new India by 2022.
- Prof. Sam Martin, Professor, Fish Physiology, University of Aberdeen delivered Platinum Jubilee lecture on anti viral responses in fish : new investigations using gene editing on 20 June 2017.
- Awareness meeting on e-marketing with Director, DGS&D, Kolkata on 24-04-17.
- Planting of saplings under Ganga Briksharopan Saptah (25-30July 2017) of NMCG programme.
- Director, ICAR-CIFRI visited cage culture site at Chandil reservoir on 10 July 2017. He held an interactive Meeting with Department of Fisheries, Jharkhand.

Mera Gaon Mera Gaurav

"Mera Gaon, Mera Gourav (MGMG)"or "My Village, My Pride" programme was conceptualized based on the initiative taken by the Honorable Prime Minister of India on 25th July, 2015 at Patna on the joint celebration of Indian Council of Agriculture Research (ICAR) Foundation Day and National Conference of Krishi Vigyan Kendras (KVKs) for better coordination between various centres and institutes of the ICAR and the state agricultural universities. The program is aimed to promote the direct interface of scientists with farmers to accelerate the lab to land process and to provide farmers with required information, knowledge and advisories on regular basis. MGMG is a frontier extension programme under the umbrella of Agricultural Extension. The Deputy Director General, Agricultural Extension Division, ICAR is implementing authority of MGMG in the country through the network of Agricultural Technology Application research Centres (ATARIs) located in different zones.

ICAR-CIFRI adopted fifty (50) villages from four districts, namely, Nadia, Hooghly, North 24 Parganas and South 24 Parganas. A total of seven Kishan Gosthis were organized and literature on climate change and adaptation and mitigation strategies, nutritional value of fishes and conservation of Hilsa fishery were distributed. Linkages were developed between farmers and State Agriculture Departments, State Fisheries Departments. A team of CIFRI scientists are involved in MGMG activities. ICAR-CIFRI has organized two farmer-scientist interaction meetings in the Institute for the farmers from the adopted MGMG villages and more than 100 fishers/fish farmers from different MGMG villages attended the meetings. The farmers were invited in the Institute's important events such as Foundation Day, Fish Farmers' Day as special invitees. The women Self Help Groups (SHGs) from MGMG adopted villages were also promoted for income generating activities. On the occasion of 29th All India Zoology Congress, ICAR-CIFRI organised an exhibition in which SHGs participated.

Dr. J. K. Jena, DDG (Fisheries Science) in agro-product stalls presented by women self-help groups

A total of 25 Soil Health Cards were distributed to the farmers from MGMG villages for better agricultural production. An initiative was taken to imbibe the concept of 'Swachhta' in MGMG adopted village Ariala, Barasat-1, North 24-Pargana District on 6th February, 2018.

Distribution of soil health card among the farmers

To turn kitchen waste to compost, an awareness camp was conducted by ICAR-CIFRI by using the Platform of 'Sabala Mela' which was organized by the self help groups. Sensitization was done regarding biodegradable waste that can convert into compost and can also be used as fertilizer. A green dustbin was given by ICAR-CIFRI to encourage the women of that village to turn kitchen waste into compost.

ICAR-CIFRI provided a green dust bin to Women SHG group

ICAR-CIFRI team visited five villages namely, Khan Saheber Abad, Khas Ramkarerchhar, Krishnanagar, Chandipur and Mansadwip under this program. A community based knowledge sharing meeting was conducted at Sagar Island on 16th February 2018.On this occasion, a discussion was arranged at Swami Vivekananda Cultural Youth Society, Krishnnagar in which a total of 200 people from selected villages attend the meeting. The fish farmers shared their experiences with the other participants on different aspects of fish culture and encouraged more and more people to initiate fish culture as a source of income. The problems were also identified and solutions were provided by CIFRI team members. Availability of quality fish seed in time was a major problem. As the Island is not connected by roads, the cost of bringing seed for stocking the ponds is very expensive. Establishment of fish hatchery was the demand of the group. Some common diseases and their treatments were also discussed. There were a good number of women folk in the meeting and they demanded training on ornamental fish culture.

Dr. B. K. Das, Director, ICAR-CIFRI and Sri B. Hazra, MLA, Sagar Island attended community interactive session during Fish Harvest Mela

'Smart village' concept was derived from Mahatma Gandhi's vision of *Adarsh Gram*, visualized among one of the National initiatives in the country which act as catalyst for holistic development of rural India. With the notion of providing multi-disciplinary information for the overall development of the area for recognising as Smart Village, ICAR-CIFRI has evolved in a dynamized survey of agro-economic conditions of the villagers of a cluster of five villages (Bhabanipur, Bhabanipur char, Chadra, Kshtriyanagar and Milangarh) of Sripur-Balagarh Gram Panchayat under Balagarh block, Hugli district of West Bengal under this MGMG programme. ICAR-CIFRI has surveyed the agricultural resources, cropping systems, fisheries resources, organisational structure, educational facility, health care, access to water, sanitation and human nutrition, enterprises to boost income, gender equality, democratic engagement and took appraisal of problems arising in agriculture, animal husbandry and general issues including villagers, livelihoods and also assembled additional information to carry out SWOT analysis of the villages for enhanced livelihood securities and income generation. The village is endorsed with enormous agricultural resources and also wooden boat building unit which secure livelihood of a major section of the community. Besides this, the SWOT analysis concluded that these villages has wide opportunities such as development of FRP boat industry, initiation of integrated aqua-farming keeping the existing fish-hatchery complex in view, plantation of boat building trees etc. There is immense scope to develop to 'smart village.

A Fish Hatchery Complex (M/S Binoy Hatcheries) at Sripur-Balagarh.

Interactive session with key informant Sri Ashok Biswas, associated with Sripur-Balagarh Anchal Fishermen Cooperative Society.

Tribal Sub Plan Activities

The Institute has been undertaking several activities for livelihood improvement of marginalized tribal population across the states under TSP. The TSP activities were undertaken in 10 districts and 12 locations in West Bengal, Odisha, Madhya Pradesh, Karnataka, Kerala and Assam during this period in which in-house trainings, off-campus trainings, awareness camps-cum-scientist-fish farmer/fishers interface programme and distribution of inputs were organized.

Allahabad Regional centre of ICAR-CIFRI is focusing on the nutritional security and livelihood development of tribal fishers of Loni wetland at Rewa district of MP. Fish seed raising in pen and stocking of advanced fingerling for production enhancement is the major focus of this programme. Fisheries activity in the wetland is managed by "*Jaagaruk Machhua Sahkaari Samiti Maryadit –Khatakri Khurd*". The centre, led by Dr. B.K. Das, Director conducted awareness camp on 04 April 2017 followed by distribution of fishing nets. Dr. R. S. Shrivastava, Head, Allahabad RRC, Dr. B.P. Mohanty and the staff of Allahabad Centre also interacted with the tribal people. The team felt that enclosure culture of fishes holds a great promise for harnessing the potential of ecosystem, employment generation and poverty alleviation of rural tribals. Accordingly, the centre built capacity of the tribal fishers for the Loni wetland management and raising of fingerling in pens as stocking material for wetland. Fishing nets were also distributed to them.

Sagar Island, also known as Ganga Sagar, is a part of Indian Sunderbans rich in mangrove swamps, water ways and small rivers. Tribals, particularly the Santhal community, have significant share in total population in this area. A fish harvest mela was organized by the Institute on 14 June 2017 and a total of 861 kg brackish water as well fresh water fishes were harvested from

0.662 ha. Earlier, the fish seeds were distributed among the fishers to stock in the canals. Ten families could earn more than ` 2 lakhs in the current year. A sensitizing meeting was also organized in which local MLA, local Sabhapati, *Karmadhaksya*, Director, ICAR-CIFRI, Incharge Kolkata RS of ICAR-CIFRI and about 100 villagers participated. On 26 October 2017 a team of dignitaries comprising of Dr. Panjab Singh, Former DG, ICAR; Dr. S. Raizada, ADG, Inland Fisheries, ICAR; Dr. P. K. Agarwal, ADG, NASF, ICAR; Dr. R. T. Patil, Former Director, ICAR-CIPHET; Dr. R. Tuli, Former Director ICAR-IISS; Dr. C. L. Acharya, Former Director, ICAR-NBRI and Dr. B. K. Das, Director, IACR-CIFRI visited the TSP site of Sagar Islands and interacted with tribal fishers. They also distributed fishing nets to the tribal fishers.

Another fish harvest mela was organized on 24 August under the leadership of the Director, at Kalitala, Hingalaganj, Sundarban area of West Bengal. Kalitala is a remote socio-economically poor tribal dominated village of Indian Sundarban area, vulnerable to flood and cyclone. ICAR-CIFRI has initiated livelihood support programme by introducing canal fisheries development through technical support, inputs and capacity building programme. The canal of Kalitala is around 850m x 30m in area. A total of 6 tons fishes mainly catla, rohu and mrigal were harvested from the canal during this year. A total of 90 tribals were involved in this programme. On the

occasion, a workshop-cum-awareness programme was organized in which Dr. B. K Das discussed different aspects of fish disease and nursery pond management. Two mass awareness camps on "Fish farming in unutilized canals through community based culture fisheries" were organized involving 600 tribal fishers in Amtoli village, Gosaba, Sunderban on 18 Feb 2018 and for 150 tribal fishers in Kalitala Village, Hingalganj, Sunderban on 19 Feb 2018. Dr. A. E. Eknath, Former DG, NACA; Dr. Dilip Kumar, Former VC, ICAR-CIFE; Dr. V. R. Chitranshi, Former ADG (Inland Fisheries), ICAR; Dr. B. C. Jha, former HoD, ICAR-CIFRI and Dr. B. K. Das, Director, ICAR-CIFRI interacted with the tribal fishers during the mass awareness programmes.

A team of ICAR-CIFRI conducted an interaction meeting at Gardanmari village situated at Bhatar Block of Burdwan district of West Bengal on 12 September 2017. Approximately 650 households concentrated in the village, majority of them are tribals. A sample survey showed that about 45% of the population is illiterate and about 65% are landless labourers. A wetland (Adivasi dighi) of around 10 ha area is the major fishery and water resource for them. *Gardanmari Adibasi Dighi Unnayan Samiti* is striving for developing fisheries in that wetland. The water quality parameters were tested at the site and sediment samples were collected. The institute also provided fish feed to the Society for enhancing production. Fish feeds and fishing nets were also distributed among the fishers of Gradanmari wetlands.

The institute also initiated TSP activities at Kalo reservoir and MIP Rajabandha of Mayurbhanj district of Odisha. Mayurbhanj ranks 15th among the most underdeveloped districts of India. 60% of the population of the district is tribals and the district is bestowed with vast water resources including 12 reservoirs with a mean water area of 4407 ha. The ICAR-CIFRI team, led by the Director Dr. B. K. Das visited the reservoir and MIP Rajabandha on 20-21 August 2017. Kalo reservoir is having a mean water spread area of 584 ha and around 110 fishers depend on this reservoir for their livelihoods. The fishing is done by the PFCS *Maa Mangala*. On the other hand the Raja Bandha MIP of Badasahi Block of Mayurbhanj is having an area of 11 ha water spread area on which livelihood of 115 tribal families of 3 villages depend. The team felt the need of scientific management of these water resources including culture based fisheries. The team also visited the tribal ornamental fish breeding and rearing cluster in Bhandarikula and adjoining villages. Eight coracles were distributed to the tribal fishers in Kalo reservoir.

The Kochi Research Station sensitized the tribal fishers for fisheries management in small reservoirs in Palakkad, Kerala. Similarly, the Guwahati regional centre sensitized the tribal fishers of Goalpara district on the aspects of fisheries development in the derelict water bodies in collaboration with Rubber Board, Zonal Office, Guwahati.

Input distribution and training under TSP

Glimpses of Swachh Bharat Activities

Inauguration of *'Swachhta hi seva'* campaign on 15.09.17

Swachhta Hi Seva Pakhwara at Barrackpore

Planting of saplings at Hingalganj, Sundarbans

Swachhta Shramdan at Barrackpore on 17.09.17

Samagra Swachhta Diwas by Barrackpore staff on 24.09.17

Sarwatra Swachhta Diwas by Barrackpore staff on 25.09.17

Closing ceremony of *Swachhta hi seva pakhwara* on 02.10.17 at Barrackpore

Director, ICAR-CIFRI handing over cleaning materials and *Swachh Bharat* uniforms to the members of Milan Dwip Development Society, Balagarh, West Bengal

Swachhta activity on Republic Day at ICAR-CIFRI, Barrckpore campus

Swachhta activities by Allahabad RRC

Swachhta hi seva shapath at Bangalore RRC

Cleaning activities at Hesarghatta lake during *Swachhta hi seva* by Bangalore RRC

Awareness among school children in Manchanbele Village by the Bengaluru staff

Swachhta hi seva shapath at Kochi R.S. on 15.09.17

Outdoor Swachhta campaign by Kochi R.S. on 23.09.17

Cleanliness activities around Samaguribeel, Nagaon district,Assam

Cleaning campaigning at Kolkata Research Station

Swachhta activities at Vadodara RRC

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Hkk–vui&dUæh; ekfRL;dh f'k{kk lLFkku] eEcb vkj çk- jeu f=onh] if'pe cxky çk.kh ,o ekfRL;dh fo'ofo|ky;] dkydkrk fo'k"k vfrfFk FkA vU; x.ekU; vfrfFk;k e çk- lR; çdk'k frokjh] çHkkxk/;{k] fgnh foHkkx] f'koij nhuc/k dkyt] gkoMk u viu 0;k[;ku e fgnh e dr0;fu"Bk l dk; dju dk vkºoku fd;kA lLFkku d fun'kd Mk- clUr dekj nkl u viu oä0; e dgk fd fgnh ek/;e l vk;kftr oKkfud dk;'kkyk l oKkfud ,o eRL; ikyd nkuk gh ykHkkfUor gkxA rRi'pkr dk;'kkyk dk rduhdh l= vkjEHk gvkA ;g rduhdh l= Mk- ch- lh- >k] io çHkkxk/;{k ,o Mk- oh- vkj- lj'k] çHkkxk/;{k dh v/;{krk e lEiUu gvkA

fgnh lIrkg 2017

lLFkku e[;ky; e fnukd 14 l 21 flrEcj 2017 d nkjku fgnh lIrkg dk vk;ktu fd;k x;kA bl ckj lLFkku e fgnh lIrkg dk ,d fo'k"k vkd"k.k Fkk] bldk Hkkjrh; foKku dkxl lLFkk] dkydkrk d lkFk l;ä :i l fgUnh lIrkg dk mn?kkVu djukA bl dk;Øe d lEekuh; vfrfFk Mk- v'kkd dekj lDluk] io egk/;{k] Mk- eukt dekj pØorh] egk/;{k] Mk- ½Jherh¼ fot;y{eh lDluk] io egklfpo] Mk- vfer –".k n] dk;dkjh lfpo] Hkkjrh; foKku dkxl lLFkk] dkydkrk ,o lLFkku d io çHkkxk/;{k] Mk- cfde pUæ >k FkA fgnh lIrkg d nkjku fun'kd] Mk- fc- d- nkl

dh v/;{krk e fnukd 15 flrEcj dk ,d fnolh; dk;'kkyk Þvrlkyh; ekfRL;dh dh oreku voLFkk ,o lEHkkouk,ß dk vk;ktu fd;k x;kA bl dk;'kkyk e lLFkku ,o vU; lLFkkuk d oKkfudk u viuy[k çLrr fd; rFkk mR—"V y[kk dk ijL—r fd;k x;kA fgnh llrkg dk lekiu lekjkg fnukd 26 flrEcj] 2017 dk vk;kftr fd;k x;k A fun'kd egkn; u oKkfud dk;'kkyk gr r;kj dh xb ,d y?k Lekfjdk ,o 'kk/k lkjk'k ifLrdk dk v,uykbu foekpu fd;kA fgnh llrkg d nkjku fofHkUu çfr;kfxrkvk dk Hkh vk;ktu fd;k x;k Fkk ftle Hkkx yu oky vf/kdkfj;k] depkfj;k] 'kk/k Nk=&Nk=k, ,o vU; dfe;k dk çfjr dju gr ijL—r fd;k x;kA

lLFkku d xokgkVh dæ e 14 l 20 flrEcj 2017 d nkjku fgUnh llrkg dk vk;ktu fd;k x;kA bl nkjku M, #Lre jk;] mifun'kd ¼iokÙkj {k=½ fgUnh f'k{k.k ;ktuk] jkthHkk"kk foHkkx }kjk ÞvulU/kku lLFkkuk e jkthHkk"kk fgUnh dk ç;kx dl c<k;ß ij 0;k[;ku fn;kA blh Øe e **iokÙkj {k= e ekfRL;dh fodkl** fo"k; ij ,d fnolh; fgUnh dk;'kkyk dk vk;ktu 19 flrEcj 2017 dk fd;k x;kA dk;'kkyk d fo'k"k vfrfFk Jh guhQ vyh] mi&eMy] eRL; fodkl vf/kdkjh] jfx;k FkA fgUnh llrkg d nkjku ç'ukÙkjh] okn&fookn vkj 'kCnkFk y[ku çfr;kfxrkvk dk vk;ktu fd;k x;kA lLFkku d oMknjk dæ e Hkh fnukd 14 l 21 flrEcj 2017 rd fgnh llrkg euk;k x;kA fnukd 19 flrEcj 2017 dk ,d fgnh dk;'kkyk dk vk;ktu fd;k x;kA bl dk;'kkyk e M,- ch- ,y- 'kekj lgk;d fun'kd] uxj jkthHkk"kk] oMknjk rFkk Jh /ku'k ijekj] ofj"B fgnh vuoknd] goh okVj lykV] oMknjk fo'k"k rkj ij mifLFkr FkA fgnh llrkg d nkjku çfr;kfxrkvk e fotrkvk dk ijL—r fd;k x;kA

Library and Informatics

Institute Library and Informatics Section is one of the oldest repertoire of fish and fishery related books, journals and other documents. With precious collections of more than 10,000 books, 5,000 journals, and 5,000 other valuable documents, it facilitates knowledge sharing and enrichment among both internal and external users. During 2017-2018, ICAR-CIFRI Central library located at Barrackpore added more than 100 numbers of documents including 12 scientific books, and also subscribed 27 Indian journals to strengthen its resources. Other than documents received from outside, the library has also been enriched with books, leaflets, posters, newsletters, roadmaps, policy papers, souvenirs, etc. published by CIFRI. The Institute has also strengthened libraries of its six Regional Centres and Stations by procuring books and journals for them. Library and Informatics Section at HQ has four distinct segments- Scientific books, Journals, CIFRI publications and Hindi books. Whole catalogue of books in Central Library is presently digitized under KOHA Open Source Library Management Software and available for online search through CIFRI website as well as through 'Agricat', a Union catalogue available to all NARS institutes for online search. It is regularly updated whenever new books etc are added in the library holdings. CIFRI library has become an active member of 'CeRA' Consortium. It sent 37 documents to different NARS institutes through Document Delivery request (DDR) during the year. A sensitization program entitled “J-Gate as one stop platform for discovering scholarly journal articles” has also been organized at HQ on 19.09.2017 where technical personnel from Global Informatics, Bangalore have interacted with the staff regarding issues with the use of CeRA facilities or download from J-Gate.

Staff Information

Staff Position (as on 31. 03. 2018)

Category	Sanctioned Strength	Filled up	Vacant
R.M.P.	1	1	----
Scientist	95	86	9
Technical	85	50	35
Administrative	67	36	31
Skilled Support Staff	130	44	86
TOTAL	378	217	161

Centre-wise staff in position (as on 31. 03. 2018)

Name of the Centre	R.M.P.	Scientist	Technical	Administrative	SSS	Total
Barrackpore	1	54	35	29	21	140
Kolkata	---	03	01	01	---	05
Vadodara	---	04	03	01	05	13
Allahabad	---	07	05	02	07	21
Bangalore	---	07	01	02	03	13
Guwahati	---	08	03	01	04	16
Kochi	---	03	02	---	04	09
TOTAL	1	86	50	36	44	217

Financial Up-gradation under MACP :

Sl. No.	Name and designation	Benefits granted	With effect from
1.	Shri N. Deka, SSS	3rd MACP with grade pay of Rs. 2400/-Level-4	09 Sept 2017
2.	Shri M. L. Sarkar, SSS	3rd MACP with grade pay of Rs. 2400/-Level-4	20 Nov 2017
3.	Shri B. K. Sahani, SSS	2nd MACP with grade pay of Rs. 2000/-/Level-3	09 Nov 2017
4.	Ms. G. Vinoda Laxmi, Pvt. Secretary	3rd MACP with grade pay of Rs. 4800/-/Level-8	14 Dec 2017

Personnel

Headquarter, Barrackpore
Director
Dr. B. K. Das
Heads of Divisions
Dr. V. R. Suresh
Dr. B. P. Mohanty
Dr. U. K. Sarkar
Principal Scientists
Dr. S. Samanta
Dr. Malay Naskar
Dr. S. K. Nag
Dr. B. K. Behera
Dr. S. K. Manna
Dr. R. K. Manna
Dr. M. A. Hassan
Dr. A. K. Das
Dr. (Md.) Aftabuddin
Dr. A. K. Bera
Dr. Arun Pandit
Scientists
Shri P. Maurye
Dr. D. Das
Shri D. Karunakaran
Shri S. K. Sahu
Smt. Sajina A. M.
Dr. Soma Das
Dr. Rohan Kumar Raman
Smt. Tanuja Abdulla
Dr. P. K. Parida
Smt. P. R. Behera
Shri Vikas Kumar
Dr. A. K. Sahoo
Shri Roshith C.M.
Shri Raju Baitha
Sushri Suvra Roy (on study leave)
Smt. Kavita Kumari
Shri S. K. Koushlesh
Shri M. H. Ramteke
Shri Shravan Kumar Sharma
Sushri Nirupada Chanu
Shri D. K. Meena
Dr. Sandhya K. M.
Dr. Suman Kumari
Shri Vikash Kumar (on study leave)
Shri Lianthuamluaia
Smt. Gunjan Karnatak

Scientists (contd……)
Shri Mishal P.
Shri Himanshu Sekhar Swain
Shri Tasso Tayung
Sushri Pritijyoti Majhi
Shri Ganesh Chandra
Dr. Aparna Roy
Sushri Anjana Ekka (on study leave)
Smt. Tanushree Bera
Sushri J. Canciyal
Dr. Monika Gupta
Dr. Dhruba Jyoti Sarkar
Shri N. Rajendra Naik
Smt. Piyashi Deb Roy
Technical Staff
Dr. S. Bhowmick
Smt. Sucheta Majumder
Shri L. R. Mahaver
Smt. Keya Saha
Shri S.K.S.S. Hameed
Shri S. K. Paul
Shri S. Bandyopadhyay
Shri Arijit Ghosh
Sk. Rabiul
Shri A. K. Jana
Shri R. C. Mandi
Shri C. N. Mukherjee
Smt. A. Sengupta
Shri D. Saha
Shri A. Roy Chowdhury
Shri S. Mondal
Smt. Suvra Saha
Shri Subrata Das
Md. Y. Ali
Shri B. K. Naskar
Shri Sujit Chowdhury
Shri Atanu Das
Shri M. Roy
Shri D. K. Biswas
Shri Loknath Chakraborty
Shri S. R. Meena
Shri T. K. Halder
Shri Soumitra Roy
Shri S. K. Biswas
Shri A. K. Mondal
Md. Quasim

Technical Staff (contd.....)
Shri A. Chakraborty
Shri Giridhari Pramanick
Shri Sanjay Kumar Das
Sushri Sunita Prasad
Administrative Staff
Shri Rajeev Lal, CAO
Shri Sudipta Gupta, AAO
Shri Sujit Ghosh, AAO
Sushri Sefali Biswas, AAO
Shri Subir Das, AAO
Shri Biswajit Barua, AAO
Smt. Pausali Mukherjee, AAO
Shri S. S. Ghosh, AAO
Smt. Jolly Saha, Private Secretary
Shri Pratyay Sarkar, Assistant
Shri Santosh Sarkar, Assistant
Shri Raushan Kumar, Assistant
Shri G. C. Barman, Assistant
Shri Satyabrata Biswas, Assistant
Smt. S. Mitra, Assistant
Shri Sukumar Sarkar, Assistant
Shri Kishore Shaw, Assistant
Smt. Runa Ghosh, Assistant
Shri M. Joarder, Assistant
Shri Chandan Chakraborty, Assistant
Smt. Swapna Chattopadhyay, Assistant
Shri Bijoy Kumar Roy, UDC
Smt. Mousumi Banerjee, UDC

Administrative Staff (contd.....)
Shri Fazal Khan, UDC
Shri Pradipta Sen, UDC
Shri Suranjan Singh, UDC
Shri B. L. Dhanuk, LDC
Shri Ganesh Bhanja, LDC
Shri Swapan Kumar Das, Time Keeper
Skilled Support Staff
Shri Somenath Banerjee
Shri P. C. Paramanick
Shri D. K. Das
Shri A. N. Prasad
Shri Gopal Chandra Roy
Shri M. L. Sarkar
Shri U. S. Ram
Shri D. Singha
Smt. Kalyani Biswas
Shri Ratan Das
Shri Anil Ch. Das
Shri Manabendra Dutta
Shri Ravi Kumar Sonkar
Shri Sukhen Das
Smt. Sibani Bhttacharjee
Shri P. R. Mahata
Smt. Bindu Singh
Shri Shabbir Ahmed
Shri B. K. Sahani
Shri Swapan Gayen
Shri K. C. Malakar

CIFRI Head Quarter, Barrackpore

Allahabad Regional Research Centre

Allahabad Regional Research Centre
Scientists
Dr. R.S. Srivastava, Sr. Scientist & Officer-in-Charge
Dr. D. N. Jha, Scientist
Md. Absar Alam, Scientist
Shri S. C. Sukla Das, Scientist
Shri Jeetendra Kuma, Scientist
Shri V. Ramrao Thakur, Scientist
Shri Rahul Das, Scientist, Scientist
Technical
Shri S. K. Srivastava
Dr. (Ms) Kalpana Srivastava
Shri Vijay Kumar
Shri J. K Singh
Shri Ram Sajiwan
Administrative
Smt. Divya Jain
Shri Manish Kumar Singh
Skilled Support Staff
Shri Sitala Prasad
Shri Gopal Chand
Shri J. R. Prasad
Smt. Laxmi Devi
Shri Anil Kumar
Shri M. R. Rana
Shri Kamlesh Kumar

Bangalore Regional Research Centre
Scientists
Dr. Preetha Panikkar, Principal Scientist & Officer-in-Charge
Dr. M. Feroz Khan, Scientist
Shri M. Karthikeyan, Scientist
Smt. Ramya V. L., Scientist
Smt. Sibina Mol. Scientist
Shri Ajoy Saha, Scientist
Smt. Jesna P. K., Scientist
Technical
Shri Vijay Kumar M.E.
Administrative
Smt. G. Vinoda Laxmi
Smt Sumithra Devi
Skilled Support Staff
Shri M. Pennappa
Shri M. Mari
Shri R. Nagrajan

Bangalore Regional Research Centre

Kochi Research Station

Guwahati Regional Research Centre

Guwahati Regional Research Centre
Scientists
Dr. B. K. Bhattacharjya, Principal Scientist & Acting Head
Dr. Sona Yengkokpam, Scientist
Dr. Dipesh Debnath, Scientist
Shri Anil Kumar Yadav, Scientist
Dr. Pronob Das, Scientist
Smt. Niti Sharma, Scientist
Shri Simanku Borah, Scientist
Shri N. S. Singh, Scientist
Technical
Shri K. K. Sharma
Shri Bipul Chandra Roy
Shri Amulya Kakati
Administrative
Shri Ranjit Kumar Roy
Skilled Support Staff
Shri N. Deka
Shri S. Kalita
Shri Hemanta Das
Shri Sudama Basfore

Kochi Research Station
Scientists
Dr. Rani Palaniswamy, Principal Scientist & Officer-in-Charge
Dr. T. T. Paul
Dr. Deepa Sudheesan
Technical
Shri S. Monoharan
Smt. Usha Unnithan
Skilled Support Staff
Shri P. V. Shajil
Shri T. V. Velayudhan
Smt. M. G. Soudamini
Shri S. Govindarajan

Kolkata Research Station
Scientists
Dr. A. Sinha, Principal Scientist & Officer-in-Charge
Dr. S. K. Das, Principal Scientist
Shri Pronob Gogoi, Scientist
Technical
Shri Arunava Mitra
Administrative
Smt. Suvra Bhattacharyya

Vadodara Regional Centra
Scientist
Shri Kamble Suhas Prakash, Officer-in-Charge
Dr. Dibakar Bhakta (on study leave)
Shri Wakambam Anand Meetei
Shri Vaisakh G.
Technical
Shri R. K. Sah
Shri J. K. Solanki
Shri Ram Prasad
Administrative
Shri C. D. Parmer
Skilled Support Staff
Shri R. N. Kantibhai
Shri H. J. Chetanbhai
Shri S. C. Machi
Shri S. C. Tadvi
Shri A.V. Dangar

Kolkata Research Station

Vadodara Regional Research Centre

New Appointments

New Appointment of ARS Scientists :

Smt. Tanushree Bera,
Scientist, Soil Sc.
Joined on 11.10.2017

Sushri J. Canciyal,
Scientist, FRM,
Joined on 16.10.2017

Dr. Monika Gupta,
Scientist, Aquaculture,
Joined on 16.10.2017

New appointment Administrative Staff :

Sl.No.	Name & Designation	Place of Posting	With Effect From
1.	Shri Raushan Kumar, Assistant	ICAR-CIFRI, Barrackpore	29.09.2017
2.	Shri Gauranga Ghosh, F&AO	ICAR-CIFRI, Barrackpore	25.04.2017 (Additional Charge)

Promotions

Administrative Staff Promotion :

Name & Designation	Promoted to	With effect from
Shri Bablu Kumar Naskar, Sr. Technician	Technical Assistant	02 April 2013
Dr. Ajay Saha, Scientist Rs. 6000 RGP	Scientist, Rs 7000 RGP	27 April 2015
Shri Saket Kumar Srivastava,ACTO	Chief Technical Officer	01 Jan 2016
Smt. K. Sucheta Majumder, ACTO	Chief Technical Officer	01 July 2016
Dr. Ranjan Kumar Manna, Sr. Scientist	Principal Scientist	19 July 2016
Ms. Sunita Prasad, STO	Assistant Chief Technical Officer	04 Oct 2016
Dr. Asit Kumar Bera, Sr. Scientist	Principal Scientist	01 Jan 2017
Shri Lokenath Chakraborty, STA	Technical Officer	30 May 2017
Shri Ranjit Kumar Roy, UDC	Assistant	21 June 2017
Smt. Usha Unnithan, Technical Officer	Senior Technical Officer	24 June 2017
Shri Manish K. Singh, LDC	Upper Division Clerk	21 July 2017
Md. Fazal Khan, LDC	Upper Division Clerk	21 July 2017

Probation Clearance

Name of the Scientists	Discipline	Date of initial appointment	Date of completion of Probationary period (2 years)	Present place of posting
Smt. V. L. Ramya	Fish Genetics & Breeding	01 Jan 2014	31 Dec 2015	Bangalore RRC
Dr. Pranaya Kumar Parida	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Barrackpore Hqs.
Shri Vaisakh G.	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Vadodara RRC
Smt. Sibina Mol S.	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Bangalore RRC
Smt. Niti Sharma	Fish Genetics & Breeding	01 Jan 2015	31 Dec 2016	Guwahati RRC
Shri Jeetendra Kumar	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Allahabad RRC
Shri Simanku Borah	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Guwahati RRC
Shri Wakambam Anand Meetei	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Vadodara RRC
Smt. Thangjam Nirupada Chanu	Fisheries Resource Management	01 Jan 2015	31 Dec 2016	Barrackpore Hqs.
Shri N. Samarendra Singh	Agricultural Chemicals	01 July 2015	30 June 2017	Guwahati, RRC
Shri Satish Kumar Koushlesh	Fisheries Resource Management	01 July 2015	30 June 2017	Barrackpore Hqs.

Supperannuations

Name & Designation	Last place of posting	Date of superannuation
Shri T. K. Gayen, SSS	Barrackpore Hqs.	05 May 2017
Dr. M. K. Bandyopadhyay Pr. Scientist	Barrackpore Hqs.	30 Sept 2017
Shri S. Karmakar Assistant	Barrackpore Hqs.	30 Sept 2017
Shri Biswanath Bose, Sr. Technician	Barrackpore	30 Nov 2017
Shri Mahadeo Panika, SSS	Allahabad	31 Dec 2017
Shri Sudama Basfore, SSS	Guwahati	31 March 2018
Shri Swapan Gayen, SSS	Barrackpore	31 March 2018

Transfers

Transfer from ICAR-CIFRI :

Name & Designation	Transferred to	Date of relieving from ICAR - CIFRI
Shri S. K. C. Bose, SF & AO	ICAR-CPCRI, Kasaragod	07 April 2017
Dr. Manas H. M., Scientist	ICAR-CMFRI, Kochi	29 September 2017
Shri Navin Kumar Jha, AO	ICAR-NIRJAFT, Kokata	23 December 2017

Transfer to ICAR-CIFRI :

Name & Designation	Transferred from	Date of Joining at ICAR-CIFRI
Smt. Piyashi Debroy, Scientist	ICAR RC-NEH, Barapani	01 April 2017
Shri V. Ramrao Thakur, Scientist	ICAR-CIARI, Port Blair	05 April 2017
Shri Kamble S. Prakash, Scientist	ICAR-CIFA, Bhubaneshwar	03 April 2017
Shri Rahul Das, Scientist	ICAR-RC NEH, Barapani	11 April 2017
Dr. Hemanta Chowdhury, Pr. Scientist	ICAR-CRIJAF, Barrackpore	19 April 2017
Dr. Dhruba Jyoti Sarkar, Scientist	ICAR-IARI, New Delhi	01 July 2017
Shri N. Rajendra Naik, Scientist	ICAR-CMFRI, Cochin	03 July 2017

Intra-institutional transfer

Name & Designation	Transferred from	Transferred to
Shri R. Nagarrajan, SSS	Kochi RS	Bangalore RRC
Shri Ram Prasad, STA	Vadodara RRC	Barrackpore
Shri Kamlesh Kumar, SSS	Allahabad RRC	Barrackpore
Shri Ranjit Roy, Assistant	Barrackpore	Guwahati RRC
Dr. Deepa Sudheesan, Scientist	Barrackpore	Kochi RS

OBITUARY

Dr. Sukriti Ranjan Das, (Retd.) Principal Scientist
expired on 5th June 2017

Shri Gobinda Chandra Laha, (Retd.) Scientist (Sr. Gr.)
expired on 4th August 2017

Dr. Benoy Krishna Biswas, (Retd.) Chief Technical Officer
expired on 25th October 2017

Shri Gunendra Lal Lahiri, (Retd.) Private Secretary
expired on 21st February 2018

Publications

Research Papers

1. Alam A, Joshi KD, Das SCS, Jha DN, Srivastava K, Vijay K and Bhattacharjya BK (2017). Enhancing fish productivity through pen culture: A case study in Sareni wetland of Uttar Pradesh. *Indian Journal of Fisheries*, 64 (Special Issue): 8-13.

2. Anand PSS, Kumar S, Kohli Singh MP, Sundaray JK, Sinha A, Pailan GH and Dam Roy S (2017). Dietary biofloc supplementation in black tiger shrimp, *Penaeus monodon:* Effects on immunity, antioxidant and metabolic enzyme activities. *Aquaculture Research*, 48: 4512-4523.

3. Baitha R, Karna SK, Ray A, Chanu TN, Swain HS, Ramteke MH, Bayen S, Manna RK and Das BK (2018). Length–weight and length–length relationships of eight fish species from river Ganga, India. *Journal of Applied Ichthyology*, https://doi:10.1111/jai.13698.

4. Baitha R, Sinha A, Koushlesh SK, Chanu T, Kumari K, Gogoi P, Ramteke M, Borah S and Das BK (2018). Length-weight relationship of ten indigenous freshwater fish species from Gandak River, Bihar, India. *Journal of Applied Ichthyology*, 34(1): 233-236.

5. Bakshi S, Behera S, Saha S, Mandal A, Das A, Bhakta D, Mondal A and Patra P (2018). Influence of spirulina powder at carotenoids concentration in fin of an ornamental fish *Trichogaster lalius*. *Journal of Entomology and Zoology Studies*, 6(1): 870-873.

6. Baksi S, Behera S, Bhakta D, Kumar S, Jomang O, Saha S and Mondal A (2017). Effects of spirulina powder in colouration and growth enhancement of an indigenous ornamental fish T*richogaster lalius*. *International Journal of Advanced Biological Research*, 7(2): 263-267.

7. Bandopadhyay C, Manna SK, Maitra N, Samanta S and Chowdhury AN (2017). Significant arsenic reduction by pond sediment microflora in arsenic affected Bengal Delta. *Soil and Sediment Contamination*, 26(5): 471–485.

8. Banerjee S, Mahanty A, Guha Mazumder D, Cash P and Mohanty BP (2017). Identification of potential biomarkers of hepatotoxicity by plasma proteomic analysis of arsenic-exposed carp *Labeo rohita*. *Journal of Hazadrous Material*, 336: 71-80.

9. Barik S K., Muduli P R., Rath P and Samanta S (2018). Spatial distribution and potential biological risk of some metals in relation to granulometric content in core sediments from Chilika Lake, India. *Environmental Science and Pollution Research*, 25: 572-587.

10. Behera BK, Bera AK, Paria P, Das A, Parida PK, Kumari S, Bhowmick S and Das BK (2018). Identification and pathogenicity of *Plesiomonas shigelloides* in Silver Carp. *Aquaculture*, 493: 314-318.

11. Behera BK, Das A, Sarkar DJ, Weerathunge P, Parida PK, Das BK, Thavamani P, Ramanathan R and Bansal V (2018). Polycyclic aromatic hydrocarbons (PAHs) in inland aquatic ecosystems: Perils and remedies through biosensors and bioremediation. *Environmental Pollution*, 241: 212-233.

12. Behera BK, Paria P, Das A, Bhowmick S, Sahoo AK and Das BK (2017). Molecular characterization and pathogenicity of a virulent *Acinetobacter baumannii* associated with mortality of farmed Indian Major Carp *Labeo rohita* (Hamilton 1822). *Aquaculture*, 471: 157-162.

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113. Samanta S, Nag SK, Saha K, Bandyopadhyay S, Ghosh A, Paul SK, Bhowmick S, Sudheesan D, Sajina AM, Naskar M, Mohanty BP and Das BK (2017). Trace metal contaminations in river Mahanadi. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

114. Samanta S, Chowdhury A, Manna SK and Mohanty BP (2018). Arsenic contaminations in aquatic ecosystems from endemic areas of West Bengal. *In:* Book of abstract, National Conference on Organic waste management for food and environmental security, held during February 08-10, 2018 at ICAR-Indian Institute of Soil Science and Bhopal Chapter of Indian Society of Soil Science, Bhopal, India.

115. Samanta S, Nag SK, Saha K, Bandopadhyay S, Ghosh A and Das BK (2018). How safe are the waste water aquaculture systems with respect to metal and pesticide contaminations? *In:* Book of abstract, National Conference on organic waste management for food and environmental security, held during February 08-10, 2018 at ICAR-Indian Institute of Soil Science and Bhopal Chapter of Indian Society of Soil Science, Bhopal, India.

116. Samanta S, Nag SK, Saha K, Mohanty BP and Das BK (2017). Inland water pollution - A growing concern for maintenance of aquatic health. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017at Kochi, Kerala, India.

117. Sandhya KM and Prasad S (2017). *Antarsthaliya jal sansadhan kshethr par adrishya matsyayan (ghost fishing) ka prabhav*. *In*: Smarika evum Sodh Saransh: Antarsthaliy Matasyaki ki Vartman Avastha evum Sambhavnaye, organised on September 15, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

118. Sandhya KM, Lianthuamluaia L, Sarkar UK, Karnatak G, Kumari S, Kumar V, Naskar B and Ali Y (2017). An assessment of species diversity, composition, conservation and management of fish communities from a tropical reservoir, Jharkhand. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017 at Kochi, Kerala, India.

119. Sandhya KM, Hassan MA, Lianthuamluaia L, Sarkar UK, Kumari S, Mishal P, Kumar V, Ali Y and Naskar B (2017). Fish assemblage in a seasonally open wetland, Khalsi, West Bengal: composition and pattern of diversity. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

120. Sarkar SD, Naskar M, Gogoi P, Raman RK, Manna RK, Samanta S, Mohanty BP and Das BK (2017). Impact of barge movement on phytoplankton in lower Ganga, India. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017 at Kochi, Kerala, India.

121. Sarkar SD, Behera SK, Nagesh TS, Das A, Johnson C and Bhakta D (2018). Awareness level of fishers for conservation of *Tenualosa ilisha* in selected areas of Hooghly-Matlah estuary in West Bengal. *In:* Books of abstract, National Symposium on Role of Veterinarians in improving food safety through 'one World-one health and one medicine' approach in India, held during January10-11, 2018 at WBUAFS, Kolkata, India.

122. Sarkar SD, Behera SK and Bhakta D (2018). Feeding intensity and diet composition of Indian shad, *Tenualosa ilisha* occurring in Hooghly estuary system of West Bengal. *In:* Books of abstract, National Symposium on Role of Veterinarians in improving food safety through 'one World-one health and one medicine' approach in India, held during January10-11, 2018 at WBUAFS, Kolkata, India.

123. Sarkar SD, Samanta S, Mohanty BP, Naskar M, Manna RK, Sahoo AK, Raman RK, Gogoi P, Sengupta A and Das BK (2017). Effect of barge movement on primary producers: an impact study in Bhagarathi-Hoogly stretch of river Ganga. *In:* Book of abstract, All India Zoological Congress and International

Symposium on Culture Based Fisheries in Indian open water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

124. Sarkar UK, Kumar S, Sandhya KM, Liamthumluaia, Karnatak G, Mishal P, Das AK and Das BK (2017). *Bhartiya jalashayo me matsyapalan samvardhan ki sthiti, pratyashit sambhavnaye*. *In:* Smarika evum Sodh Saransh: Antarsthaliy Matasyaki ki Vartman Avastha evum Sambhavnaye, held on September 15, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

125. Sharma N, Bhattacharjya BK, Borah S, Yengkokpam S, Debnath D, Das P, Yadav AK, Kakati AK, Sarma KK and Gogoi P (2017). Seasonal Variation of Biotic Communities in Selected Floodplain Wetlands of Assam. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

126. Sharma N, Mohanty BP, Bhattacharjya BK, Sarma KK, Phukan B and Das BK (2017). *Bharat ke purbatar shestra main arsenic k khatrae*. *In*: Smarika evum Sodh Saransh: Antarsthaliy Matasyaki ki Vartman Avastha evum Sambhavnaye, organised on September 15, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

127. Sharma SK (2017. *Paale hue benthic invertebrates ka sanchayan: Paramparagat sanchan par labh*. *In:* Smarika evum Sodh Saransh: Antarsthaliy Matasyaki ki Vartman Avastha evum Sambhavnaye, held on September 15, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

128. Sibina Mol S, Ramya VL, Rao DSK, Panikkar P, Karthikeyan M and Vijaykumar ME (2017). Fish communities along the littoral-limnetic zones in a eutrophic lake in Karnataka. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

129. Singh A, Manna RK, Baitha R, Paul SK, Chakraborty L and Das BK (2017). A survey on trap fishery in River Ganga. In: Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian open water and Satellite Symposium on Fish Immunology held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

130. Sinha A (2017). *Nehro me matsyiki. Kisano ki aay vriddhi k naye ayam*. *In:* Smarika evum Sodh Saransh: Antarsthaliy Matasyaki ki Vartman Avastha evum Sambhavnaye, held on September 15, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

131. Sinha A, Roy A and Das BK (2017). Utilization of derelict open waters for improving livelihoods of rural tribals of Sagar Island, Sundarbans: Perspective and prospective. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017at Kochi, Kerala, India.

132. Sudheesan D, Sajina AM, Samanta S, Paul SK, Nag SK, Baitha R and Bhowmick S (2017). Fishing crafts and gears of river Mahanadi. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017at Kochi, Kerala, India.

133. Sudheesan D, Roshith CM, Manna RK, Das SK, Koushlesh SK, Chanu TN and Bhakta D (2017). Implication towards growth overfishing of *Harpadon nehereus* in bag net fishing. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

134. Swain HS, Sahoo AK, Raman RK, Meena DK, Das BK (2017). Study on otolith and fish length of *Tenualosa ilisa* in Inland waters. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017 at Kochi, Kerala, India.

135. Thakur VR and Shrivastava RS (2017). A conceptual note on loni wetland ecosystem in Bundelkhand region. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

136. Vaisakh G, Meetei AM, Bhakta D, Kamble S, Solanki JK and Sah RK (2017). Fish biodiversity and conservation status in Narmada estuary. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

137. Varghese T, Sahu NP, Dasgupta S, Mishal P, Jeena K and Pal AK (2017). Arginine improves immune status of *cirrhinus mrigala* exposed to acute hypoxia. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

138. Verma NK, Dana S, Das S, Kumar S and Bhakta D (2018). Gender and Women Empowerment through Co-operatives. *In*: Books of abstract, National Symposium on Role of Veterinarians in improving food safety through 'one World-one health and one medicine' approach in India, held during January 10-11, 2018 at WBUAFS, Kolkata, India.

139. Yadav AK, Das KK, Bhattacharjya BK, Raman RK, Naskar M and Das BK (2017). Trend of fish landings of Brahmaputra river at Guwahati, Assam, India. *In:* Book of abstract, 11th Fisheries and Aquaculture Forum, held during November 21-24, 2017at Kochi, Kerala, India.

140. Yengkokpam S, Bhattacharjya BK, Yadav AK, Sharma N, Debnath D, Das P, Borah S, Sarma KK, Gogoi P, Kakati A and Singh NS (2017). Fish species composition and limnological variables in relation to stock enhancement in selected beels of Assam. *In:* Book of abstract, All India Zoological Congress and International Symposium on Culture Based Fisheries in Indian Open Water and Satellite Symposium on Fish Immunology, held during June 9-11, 2017 at ICAR-Central Inland Fisheries Research Institute, Barrackpore, India.

Extension Materials

1. Baitha R, Sinha A, Koushlesh SK, Chanu TN, Gogoi P, Ramteke MH, Sharma SK and Roshith CM (2017). Fishes of River Gandak (Leaflet). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

2. Bandopadhayay BK, Manna RK, Roy A, Parida PK, Sinha A, Pandit A, Bhowmick S and Mandal S (2017). Canal fisheries development- A potential source of livelihood improvement in Sundarbans. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

3. Bhattacharjya BK, Debnath D, Sharma N, Roy A and Das BK (2017). Small-scale inland fisheries in India. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

4. Das AK, Das BK, Sarkar UK, Karnatak G and Tayung T (2018). Cage culture of *Pangasianodon hypophthalmus* (Leaflet), ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

5. Das BK et al. (2018). Restoration and conservation of fisheries of river Ganga – CIFRI's initiative under NMCG project. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

6. Debnath D, Payeng LK, Bera AK, Bhattacharjya BK, Das BK and Manna SK (2018). Fish health management in floodplain wetlands of Assam. Pamphlet, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

7. Gogoi P, Sinha A, Roy A, Das SK, Tayung T, Ramteke MH and Koushlesh S (2018). Sirhind canal in Punjab: A potential resource for fisheries development-ICAR-CIFRI initiative. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

8. Hassan MA, Aftabuddin Md, Meena DK, Mishal P, Das Gupta S and Saha S (2017). Carp feed for open water farming: preparation and feeding (Leaflet). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

9. Karthikeyan M, Rao DSK, Vijayakumar ME, Sandhya KM, Sarkar UK, Mishal P and Remya L (2018). eDas, Jalashayom se matsyaki ankada samnchayan ke liye edas pranali: ek naveen evam unnath prayog (Leaflet). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

10. Mohanty BP, Behera PR, Majhi P and Das BK (2017). Nutrient profiling and evaluation of fish as a dietary component (NutrifishIN Database) (Pamphlet in English/Oriya). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

11. Mohanty BP, Sahoo AK, Behera PR, Majhi P and Das BK (2017). Fish as healty food (Leaflet in Oriya). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

12. Panikkar P, Amala U, Selvaraj SS, Khan F, Jesna PK, Das BK, Chandish RB, Jagadish TD and Vijayakumar ME (2018). Meetha jal matsya paalan main black soldier fly ka bhoomika (Pamphlet). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

13. Ramya VL, Jesna PK, Sibina Mol S, Khan MF, Jagadeesh TD, VijayKumar ME Panikkar P, Karthikeyan M and Saha A (2018). Diversity and conservation status of Ichthyofauna in Inland water bodies of Karnataka. Pamphlet, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

14. Roy A, Sinha A, Manna RK and Majumder S (2017). Socio-cultural aspects of Rava tribe. ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

15. Sarkar UK et al. (2018). Documentary film on Climate resilient pen culture systems in wetlands. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

16. Sharma SK, Sahoo AK, Raman RK, Choudhury AR, Das BK (2018). Gastropods and bivalves of river Mahanadi, Odisha. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

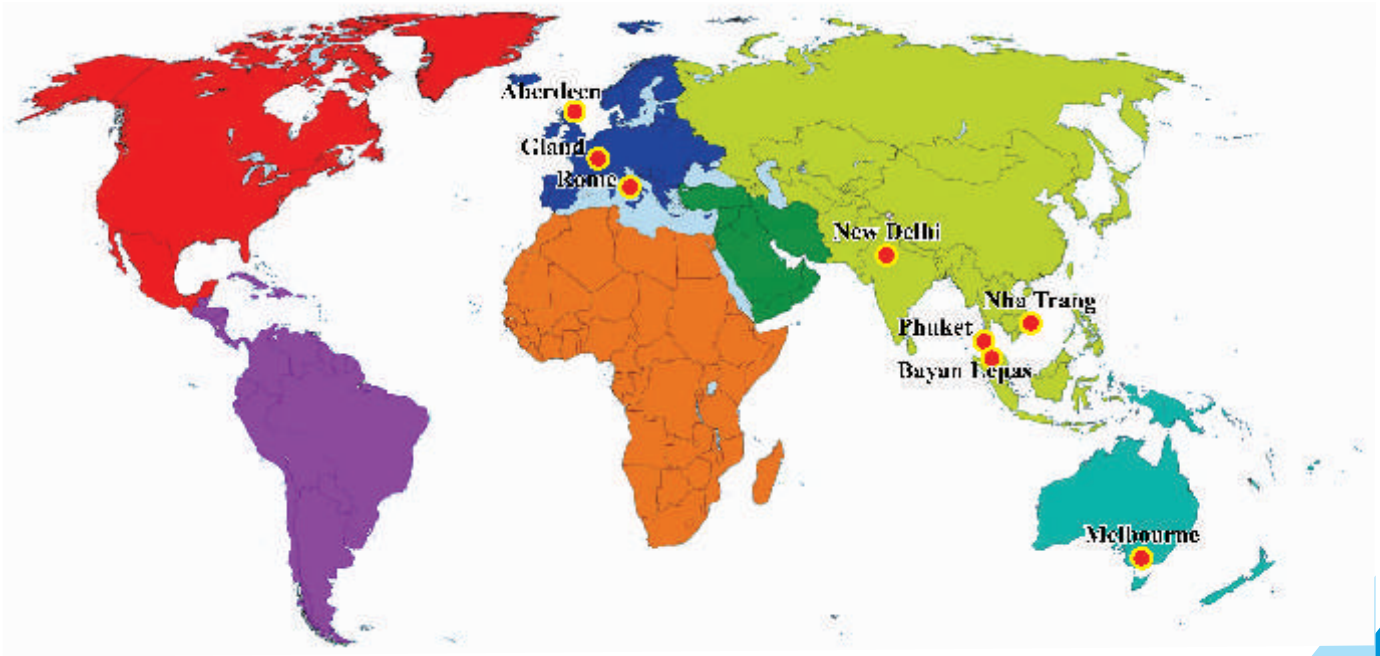
17. Sinha A, 2017. Poshakiya Suraksha Abam Gramin Vikash Hetu Chhoti Deshi Matsya Prajatio ka Palan. ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India.

Linkages

The institute maintains close linkages with several organizations involved in fisheries research and development in India and abroad. The institute collaborated with them in research, development, extension, outreach activities, seminars, workshops and publications. The key partners of the institute in 2017-18 were:

International

- Bay of Bengal Large Marine Ecosystem (BOBLME)
- Food and Agriculture Organization (FAO)
- International Union for Conservation of Nature (IUCN)
- World Fish Centre, Malaysia
- Wetland International, New Delhi
- WWF-India, New Delhi
- University of Aberdeen, UK
- Nha Trang University, Vietnam
- RMIT University, Melbourne, Australia



Foreign visit 1- Dr. B.K. Das, Director and Dr. B.P. Mohanty, Head of Division-FREM, ICAR-CIFRI under Academic Research Exchange Visited University of Aberdeen, Scotland, UK. In photo: with Dr Sam Martin, Professor, School of Biological Sciences

Foreign visit 2- Dr. B.K. Das, Director and Dr. B.P. Mohanty, Head of Division-FREM, ICAR-CIFRI under Academic Research Exchange Visited University of Aberdeen, Scotland, UK. In photo: with Prof. Graeme Paton, Head of School of Biological Sciences

Foreign Visit 3- Dr. B. K. Behera (2nd from left) from ICAR-CIFRI at RMIT University, Melbourne, Australia

National

University

- State Institute of Rural Development (SIRD), Govt. of Assam
- Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal
- G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand
- Rajendra Agricultural University, Pusa, Samastipur, Bihar
- West Bengal University of Animal and Fisheries Sciences, Kolkata, West Bengal
- Assam Agricultural University, Jorhat, Assam
- Department of Zoology, University of Calcutta, West Bengal
- Department of Environmental Science, Manonmaniam Sundar University, Alwarkurichi, Tamil Nadu

- University of Kalyani, Kalyani, West Bengal
- Vidyasagar University, Midnapore, West Bengal
- Visva-Bharati University, Santiniketan, West Bengal
- Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal
- Garhwal University, Srinagar, Uttarakhand
- Centre for Innovation in Public Sector, Hyderabad
- University of Agriculture Science, Dharward
- Central University of Bihar, Patna
- Manipur University, Imphal, Manipur
- College of Fisheries, Central Agricultural University, Lembucherra, Agartala
- Indian Institute of Science Education and Research, Kolkata
- Indian Statistical Institute, Kolkata
- Indian Institute of Technology, Kharagpur
- Faculty of Life Sciences, Manipur University, Imphal
- School of Environmental Sciences, JNU, New Delhi

Central organizations

- National Fisheries Development Board, Hyderabad
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- National Institute of Oceanography (NIO), Dona Paula, Goa
- Chilika Development Authority, Bhubaneswar
- National Institute of Ecology, Jaipur
- Space Applications Centre, Ahmedabad
- ITCOocean, INCOIS, Hyderabad
- National Mission for Clean Ganga, Ministry of Water Resources (MoWR), New Delhi
- Central Water Commission, New Delhi

ICAR organizations

- ICAR-Indian Agricultural Research Institute, New Delhi
- ICAR-Central Institute of Fisheries Education, Mumbai
- ICAR-National Academy of Agricultural Research Management, Hyderabad
- ICAR-ICAR Research Complex for NEH , Umiyam, Meghalaya
- ICAR-Agricultural Technology Application Research Institute, Umiam, Meghalaya
- ICAR-Central Marine Fisheries Research Institute, Kochi
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Directorate of Coldwater Fisheries, Bhimtal
- ICAR-National Bureau of Fish Genetic Resources, Lucknow
- ICAR-National Research Centre on Pig , Rani, Assam
- ICAR-Agricultural Technology Application Research Institute, Kolkata
- ICAR-National Institute of Research on Jute & Allied Fibre Technology, Kolkata
- ICAR-Central Research Institute of Jute & Allied Fibre, Barrackpore, Kolkata

- ICAR- National Institute of Animal Nutrition and Physiology, Bangalore
- ICAR - National Bureau of Agricultural Insect Resources (NBAIR)

State departments

- Commissioner of Fisheries, Gujarat
- Directorate of Fisheries, Assam
- Directorate of Fisheries, Bihar
- Directorate of Fisheries, Jharkhand
- Directorate of Fisheries, West Bengal
- Directorate of Fisheries, Odisha
- Directorate of Fisheries, Himachal Pradesh
- Directorate of Fisheries, Chattishgarh
- Directorate of Fisheries, Telangana
- Directorate of Fisheries, Karnataka
- Directorate of Fisheries, Madhya Pradesh
- Directorate of Fisheries, Kerala
- Directorate of Fisheries, Uttar Pradesh
- Directorate of Fisheries, Andhra Pradesh
- Department of Fisheries, Government of Uttarakhand
- Gujarat Forest Department, Ukai
- Narmada Water Resources, Water Supply and Kalpasar Department, Gandhinagar, Gujarat
- Assam Rural Infrastructure and Agricultural Services Society (ARIAS)

Industries/Corporation/State Board

- Assam Fisheries Development Corporation
- Sardar Sarovar Narmada Nigam Limited (SSNNL)
- National Hydro Power Corporation Limited (NHPC)
- Inland Waterways Authority of India
- Madhya Pradesh Fisheries Cooperative Federation
- Gujarat Maritime Board, Bharuch
- Sundarbans Development Board, West Bengal
- Farakka Barrage Authority, Murshidabad, West Bengal
- North Eastern Electric Power Corporation Limited (NEEPCO)

ICAR-CIFRI in Media

Seminars/Symposia/ Meetings Attended

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
1	Meeting with staff of ICAR-CIFRI, Allahabad Centre to evaluate and formulate research programmes and other infrastructural setup	2 - 5 April 2017	B. K. Das	ICAR - CIFRI, Allahabad Centre
2	EFC and Cadre strength meeting of Fisheries Science Division, ICAR, New Delhi	6 - 7 April 2017	B. K. Das	ICAR Headquarters, New Delhi
3	Conference on Climate Change and Agricultural Production (CCAP)	6 - 8 April 2017	A. K. Das	BAU, Sabour, Bhagalpur, Bihar
4	Coordination Committee Meeting for Doubling Farmers Income by March 2022 for West Bengal	7 April 2017	U. K. Sarkar	ICAR-ATARI, Kolkata
5	Meeting with DFO, Khurda to prepare a techno-feasibility report and a comprehensive DPR for development for Aquaculture Cluster in the periphery of Chilika in Khurda district of Odisha	15 April 2017	B. K. Das	DFO, Khurda, Odisha
6	Review of PRC meeting of Dept. of Scientific and Industrial Research (DSIR sponsored project)	17 April 2017	U. K. Sarkar	Lake Hall, BCKV, Kalyani
7	Review Meeting at Krishi Bhavan, New Delhi	18 April 2017	B. K. Das	Krishi Bhavan, New Delhi
8	Meeting on Central Committee on Fisheries Scheme (CCFS) for formulation of unit cost norms of the proposed Central Plan Scheme on Blue Revolution - Integrated Development and Management of Fisheries	25 April 2017	B. K. Das	National Fisheries Development Board, Hyderabad
9	Regional Consultation for Open water fisheries development in NE region at Guwahati by involving corporations and other stakeholders of NE region	29 April 2017	B. K. Das	ICAR-CIFRI, Guwahati Centre
10	Meeting with Dept. of Fisheries, Andaman &Nicobar Administration for Developing Fisheries Roadmap	2 - 6 May 2017	B. K. Das B. P. Mohanty A. K. Das	Andaman & Nicobar Islands
11	Inland Fisheries Policy Meeting and development of Road map of Bihar	8 May 2017	U. K. Sarkar	Dept. of Fisheries, Patna
12	Internal Auditing ISO 9001:2015	11 - 12 May 2017	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
13	National Workshop on Arsenic contamination of the food chain: present scenario and the future projections	12 May 2017	B. K. Das B. P. Mohanty S. Samanta	FACC, BCKV, Kalyani

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
14	Brainstorming session on E-Flow of river Ganga	17 May 2017	B. K. Das	Central Water Commission, New Delhi
15	Meeting on project Impact assessment of coal transportation through barges along the NW-1	19 May 2017	B. K. Das	IWAI, NOIDA, Uttar Pradesh
16	Programme on Launching of ranching of Mahaseer fish by Hon'ble Minister of State, MoWR, RD & GR under the fishery programme of NMCG Meeting	23 May 2017	B. K. Das	Haridwar (Rishikesh) Dehradun, Uttarakhand
17	Workshop for approval of the final report of ICAR-CIFRI on CIFRI/CDA-ICZMP Consultancy Research Project organized by CDA	23 May 2017	B. K. Das	WRTC, Barkul, Odisha
18	Zonal Workshop on Skill Development in Agricultural Sectors jointly and take lead role in policy support in Fisheries sector	25 May 2017	A. K. Das	Dept. Of Agri. W.B . & Ministry of Skill Development. Govt. of India RMIC, Goal Park, Kolkata
19	NICRA-Technical Programme Finalization Workshop	27 May 2017	U. K. Sarkar	NASC Complex, New Delhi
20	Second Bangladesh - India Joint Consultation on the Roadmap for Sustainable Management of Inland Navigation and Fisheries Resources	30 - 31 May 2017	B. K. Das S. Samanta	Organized by IUCN, The Asia Foundation and BRIDGE at Kolkata
21	Discussion on Consultancy project on Study on assessment of efficacy of Fish Pass/Fish Ladder in Teesta Low Dam III &Teesta Low Dam IV Power Stations, West Bengal	31 May - 1 June 2017	B. K. Das	NHPC, West Bengal
22	Interaction meeting with Hon'ble Agriculture Minister Dr. Radha Mohan Singh for doubling farmers income	3 June 2017	U. K. Sarkar	ICAR - NRIAFT, Kolkata
23	ICAR-DAC Interface Meeting on Enhancing the Preparedness of Agricultural Contingencies for West Bengal	6 June 2017	U. K. Sarkar	Nabanna building, Howrah
24	29th All India Congress of Zoology, International Symposium on Culture Based Fisheries in Inland Open Waters, and International Satellite Symposium on Fish Immunology	9 - 11 June 2017	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
25	Fish Harvest Mela at Khansaherabad Village, Sagar Island under TSP programme	14 June 2017	B. K. Das	Sagar Islands, Sundarbans, West Bengal
26	Zonal Review Meeting and Stakeholder Consultation for formulation of National Inland Fisheries & Aquaculture Policy	16 June 2017	B. K. Das	Guwahati, Assam

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
27	EFC meeting at Fisheries Division, ICAR, New Delhi	18 - 19 June 2017	B. K. Das	ICAR, New Delhi
28	International workshop on "Bioinformatics in Fisheries and Aquaculture"	19 - 21 June 2017	B. K. Das B. P. Mohanty U. K. Sarkar B. K. Behera A. K. Yadav P. K. Parida N. Sharma Pritijyoti Majhi R. K. Raman Raju Baitha Kavita Kumari	ICAR-CIFRI, Barrackpore
29	Meeting with ICAR-CIFA, Bhubaneswar under bilateral research exchange collaboration programme along scientists from University of Aberdeen, Scotland, U.K.	21 June 2017	B. K. Das B. P. Mohanty	ICAR - CIFA, Bhubaneswar
30	Academic Research Exchange Visit with Academic Visitors from University of Aberdeen, UK	20 - 22 June 2017	B. K. Das B. P. Mohanty	ICAR - CIFA and CDA Balugaon
31	Final workshop of CIFRI-CDA/ICZM Project	23 June 2017	S. Samanta S. K. Nag	CDA Wetland Research Station, Chilika, Odisha
32	Interaction and Co-operation in project "Innovation for Health and Robustness in Fisheries and Aquaculture in Eastern & North East India and UK"	24 June - 2 July 2017	B. K. Das B. P. Mohanty	University of Aberdeen, Scotland, U. K.
33	NICRA workshop on Technical Programme Finalization	27 June 2017	S. K. Nag	NASC Complex, New Delhi
34	Panel discussion on development of inland fisheries policy for small fish worker group	30 June 2017	U. K. Sarkar	Seva Kendra, Kolkata
35	Meeting on Stakeholder Consultation for formulation of National Inland Fisheries and Aquaculture Policy	3 July 2017	A. K. Das	Organized by DAHDF at Bilaspur, Himachal Pradesh
36	Foundation Day and Annual Convocation of Ramkrishna Mission Vivekananda University	4July 2017	B. K. Das B. P. Mohanty B. K. Behera	Ramkrishna Vivekananda Mission University, Narendrapur
37	Fish Farmers Day	10 July 2017	All Staff of ICAR - CIFRI, Barrackpore	ICAR-CIFRI, Barrackpore
38	Meeting with Director of Fisheries, Government of Jharkhand to discuss species diversification in cages installed in reservoirs of Jharkhand	11 July 2017	B. K. Das	Directorate of Fisheries, Government of Jharkhand, Ranchi
39	Hands on training on Collection, preservation and identification of freshwater plankton	11 - 14 July 2017	Pritijyoti Majhi	ICAR - CIFRI, Barrackpore
40	ICAR Foundation Day, Awa rd Ceremony - 2017 and Directors' Conference	16 July 2017	B. K. Das	ICAR, New Delhi

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
41	Stakeholders Consultation meeting for formulation of National Inland Fisheries and Aquaculture policy	22 July 2017	B. K. Das	Patna, Bihar
42	Discussion on All-India Entrance Examination	24 July 2017	B. K. Das	ICAR - CIFE, Mumbai
43	Meeting with Board of Examiners, University of North Bengal, Darjeeling	26 July 2017	B. K. Das	University of North Bengal, Darjeeling
44	31st Executive Committee meeting of NFDB for discussion on Strengthening of Database and Geographical Information System	29 July 2017	B. K. Das	NFDB, Hyderabad
45	Ranching cum Awareness program under NAMAMI GANGE (NMCG) project sponsored by Ministry of water resources, Govt. of India	1 August 2017	B. K. Das	Allahabad
46	Meeting for preparation of Management Plan for Sardar Sarovar Reservoir with Sardar Sarovar Narmada Nigam Ltd.	3 August 2017	B. K. Das	Gandhinagar, Gujarat
47	Town Official Language Implementation Committee (CO-1)	3 August 2017	A. K. Yadav	TOLIC at O/o Pr. Chief Commissioner of Income Tax, Guwahati
48	Meeting on Bhadbhut Barrage Project, Kalpasar Department	4 August 2017	B. K. Das	Gandhinagar, Gujarat
49	Visit to Regional Centre of ICAR-CIFRI, Vadodara for an interactive meeting with staff members to evaluate and formulate research programmes and other infrastructural setup	5 August 2017	B. K. Das	ICAR - CIFRI, Vadodara Centre
50	Meeting at ICAR-CIFA on fish production	7 August 2017	B. K. Das	ICAR - CIFA, Bhubaneswar
51	Inaugural programme of NFDB Training at Kalinga Institute of Social Sciences, Bhubaneswar	7 August 2017	B. K. Das	Kalinga Institute of Social Sciences, Bhubaneswar
52	4th Brain Storming Session at National Water Mission on National Action Plan for Climate Change at Ministry of Water Resources, River Development and Ganga Rejuvenation	10 August 2017	B. P. Mohanty B. K. Behera	New Delhi
53	Meeting with the Commissioner of Fisheries, Telangana	10 August 2017	R. K. Manna	ICAR - CIFRI, Barrackpore
54	Meeting at CDA, Bhubaneswar	11 August 2017	B. K. Das	CDA, Bhubaneswar
55	Meeting of Expert Committee of Assam State Biodiversity Board	21 August 2017	B. K. Bhattacharjya	Assam State Biodiversity Board, Guwahati

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
56	Meeting on Assessment of Inland Fish Production and Strengthening of Database and Geographical information System by ICAR-CIFRI	4 September 2017	B. K. Das	ICAR, New Delhi
57	Institute Management Committee	5 September 2017	B. K. Das	ICAR - CIFRI, Barrackpore
58	Meeting with MP Fisheries Federation, Bhopal, Government of Madhya Pradesh for finalization of report submitted by ICAR-CIFRI for enhancing fish production in reservoirs	12 September 2017	B. K. Das	MP Fisheries Federation, Bhopal
	Training on Online Store Indent Creation	12 September 2017	Pritijyoti Majhi Tasso Tayung	ICAR - CIFRI, Barrackpore
59	Platinum Jubilee Hindi Workshop on Current Scenario of Inland Fisheries	15 September 2017	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
60	Meeting with NFDB for discussion on Project finalization	16 September 2017	B. K. Das	NFDB, Hyderabad
61	Review meeting on drawing up action plans by KVKs of Assam for doubling farmers' income	18 September 2017	B. K. Bhattacharjya	ICAR - ATARI, Zone IV, Guwahati
62	J-Gate as One Stop Platform for Discovering Scholarly Journal Articles under CeRA Consortium	19 September 2017	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
63	Meeting at ASRB, ICAR, New Delhi	20 - 21 September 2017	B. K. Das	ASRB, ICAR, New Delhi
64	Meeting at National Commission for SC, New Delhi	22 September 2017	B. K. Das	National Commission for SC, New Delhi
65	Meeting with CEO, NFDB, Hyderabad	24 - 27 September 2017	Raju Baitha	Motihari, Bihar
66	Organizing Training programme on Wetland issues and management, Bihar under NFDB funded project	6 - 8 October 2017	B. K. Das	Motihari, Bihar
67	Discussion on issues and management of wetland of Bihar under NFDB funded project with Hon'ble Minister, Agriculture & Farmers Welfare	8 October 2017	B. K. Das	Motihari, Bihar
68	OPFS Board Meeting	14 October 2017	B. K. Das	Bhubaneswar
69	World Food Day Celebration by Odisha Krushak Samaj	16 October 2017	B. K. Das B. P. Mohanty A. K. Das P. K. Parida	Bhubaneshwar
70	Workshop on Blue Revolution: prospects and opportunities for doubling fishery income & act as Convener in the Working Group "Processing, Value Addition and Marketing"	22 - 24 October 2017	B. K. Das B. P. Mohanty A. K. Das	Lucknow
71	Inaugural Session of Workshop on "Hilsa Breeding and Management: Way Forward" under ICAR-NASF Project	24 October 2017	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
72	Workshop on "Hilsa Breeding and Management: Way Forward" under ICAR-NASF Project	24 - 26 October 2017	B. K. Das V. R. Suresh B. P. Mohanty U. K. Sarkar M. A. Hassan A. K. Das A. K. Bera R. K. Manna D. K. Meena Sandhya K. M. Lianthuamluaia Gunjan Karnatak Suman Kumari H. S. Swain A. K. Sahoo Roshith C. M. Rajendra Naik Shravan Kumar Sharma Mitesh H. Ramteke Sandhya K. M. Sajina A. M. Sucheta Majumdar Atanu Das	ICAR - CIFRI, Barrackpore
73	Second Meeting of Joint Working Group (JWG) between India and Bangladesh on cooperation in the field of fisheries	28 - 29 October 2017	R. K. Manna	Hotel Taj Vivanta, Goa
74	Training course on Culture Based Fisheries	29 October - 9 November 2017	A. K. Sahoo	Nha Trang University, Vietnam
75	15th Institute Management Committee Meeting of NRC Pig	30 October 2017	B. P. Mohanty	ICAR - National Research Centre on Pig, Rani, Guwahati
76	ICAR sponsored 21 days winter school on 'Recent Advances in Aquaculture Biotechnology'	1 - 21 November 2017	Niti Sharma SonaYengkokpam	Department of Fish Genetics and Reproduction, College of Fisheries, CAU, Lembucherra, Tripura
77	16th National Academy of Veterinary Sciences (NAVS -I) Convocation cum Scientific Convention on Advancement in Veterinary Sciences: Impact on Farmers' Income	5 November 2017	B. P. Mohanty	SVVU, Tirupati
78	Joint Technical Seminar of Eastern and North-East Region on Official Language	10 November 2017	B. K. Bhattacharjya A. K. Yadav	Dept. of Official Language, MHA; District Library, Guwahati
79	Mid-term Review Meeting of ICAR Regional Committee-II	13 November 2017	All Senior Scientific Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
80	Brainstorming Session on GIS	15 November 2017	D. N. Jha	NMCG Office, New Delhi
81	Launching Workshop of USAID, WorldFish, ARD, Govt. of Odisha Project	19 November 2017	B. P. Mohanty A. K. Sahoo H. S. Swain	Hotel Pal Height, Bhubaneswar
82	Seminar on Recent Advances in Aquaculture	19 November 2017	A. K. Yadav S. Borah	Dept. of Fisheries, Govt. of Assam, Silchar

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
83	11th Indian Fisheries and Aquaculture Forum on Fostering Innovations in Fisheries and Aquaculture: Focus on Sustainability and Safety	21 - 24 November 2017	B. K. Das U. K. Sarkar A. K. Das A. K. Bera D. K. Meena Sandhya K. M. Lianthuamluaia H. S. Swain Aparna Roy Piyashi DebRoy Pritijyoti Majhi Prajna R. Behera R. K. Raman S. K. Nag Archana Sinha R. K. Manna Kavita Kumari Raju Baitha	Organized by ICAR – Central Institute of Fisheries Technology, Kochi and AFSIB (IFAF) at *Le Meridian*, Kochi
84	Special Symposium on Gender in Aquaculture and Fisheries in India (GAF - India) at 11th Indian Fisheries and Aquaculture Forum	21 - 24 November 2017	Piyashi DebRoy Aparna Roy	Organized by ICAR - Central Institute of Fisheries Technology, Kochi and AFSIB (IFAF) at *Le Meridian*, Kochi
85	FAO/ICAR - CIFRI Workshop on Fish Passage Design at Cross-River Obstacles - Experience from Different Countries, with Potential Relevance to India	29 November - 1 December 2017	B. K. Das B. P. Mohanty U. K. Sarkar A. K. Sahoo Arun Pandit D. N. Jha Piyashi DebRoy S. C. S. Das R. K. Raman Raju Baitha T. Nirupada Chanu Satish K. Aparna Roy	ICAR - CIFRI, Barrackpore
86	9th Annual Meeting of Proteomics Society, India (PSI) & International Conference on Proteomics in Health and Disease	30 November - 2 December 2017	B. P. Mohanty	ILS, Bhubaneswar
87	87th Annual Session and Symposium on Basic Research- Its Role in National Development	8 - 10 December 2017	B. P. Mohanty	Savitribai Phule Pune University (SPPU), Pune
88	82nd Annual Convention and National Seminar of Indian Society of Soil Science	11 December 2017	S. Samanta	Amity University, Kolkata
89	2nd Regional Science Congress (Southern Region)	14 - 15 December 2017	U. K. Sarkar	Kalyani University, West Bengal
90	Meeting held on the occasion of inaugurating a 3-month skill development course in 'Aquaculture' at ITI, Guwahati	16 December 2017	B. K. Bhattacharjya	Department of Skill Development, Govt. of Assam in collaboration with Directorate of Fisheries, Assam
91	Meeting at Ministry of Water Resources & Fisheries	16 - 18 December 2017	A. K. Das	Bhubaneswar, Odisha

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
92	Meeting with Department of Fisheries, Govt. of Telangana, Hyderabad for finalizing MoU on Cage Culture with Department of Fisheries, Telangana	19 - 20 December 2017	B. K. Das	Department of Fisheries, Govt. of Telangana, Hyderabad
93	Meeting on cage culture in Telengana reservoir & signing of MoU	19 - 22 December 2017	U. K. Sarkar	Dept. of Fisheries, Govt. of Telangana
94	Krishi Mela at Akaipur, West Bengal	21 December 2017	S. K. Nag	Organized by Akaipur Gram Panchayat and Directorate of Agriculture at Bongaon Sub Division, West Bengal
95	Mid-term Review Meeting of ongoing Namami Gange project	22 December 2017	B. K. Das	NMCG Office, New Delhi
96	Meeting with Director & Warden, State Department of Fisheries, Punjab and Dean, College of Fisheries, GADVASU, Ludhiana	28 December 2017	Archana Sinha	Directorate of Fisheries, Chandigarh, Punjab
97	Meeting of 'Parliamentary Standing Committee on Water Resources' for evaluation of 'Namami Gunge' program	15 January 2018	B. K. Das R. K. Manna	Hotel Taj Bengal, Kolkata
98	Meeting with Director, Directorate of Fisheries, Government of Odisha, Bhubaneswar	29 January 2018	B. K. Das	Directorate of Fisheries, Government of Odisha, Bhubaneswar
99	2nd meeting of the Committee to study the minimum required e-flow of river Ganga	30 January 2018	B. K. Das	Central Water Commission, New Delhi
100	Institute Management Committee meeting of ICAR - NBFGR as a ICAR nominated member	30 January 2018	U. K. Sarkar	NBFGR, Lucknow
101	1st International Extension Congress with the theme New Horizons of Extension - Challenges and Opportunities	1 - 3 February 2018	Arun Pandit Piyashi DebRoy	ICAR - Central Institute for Women in Agriculture, Bhubaneswar
102	International Training Workshop on Meiofauna	6 - 9 February 2018	Pronob Gogoi Shravan K. Sharma	CUSAT, Kochi organized by Deptt. of Marine Biology, Microbiology and Biochemistry, CUSAT
103	National Conference on Organic Waste Management for Food and Livelihood Security	8 - 10 February 2018	B. K. Das S. Samanta	ICAR - IISS, Bhopal
104	Meeting with World Bank team members	9 February 2018	B.K. Das	Bhubaneswar, Odisha
105	TSP program at Kalo reservoir, Mayurbhanj, Odisha	12 February 2018	B.K. Das	Mayurbhanj, Odisha
106	National Seminar on Antimicrobial Resistance & Alternatives to Antibiotics use in Aquaculture	12 - 13 February 2018	B. K. Das B.P. Mohanty A. K. Sahoo	ICAR - CIFA, Bhubaneswar

Sl. No.	Name of the Programme	Date	Participants	Organizer and Venue
107	Fish seed stocking programme in pens and interaction meeting with Fishers	16 February 2018	U. K. Sarkar A. K. Das Lianthuamluaia Mishal P. Gunjan Karnatak	Bhomra beel, Haringhatta, Nadia Under NICRA project
108	Towards developing multi-disciplinary approach in project formulations and innovations in agriculture and allied sectors among all Kolkata-based ICAR -Institutes/Centres	17 February 2018	All Scientific Staff	ICAR - CIFRI, Barrackpore
109	Awareness programme under TSP for livelihood development of tribal fishers at Sundarban, West Bengal	18 - 19 February 2018	B. K. Das	Sundarban, West Bengal
110	Training-cum-Workshop on "Fish Pass Design"	21 - 22 February 2018	B. K. Das	National Water Academy, Pune, Maharashtra
111	DBT Brain storming session at Nutrition & Live Feed for Aquaculture species, Fakir Mohan (FM) University, Balasore	21 - 22 February 2018	B. P. Mohanty	FM University, Balasore
112	Meeting with Director of Fisheries, Government of Odisha on fisheries development in dead rivers of Odisha	24 February 2018	B. K. Das	Director of Fisheries, Government of Odisha, Bhubaneswar
113	Research Advisory Committee (RAC) Meeting	5 - 6 March 2018	All Scientific Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
114	Krushi Odisha	6 - 9 March 2018	B. K. Das H. S. Swain	Bhubaneswar, Odisha
115	Director's Conference	8 - 9 March 2018	B. K. Das	ICAR, New Delhi
116	National Workshop on Antimicrobial Resistance & Alternatives to Antibiotic Use in Aquaculture	12 - 13 March 2018	B. K. Das	ICAR - CIFA, Bhubaneswar
117	Workshop on Biodiversity of River Ganga and its Conservation for Sustainable Fisheries	15 March 2018	All Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
118	Brainstorming Session on Cage Culture in Inland Open Waters	16 March 2018	All Scientific Staff of ICAR - CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
119	Institute Research Committee (IRC) Meeting	18 to 20 March 2018	All Scientific Staff of ICAR-CIFRI, Barrackpore	ICAR - CIFRI, Barrackpore
120	Conference on Biodiversity Conservation	19 to 23March 2018	Sandhya K.M.	Wild Life Institute of India, Dehradun
121	UGC nominee for review of UGC-SAP Research program of the Dept. of Zoology	28 March 2018	U. K. Sarkar	Guru Nanak Dev University, Amritsar

Distinguished Visitors

Sushree Uma Bharati, Union Minister of Water resource, River Development and Ganga rejuvenation, Govt. of India visited ICAR-CIFRI and graced the ranching programme

Shri Joyprakashji, Minister of Fisheries attended ranching programme conducted by ICAR-CIFRI, RRC, Allahabad

Shri P. Suklabaidya, Minister of Fisheries, Govt. of Assam
visited ICAR-CIFRI Regional Centre, Guwahati

Shri Pramod Madhwaraj, Former Fisheries Minister, Govt. of Karnataka
visited Research Centre, ICAR-CIFRI, Bangalore

Dr. J. K. Jena, DDG (Fy), ICAR, New Delhi inaugurated RAS System and Knowledge point at CAR-CIFRI, Barrackpore

Padmashree R. K. Sinha, Vice-Chancellor, Nalanda open University attended the ranching programme and graced the workshop on Biodiversity of River Ganga and its conservation

Mr. Chabilendra Roul, IAS, Special Secretary DARE (on Right),
visited ICAR-CIFRI, Barrackpore

Dr. A. E. Eknath (on Right) Former Director General, NACA, Bangkok

Dr. Gerd Marmulla, FIAF branch, FAO, UK

Mr. Gebler Rolf Jurgen, Fish Pass Designer, Germany

Mr Andreas Zittek, Team leader, ESEstudies, Austria

- Ronald Sapa Tlau, MP, Rajya Sabha, New Delhi
- Shri. Sudharsan Bhagat, Hon'ble Union Minister, Ministry of Agriculture and Farmers welfare, Govt. of India visited Kochi Centre
- Smt. Krishna Raj, Union Minister of State for Agriculture and Farmers Welfare, Govt. of India visited ICAR-CIFRI Kochi Research Station
- Dr. Punjab Singh, Former Director General, ICAR, New Delhi
- Dr. Dillip Kumar, Former Vice-Chancellor, ICAR-CIFE, Mumbai
- Dr. Gopal Krishna, Vice-Chancellor, ICAR-CIFE, Mumbai
- Dr. D. D. Patra, Vice-Chancellor, BCKV, West Bengal
- Dr. N.P Singh, Director, ICAR-NIASM, Baramati
- Dr. V. V. Sugunan, Former ADG (Inland Fisheries), ICAR, New Delhi
- Dr. M. Sinha, Former Director, ICAR-CIFRI
- Dr. A. P Sharma, Former Director, ICAR-CIFRI
- Dr. S. D. Tripathy, Former Vice-Chancellor , ICAR- CIFE, Mumbai
- Dr. A. E. Eknath, Former Director General, NACA
- Dr. Jeevan K. Mitra, Director (Acting) ICAR-CRIJAFT
- Dr. J. K. Jena, Deputy Director General (Fy), ICAR, New Delhi
- Dr. H. S. Sen, Former Director of ICAR-CRIJAF, Kolkata

Inger Midtkandal, Royal Norwegian Embassy

- Dr. P. Das, Former Director, ICAR-NBFGR, Lucknow
- Mr. Ranjan Agrawal, Director (DARE) & CVO (ICAR& DARE), New Delhi
- Professor S. N. Labh, FLS and Head Department of Zoology, Kathmandu, Nepal
- Dr. Nitya Nanda Das, Aquatic Biodiversity and Community Based Fisheries Management Specialist, Dhaka, Bangladesh
- Sk. Muslafogur Rahman, Addl. Director General, Department of Fisheries, Bangladesh
- David Wilkes, Global Flood Resilience Leader, ARUP, UK
- Tom House, Ecologist, ARUP, UK
- Inger Midtkandal, Science councellor, Royal Norwegian Embassy
- Dr. S. K. Das, ACS, Managing Director, Assam Fisheries Development Corporation and Director, Department of Fisheries, Govt. of Assam Karnataka honourable Fisheries Minister
- Shri. Devendra Choudary, IAS, Secretary, DADF, Min. of Agriculture and Farmers Welfare
- Dr B. P. Das, Former Engineer in Chief and Former expert consultant, FAO
- Mr. Vinod Kumar, IAS, Principal Secretary, Department of Fisheries, Govt. of M.P
- Dr. C. Suvarna, Commissioner of Fisheries, Govt. of Telengana
- Mr. Asok Kumar Saxena, Former General President, ISCA, Kolkata
- Mr. Asheesm Agarwal, Royal Norwegian Embassy, New Delhi
- Mr. K Jayaraman, IPS, SVS Police academy Barrackpore, Kolkata
- Dr. Jose T Mathew IFS, Principal Chief Commissioner of Forest, Sunderban
- Dr. D. D. Patra, Vice- Chancellor, BCKV, West Bengal
- Dr. Sandeep Behera, Biodiversity consultant, NMCG, New Delhi
- Prof. Amalesh Choudhury, Ecologist, West Bengal
- Dr P. K. Agarwal, ADG, NASF, New Delhi
- Mr. M. S. Dhakad, MD, MP Fisheries Federation, M.P
- Dr. M. Mukherjee, Additional Director, DOF, West Bengal
- Shri Saumyajit Das, MD, SFDC, West Bengal
- Shri Malay Ghosh, Chairman of North Barrackpopre Municipality
- Mr. N. C. Sahu, DSP (Special Crime Branch), CBI, Kolkata visited the centre on the Vigilance Week

Foreign Visitors

Dr Sam Martin, Professor, University of Abardeen, UK, Dr Alex Douglas, Senior Lecturer, University of Abardeen, UK

Scientist Team from NOFIMA, Norway

Ratna Chuenpagdee,
Memorial University of Newfoundland, Canada,
Derik Johnson, University of Manitoba, Canada

Dr Sam Martin, Professor, University of Abardeen, UK,

FREM Division Scientists at East Kolkata Wetlands on field exposure visit with ARS Probationers

Acronyms

ab Maneri1	Above Barrage Maneri1	**IISS**	Indian Institute of Soil Science
ADF	Assistant Director of Fisheries	**IMC**	Indian Major Carp
ADG	Assistant Director General	**IRC**	Institute Research Committee
AFDC	Assam Fisheries Development Corporation	**ISTM**	Institute of Secretariat Training and Management
AKMU	Agricultural Knowledge Management Unit	**ITK**	Indigenous Technical Knowledge
Ald rs	Allahabad	**ITMU**	Institute Technology Management Unit
ANOVA	Analysis of Variance	**IUCN**	International Union for Conservation of Nature
bl Maneri2	Below Barrage Maneri1	**Kanj**	Kannauj
BCKVV	Bidhan Chandra Krishi Vishwa Vidyalaya	**Kanp Ab**	Kanpur Above Barrage
Bijn. Ab	Bijnor Above Barrage	**Kanp bb**	Kanpur Below Barrage
Bijn. Bl	Bijnor Below Barrage	**Kanp bb**	Kanpur Below Barrage
BMI	Body Mass Index	**l**	litre
BMP	Best Management Practice	**MDS**	Multi-dimensional Scaling
CABIN	Centre for Agricultural Bio-informatics	**MEI**	Morpho Edaphic Index
CBF	Culture Based Fisheries	**Mg**	Mega gram
CCA	Canonical Correspondence Analysis	**MGMG**	*Mera Gaon Mera Gaurav*
CDA	Chilika Development Authority	**MoEF & CC**	Ministry of Environment, Forest and Climate Change
Chilasis	Chinyalisaur	**MSY**	Maximum Sustainable Yield
CIBA	Central Institute of Brackishwater Aquaculture	**MT**	Metric Tonnes
CIFA	Central Institute of Freshwater Aquaculture	**NAARM**	National Academy of Agricultural Research Management
CIFE	Central Institute of Fisheries Education	**Narora ab**	Narora Above Barrage
CIFRI	Central Inland Fisheries Research Institute	**Narora bl**	Narora Below Barrage
CMFRI	Central Marine Fisheries Research Institute	**NASF**	National Agricultural Science Fund
CPCB	Central Pollution Control Board	**NBFGR**	National Bureau of Fish Genetic Resources
CPUE	Catch Per Unit Effort	**NBSSLUP**	National Bureau of Soil Survey and Land Utilization Planning
CPWD	Central Public Works Department	**NEH**	North-East Hill
CRIJAF	Central Research Institute for Jute and Allied Fibres	**NFDB**	National Fisheries Development Board
DAHDF	Department of Animal Husbandry, Dairying and Fisheries	**NICRA**	National Innovations on Climate Resilient Agriculture

Cont .....

Acronyms continued

DARE	**Department of Agricultural Research and Education**	**NIRJAFT**	**National Institute of Research on Jute and Allied Fibre Technology**
DDE	Dichlorodiphenyldichloroethylene	**NMCG**	National Mission for Clean Ganga
DDT	Dichlorodiphenyltrichloroethane	**NPP**	Net Primary Productivity
DHA	Docosa Hexaenoic Acid	**OTA**	Over-time Allowance
e-DAS	electronic Data Acquisition System	**OUAT**	Orissa University of Agriculture and Technology
EHP	Enterocytozoon Hepatopenaei	**PFZ**	Potential Fishing Zone
eLDAS	electronic Length Data Acquisition System	**PME**	Priority setting, Monitoring and Evaluation
EPA	Eicosa Pentanoic Acid	**PUFA**	Polyunsaturated Fatty Acid
FCR	Food Conversion Ratio	**RAC**	Research Advisory Council
FEO	Fisheries Extension Officer	**REF**	Riverine Ecology and Fisheries
FL	Fingerling	**RFD**	Results-Framework Document
FREM	Fishery Resource and Environmental Management	**RGCA**	Rajiv Gandhi Centre for Aquaculture
FRL	Full Reservoir Level	**RS**	Research Station
FSSAI	Food Safety Standards Authority of India	**RRC**	Regional Research Centre
GADVASU	Guru Angad Dev Veterinary and Animal Sciences University	**RWF**	Reservoir and Wetland Fisheries
GaSI	Gastro-somatic Index	**SGR**	Specific Growth Rate
GEFC	Global Environmental Flow Calculator	**SHG**	Self Help Group
GIS	Geographic Information System	**SIF**	Small Indigenous Fish
GPP	Gross Primary Productivity	**Sring ab**	Srinagar Above Barrage
GSI	Gonado Somatic Index	**Sring bb**	Srinagar Below Barrage
Haridwar ab	Haridwar Above Barrage	**SSB**	Spawning Stock Biomass
Haridwar bl	Haridwar Below Barrage	**t**	Tons
HCH	Hexachlorocyclohexane	**Tehri ZP**	Tehri Zero Point
HPLC	High-performance liquid chromatography	**TDS**	Total Dissolved Solid
HRD	Human Resource Development	**TL**	Total Length
IARI	Indian Agricultural Research Institute	**TSP**	Tribal Sub-Plan
ICAR	Indian Council of Agricultural Research	**Vindh**	Vindhyanchal
ICDS	Integrated Child Development Scheme	**WBUAFS**	W.B. Univ. of Animal and Fishery Sciences
IHHNV	Infectious Hypodermal and Hematopoietic Necrosis	**WSSV**	White Spot Syndrome Virus

Important Contacts

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