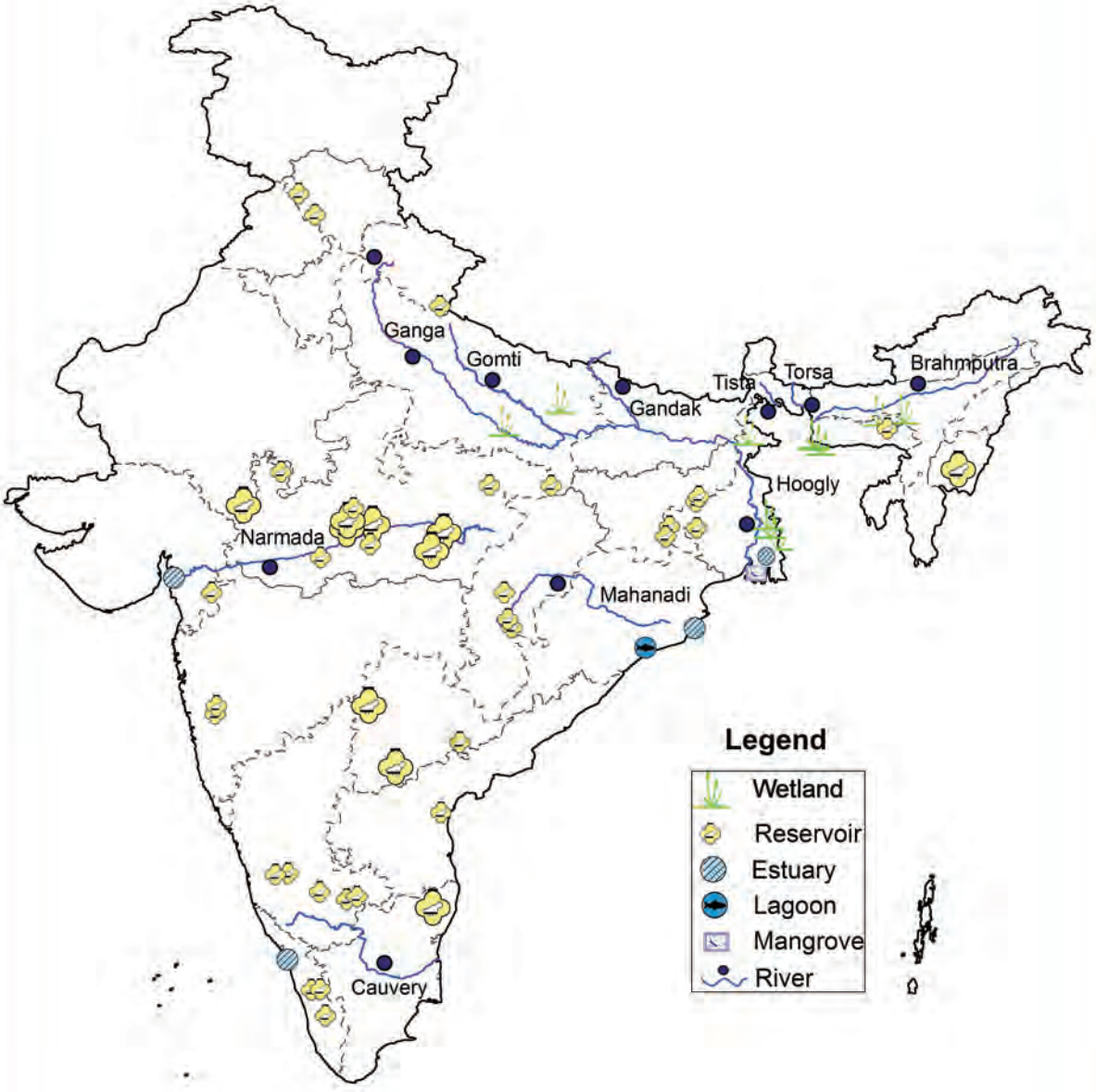
वार्षिक प्रतिवेदन
Annual Report
2015-2016

भा.कृ.अनु.प.–केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान
ICAR-Central Inland Fisheries Research Institute
Barrackpore, Kolkata-700120
बैरकपुर, कोलकाता – 700 120

State-wise outreach of ICAR-CIFRI



ANNUAL REPORT
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बैरकपुर, कोलकाता-700 120, पश्चिम बंगाल

ICAR-Central Inland Fisheries Research Institute

Barrackpore, Kolkata-700 120, West Bengal

www.cifri.res.in

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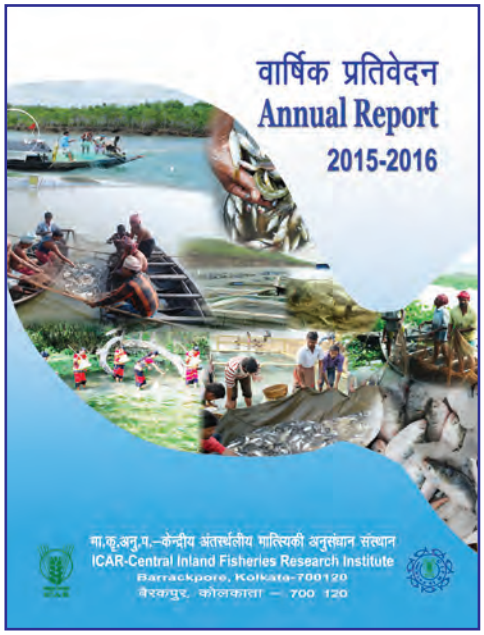

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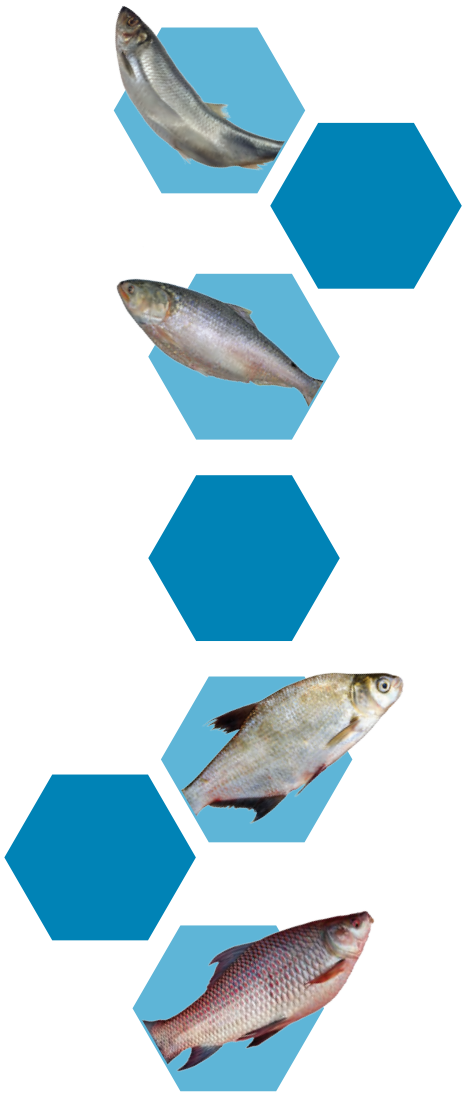

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PREFACE

Inland open water fisheries sector has important status in national economy and continues to provide livelihood opportunities, food and nutritional security and invaluable ecosystem services to growing population of the country. The inland resources in the form of rivers, estuaries, floodplain wetlands, reservoirs, backwaters, lakes and lagoons offer tremendous scope for fisheries development. In this context, ICAR-CIFRI has accomplished significant scientific and technological milestones towards generating a dynamic 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 2015-16. Updation of data base on ecology and fisheries of major inland open water resources has been one of such major mandated activities. Preparation of E-atlas of Odisha and Himachal Pradesh, designing and testing of e-DAS mobile application for fish catch data collection; successful demonstration of cage culture in reservoirs in a number of States; cost effective fish feed development for enclosure culture; stock assessment of Hilsa, fishes of Chilika lake as well as Sundarbans and other open water resources; assessment of impact of multiple habitat alterations on fisheries and ecology of river Ganga; e-flow estimation and recommendations for a number of rivers; impact of climate change on inland fisheries; valuation of ecosystem goods and services; ecosystem modeling; nutrient profiling of fishes; disease surveillance and fish genetic characterization; identification of novel genes and bacteria; pollution biomarkers and ecosystem health assessment are some of the major areas where the institute has made measurable strides.

The Institute could bring new projects on fish health, Ganga fisheries restoration, bioinformatics and computational biology, remote sensing, and impact of coal transportation along inland water way. I feel elated that the institute conducted about 40 training programmes, benefitting more than 500 farmers and other stakeholders from various States. The Institute successfully organized meeting of Mid-term review of ICAR Regional Committee II, workshop for preparing road map of agriculture development in lower gangetic region, national seminar on Hilsa, mass awareness programmes and a number of other important meetings enhancing visibility across the country. Our massive drive on Swachh Bharat Mission and coverage under *Mera Gaon Mera Gaurav* received wide appreciation.

The Institute has executed Tribal Sub Plan and North Eastern Hill Region components, benefitting tribal fisher community through canal fisheries development, integrated farming and distribution of inputs for fish culture and fishing implements and pen culture and wetlands 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 and symposia, meetings, etc. The Institute has now become stronger with 11 new recruits of Agriculture Research Service Scientists from various disciplines, whom we look at with hope for holding the Institute flag aloft in future.

I acknowledge the guidance and support of the Secretary, DARE and Director General, ICAR, Deputy Director General (Fisheries), Assistant Director General (Inland Fisheries) and the "Team ICAR-CIFRI'' for their untiring support and co-operation.

Barrackpore,
Dated 8th July, 2016

V. R. Suresh
Director (Acting)

EXECUTIVE SUMMARY

ICAR-Central Inland Fisheries Research Institute registered significant scientific and technological progress towards generating knowledge and skill base for ensuring sustainability of inland open water ecology and fisheries. Currently, the institute has 79 Scientists, 53 Technical Officers, 39 Administrative and 58 Supporting personnel, posted at its Head Quarter at Barrackpore and Regional Centers/ Stations.

During the year 2015-16, the Institute conducted research under 4 in-house research programs with 17 projects, implemented through the Riverine Ecology and Fisheries, Reservoir and Wetlands Fisheries, Fisheries Resource and Environment Management Divisions and Fisheries Socio-Economics Section. Besides these, 3 ICAR outreach activities, 10 externally funded research and 5 consultancy projects have also been operated. A number of training and extension programs benefiting more than 500 persons, were also executed successfully. The major achievements during 2015-16 are summarized below.

Reservoir ecology and fisheries

Food web interactions in Hemavathy reservoir, Karnataka was studied to assess the impact of stocking Indian Major Carps on ecosystem and native fish fauna. Ecopath modelling indicated that the post-stocking food web was more resilient than the pre-stocking food web to perturbations. The results are consistent with relative overhead being positively associated with maturity. The 'health' of the ecosystem showed an improvement, which indicates a positive impact of stock of Indian Major Carps.

Hydro-acoustic surveys were conducted for estimation of target strength of selected fishes and quantitative assessment of fish stocks. For fish biomass estimation using acoustics target strength of *Catla catla* (0.77 to 1.5 kg) ranged between -38.7 and -45.0 decibel. *Labeo rohita* (520 g) had target strength of -45.8 decibel. Target strength varied from -41.5 to -40.3 decibel for *Heteropneustes fossilis* measuring 160 mm. *Mystus cavasius* measuring 210 mm had a target strength of – 45.2 decibel, whereas *Piaractus* sp. weighing 760 g showed a target strength of -38.1 decibel. The acoustic survey conducted in different zones of Karapuzha reservoir recorded minimum 52 fishes and maximum of 108 fishes intransects.

Assessment of fish stock and impact of stocking in reservoirs indicated that stocking increased fish production from reservoirs of Chhattisgarh, Odisha, Madhya Pradesh, Jharkhand, Karnataka, and Himachal Pradesh. An increase in fish production from 8.2 t during 2010-11 to 73.6 t during 2014-15 was achieved through annual stocking of Indian Major Carps in small reservoirs of Odisha. Highest fish production of 149 $kgha^{-1}yr^{-1}$ was achieved during 2014-15 from Govind Sagar, Himachal Pradesh. In Tamil Nadu reservoirs, a significant positive correlation was observed between stocking density

and average fish yield. Implementation of culture-based fisheries in small reservoirs of Chhattisgarh could increase the average fish production from 1.0 $kgha^{-1}yr^{-1}$ (2008) to 1858 $kgha^{-1}yr^{-1}$ (2014-15). Studies on the fish species composition in reservoirs of Himachal Pradesh showed continued dominance of exotic fishes like silver carp and common carp in Gobindsagar reservoir, while in Pong reservoir *Sperataseenghala* formed 53% of the catch, followed by *Labeo rohita* (16%) and *Cirrhinus mrigala* (13%).

Brewery waste based floating feed for cage culture of *Labeo bata* has been developed, which reduces feed cost by 33.8% (9.18 Rs/ kg) in comparison to soybean/ fish meal based feed. Growth trials conducted in cages using soybean based iso-caloric, iso-nitrogenous floating diets showed comparable growth rate (% live weight gain) in *Catla catla* (68.8) and *Labeo rohita* (66.7), indicating suitability of the feed formulations for these major carps as well.

An Electronic Data Acquisition System, developed by the Institute, was installed in mobile phones and trial tested in Tunga, Manchanbele, Karapuzha and Banasura Sagar reservoirs and showed potential for easy and real time fish catch data collection from field.

Wetland ecology and fisheries

Studies in floodplain wetlands of Assam (Mer, Damal, Sukdol-Sarubori), West Bengal (Akaipur, Khalsi) and Uttar Pradesh (Lohsar, Gujwar, Baghar, Ajjeypur tal) showed higher fish yield rates in stocked wetlands than that in non-stocked ones. Stocking rate up to 3000 ha^{-1} of advanced fingerlings of IMC did not adversely affect limno-chemical variables and biotic communities (including indigenous fish species) in seasonally open wetlands. The biochemical and microbiological properties of water and sediments showed an increase in carbon mineralization, alkaline phosphatase activity and organic matter in better stocked wetlands.

Studies conducted in three wetlands of Meghalaya (Boro, Katuli and Kumligaon) indicated favorable ecology for fisheries. Small indigenous fish species (*Puntius* spp., *Trichogaster* spp., *Mystus* spp., *Channa* spp., *Amblypharyngodon mola*, *Notopterus notopterus*) contributed 60-70% of total catch in Boro wetland, 30-40% in Katuli wetland and 25-30% in Kumligaon wetland. The remaining share was from larger river fishes (*Wallago attu*, *Sperata seenghala*, *S. aor*, *Chitala chitala*; Indian major carps) and exotic fish like *Clarias gariepinus*.

Riverine and estuarine fisheries

River Torsa in Brahamputra river basin and river Gandak in Ganga basin were surveyed for small indigenous fish (SIF) species diversity. Survey in river Gandak recorded 45 SIF species,out of total 65 fish species recorded. In river Torsa, out of the 53 species recorded, 37 were SIFs. A new species under Genus *Barilius* was described from river Torsa. A site for conservation of small indigenous fishes (SIF) in Madanganj in Indian Sunderbans has been identified and developed with community participation.

Investigations on fisheries and ecology rivers recorded a total of 125 fish species in river Ganga and 37 species in Mahandi estuary. *Garra lamta*, a hill stream cyprinid, was recorded for the first time from Haridwar. In river Mahanadi fish diversity was dominated by a single species, *Eleutheronema tetradactylum*. *Gonialosa modesta* (Burmese river gizzard shad) has been reported for the first time from lower stretches of river Mahanadi In Narmada estuary a total of 86 fish and shell fish species have been recorded so far with *O. pama* contributing maximum to the winter gill net catches.

Determination and maintenance of environmental flow requirements is a prerequisite for maintaining ecology and fisheries of rivers; environmental flow requirements of river Ganga at Bhimgoda barrage, Haridwar was estimated to be 132.48-140.84 Cumecs for lean season (December to March) to maintain the river at least in Environmental

Class D. Importance of water flow and deep pools in river Mahanadi for large bodied fish species during lean period was analyzed. *Chitala chitala* (av.1950g) preferred an average depth of 24 feet, while *Catla catla* (av. 3500g), *Labeo rohita* (av. 2500g) and *Tor mahanadicus* (av. 1800g) preferred average water depth of 18 feet based on abundance depth relations.

Catch per unit effort (CPUE), population structure and identification of major breeding grounds of Hilsa, *Tenualosa ilisha* were studied in Hooghly-Bhagirathi estuarine system. The total Hilsa catch during the year 2015-16 was estimated at 12191 t. Stock assessment indicated 20% over-exploitation above Maximum Sustainable Yield and 72.4% decline in Standing Stock Biomass. Regulation of mesh size of gill nets at 90 mm, will protect significant number of breeding population, without serious reduction in catch for fishers. Major breeding grounds were identified at Godakhali on main stream Hooghly and Kolaghat on Rupnarayan tributary of the river.

Nutrient dynamics in mangrove ecosystem, fish and shell fish diversity and ecology of Sundarbans estuary have been carried out. Under nutrient dynamics studies in Sundarbans, litter fall from major mangroves was quantified at 3.51 t yr^{-1}. In situ decomposition study estimated an average of 37% retention of leaf litterbiomass after 3 months decomposition, suggesting a substantial carbon sequestration in mangroves soil of the Sundarbans. High salinity regime in Sundarbans has impacted fish species abundance with dominance of marine migrant fishes. At Jharkhali, *Harpadon nehereus* dominated the catch along with *Setipinna taty*; dominance of *Escualosa thoracata* was recorded at Pathar Pratima. About 43 percent of bag net catch of *Harpadon nehereus* was in the size range 51-100 mm. Since the species attains sexual maturity at ≥214.5 mm,catch of small ones may lead to decline. A significant decline in *Harpadon* catch was observed in winter bag net fishery this year.

Studies on the ecology and fisheries of Chilika lagoon showed that the fishery is currently at marginally above optimum state of exploitation. Within the current fishing scenario, the catch is expected to fluctuatemarginally from the level of 2015 for at least near future, hence there is need for maintaining at least the current level of fishing effort; increasing the fishing effort may result in decline in catch.

Ecosystem and fish health

Under ecosystem and fish health program the ecological health assessment of rivers, identification of pollutant degrading bacteria, development of pollution biomarkers and formulation of eco restoration protocol and studying impact of changing climate on fisheries and ecology have been the major focus of research. The scoring criteria of Index of Biotic Integrity (IBI) for study of ecological health of river Mahanadi have been modified. The modified index revealed that 650 km river stretch from Seorinarayan to Paradip is moderately impaired (IBI score > 50%, but <75% of the maximum value).

In river Gomti a significant accumulation of different pesticides was recorded: 36 out of 76 samples were contaminated with pesticide residues. Organochlorine insecticides, including HCH and DDT, dominated in the residues. Concentration of α-HCH in one and γ-HCH in two samples exceeded the permissible Maximum Residue Limit (MRL) of 0.25 mg/kg indicating human health risk from consumption of such fishes. High values of water specific conductivity (421-558 µS cm^{-1}), alkalinity (232-295 ppm), hardness (177-223 ppm), phosphate (up to 1.57 ppm) and moderate BOD (up to 5.2 ppm) also indicated stressed ecosystem of the river. Triclosan, a widely used antimicrobial, was detected in the water of the river Gomti at levels of 1.62-9.65 µg/l and may be toxic to algae, protozoa, macrophytes, crustaceans and molluscs. In fish, it was found in the range of 0.36 to 1.12 mg/kg. Accumulation of TCS in fish at this level is safe for humans, considering the acceptable daily intake (0.05 mg/kg body wt./day) and USEPA reference dose (0.3 mg/kg body wt./day).

Phenol and chlorophenol degrading bacteria from various polluted river stretches were identified; *Pseudomonas* spp., *Acinetobacter* spp., *Stenotrophomonas maltophilia*, *Bacillus* spp., *Cupriavidus* spp., *Cloacibacterium normanense*, *Ochrobactrum* spp., *Klebsiella pneumonia*, *Comamonas* spp., *Cupriavidu* spp., *Chryseobacterium* spp., *Flavobacterium* sp., *Alkaligenes faecalis*, and *Citrobacter freundi*.

The *hsp47, hsp70, hsc70, hsp90* genes were up-regulated, while *hsp27* gene was down-regulated in liver and gill tissues of riverine catfish *Rita rita* collected from different stretches of river Ganga *viz*. Kanpur, Allahabad, Varanasi, Bhagalpur, Farakka (reference site), Serampore and Howrah. Correlation between gene expression pattern and water quality parameters showed that *hsp70* and *hsp47* could be possible biomarkers for contamination with organic pollutants and heavy metal in aquatic environment, whereas *hsp27* could be possible biomarker for coliform contamination.

Bacteria such as, *Citrobacter freunddii, Acinetobacter baumannii, Acinetobacter lwoffii* and *Klebsiella pneumoniae* have been isolated from diseased fish samples collected from West Bengal and Assam.The fish parasitic diseases viz., *Myxobolus, Argulus* and *Dactylogyrus* were reported from fish farms of West Bengal and Assam. Shrimp diseases *viz*. WSSV and EHP were reported from *P. monodon* and *L. vannamei* in West Bengal.

Resource assessment and modeling

Under resource assessment and modeling, district wise resource mapping have been completed for 70 small reservoirs of Odisha incorporating information on location, area, productivity, etc. On a GIS platform. Delineation of water area in different months for 20 reservoirs of Chhattisgarh and 5 reservoirs of Odisha revealed reduction of water area in the range of 3 to 45% of the maximum recorded area. During Jan 2015 to Dec 2015 none of the reservoir reached Full Reservoir Level (FRL).

Electronic atlases of water bodies of >0.5 ha for the Odisha and Himachal Pradesh have been developed for their scientific management planning. Water bodies >0.5 ha in Gujarat were delineated from LISS III and PAN image. Electronic atlas user manuals have been generated for Chhattisgarh, Uttar Pradesh, Odisha, Maharashtra, Kerala and Punjab.

Generalized Linear Model (GLM) and non-linear Generalized Additive Models (GAM) based inferences on plankton abundance in relation to water quality were carried out for Narmada River. Water quality of the river was characterized by four parameters, out of 13 parameters, and these four factors explained 85% of the variability. Factor1 and Factor2 represented productivity potential. Factor3 was derived as water clarity. Factor4 is contributed by pH.The Factor1 (productivity potential) had highest positive linear significant effect on zooplankton abundance. Water clarity had non-linear effect on zooplankton abundance.

Fisheries socio-economics

Valuation of goods and services provided by the Deepor wetland of Assam was estimated in terms of livelihood, employment generation of fishermen and tourism value. The tourism value of the wetland is ₹ 16 lakh and there exists much higher scope to increase the value.

NEH activities

Under the NEH Activities, fish stock enhancement programs were executed in Mer wetland (Nagaon district) and in Sarbhog wetland (Barpeta district) of Assam, in collaboration with Assam Fisheries Development Corporation (AFDC) Ltd., Guwahati. Collaborative fish stock enhancement programs in two floodplain wetlands of Bodoland Territorial Council (BTC) areas have been initiated in collaboration with BTC, Kokrajhar.

Tribal sub plan activities

Under TSP, fish production enhancement and conservation activities in tribal fish farms of Chandan Chouki in Uttar Pradesh was conducted. Awareness cum training programs were organized for tribal fishers. IMC fingerlings and other inputs like fish feed, lime were also distributed among tribal fishers.The Institute initiated pond and canal fisheries development based on species diversification for livelihood support in Sundarbans. IMC fingerlings, brackish water fish seeds and lime were distributed to twenty tribal fisher family of Khansahebabad village, Sagar island (Sundarbans), West Bengal. Selected canal resources of Bali and Kalitala, Sunderbans, West Bengal, have been brought under culture-based fisheries in order to improve the livelihood of tribals of the area. A total of 17680 kg of table size Indian major carps could be harvested from the TSP adopted canals as interim harvest after 6 months of stocking, providing livelihood and nutritional support to 1200 tribal fishers. Mass awareness programs on safe fishing using fiber glass coracles was organized for tribal fisher's of Wayanad district. Sixty fishers of Vanivilassagar Reservoir, Karnataka have been trained on cage and pen culture.

Human resource and skill development

The institute provided training and skill development on inland fisheries development to 538 fish farmers of Bihar. The Institute also arranged exposure visits to 327 Student on Inland fisheries management and facilitated study tour of 61 studentsfrom different parts of the country. Orientation training on reservoir fisheries management and cage culture activities was also conducted besides training on lake fisheries management specific to Chilika lagoon.

ICAR-CIFRI

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

1. Basic, strategic and applied research for sustainable management of inland open water resources
2. Develop protocols for productivity enhancement in reservoirs and wetlands and aquatic ecosystems health management
3. Acts as repository of information on inland open water resources
4. Human resource development through training, education and extension

INTRODUCTION

History

ICAR-Central Inland Fisheries Research Institute started its journey as Central Inland Fisheries Research Station at Calcutta under the Ministry of Food and Agriculture, Government of India from 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 its own building at Barrackpore, West Bengal. The Institute came under the umbrella of Indian Council of Agricultural Research, New Delhi in 1967. During the last seven decades, the institute has grown from strength to strength and established itself as a prominent inland fisheries research institute. The objectives of the institute were to assess inland fishery resources and to evolve strategies to obtain optimum fish production. Accordingly the research efforts of the institute were directed to understand and document the ecology and production functions of various inland water bodies in the country. 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, including rivers, reservoirs, floodplain wetlands, estuaries, lagoons and backwaters. These resulted in development of reservoir and floodplain wetland fisheries, database on inland open water ecology and fisheries, conservation of rivers and lagoons. The focus of the Institute has recently re-aligned to Natural Resource Management mode and modified its mandate.

Organizational structure

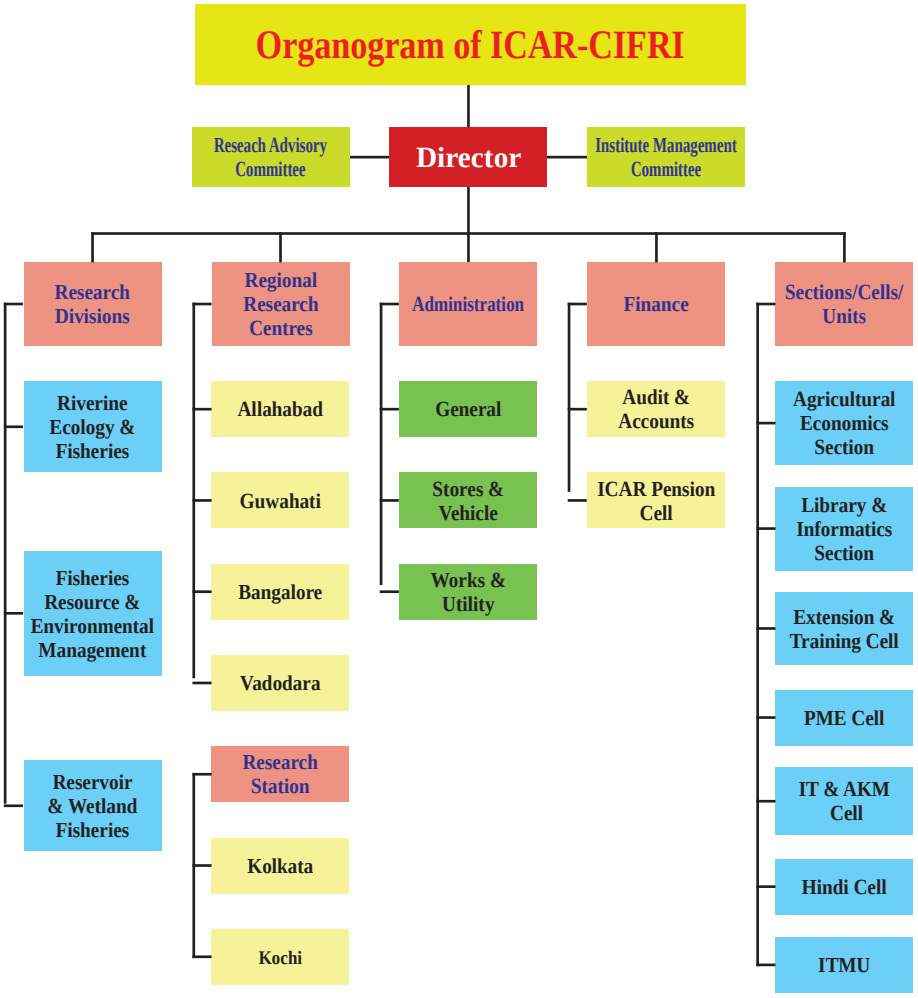
To address the mandate, the Institute is organized in the following manner: the Headquarters of the Institute is located at Barrackpore, West Bengal; the Regional Research Centers are located at Allahabad, Guwahati, Bangalore and Vadodara, with Research stations at Kochi and Kolkata. In XI Plan, the 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

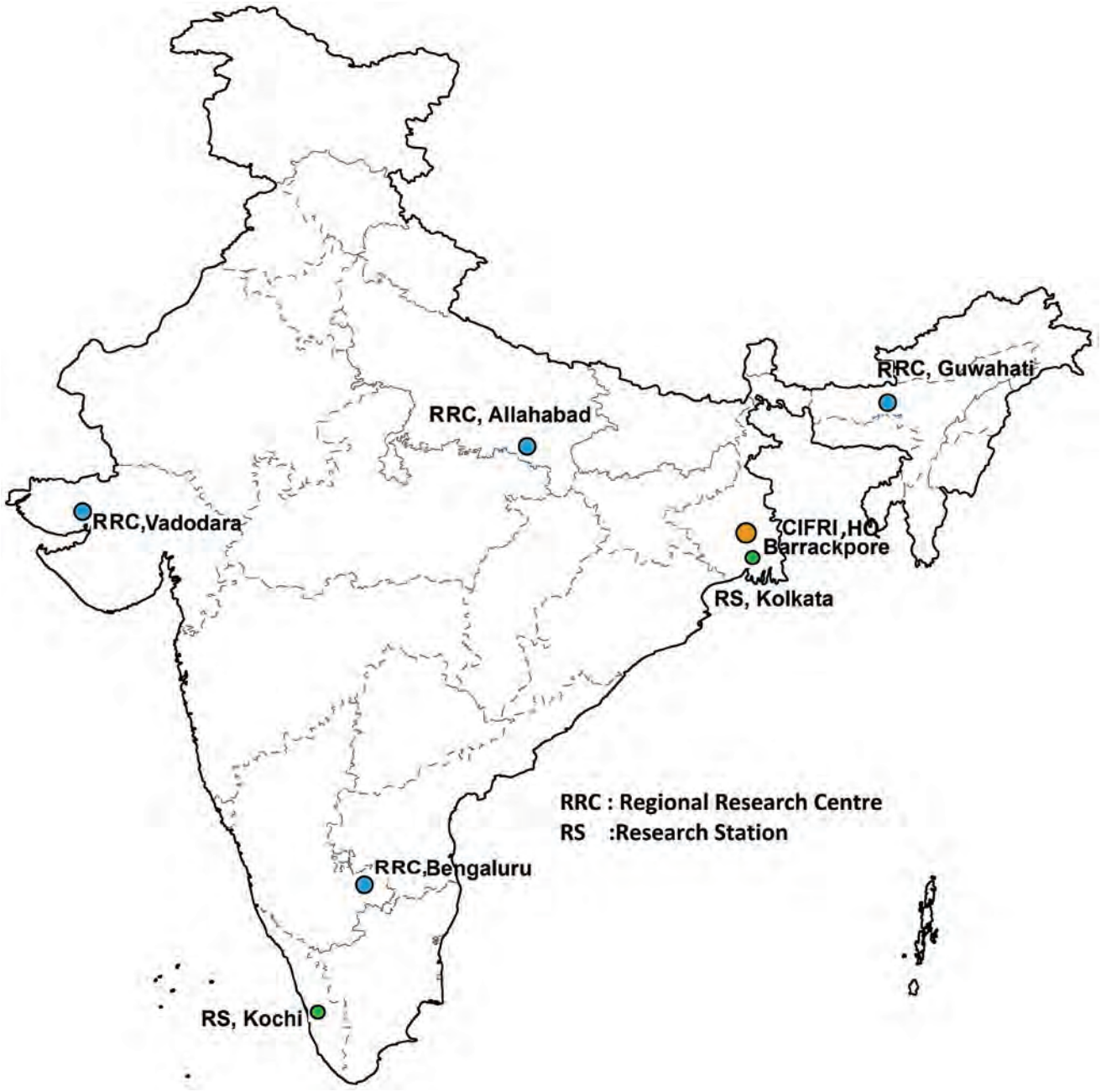
Besides these, socio-economic research, extension and training activities are carried out through the 'Agricultural Economics Section' and 'Extension and Training Cell respectively. The research activities under each of these divisions are administered by Heads of Divisions appointed by ICAR. While the 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 overall administrative control is with the Director. The Institute has a cadre strength of 95 Scientists, 85 Technical Officers, 66 Administrative and 130 Supporting personnel.

Besides the three Divisions, 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 program, TSP program, RFD and HRD that execute 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.



Location of CIFRI Head Quarter, Centres and Stations



CERTIFICATE

TÜV NORD

Management system as per
ISO 9001 : 2008

In accordance with TÜV INDIA procedures, it is hereby certified that

ICAR-CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
Barrackpore, Kolkata - 700 120,
West Bengal,
India

applies a quality management system in line with the above standard for the following scope

Basic, Strategic and Applied Research on Sustainable Fisheries Management in Inland Waters

Certificate Registration No. **QM 05 00293**
Audit Report No. **Q 5533/2014**

Valid until **02.06.2017**
Initial Certification **03.06.2014**

S.K.Kulka

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MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

BUDGET DETAILS

Budget details for the year 2015-16

(₹ in lac)

Head of Account	Budget (RE)		Expenditure	
	Plan	Non Plan	Plan	Non Plan
Pay and Allowance including OTA*	0.00	5412.00	0.00	5312.98
TA	45.00	6.00	45.00	6.00
Other charges including equipment, Library books, IT and HRD	473.01	224.50	464.06	224.18
Works	1.99		1.99	0.00
Grand Total	**520.00**	**5642.50**	**511.05**	**5543.16**

* includes Pension also

The budget & expenditure under non plan and plan for the financial year 2015-16

(₹ in lac)

Budget head	Non plan		Plan	
	Budget	Expenditure	Budget	Expenditure
Revenue				
Estt. Charges	1859.50	1857.21		
OTA	0.50	0.40		
TA	6.00	6.00	45.00	45.00
Other charges	199.45	199.26	257.37	257.09
Office buildings	14.41	14.41	31.63	31.63
Residential buildings	2.64	2.64		
Minor works	0.00			
Misc expenses including hrd	3.00	2.93	19.00	18.72
TSP general	0.00		8.00	7.91
NEH general	0.00		23.00	22.99
Capital				
Equipment*	5.00	4.94	50.01	50.01
Information technology	0.00		20.00	19.96
Library books			20.00	19.96
Vessel				

Budget head	Non plan		Plan	
	Budget	Expenditure	Budget	Expenditure
Furniture & fixture			20.00	19.81
Works				0.00
Minor works			1.99	1.99
TSP capital			7.00	
NEH general			17.00	15.98
Total	2090.50	2087.79	520.00	511.05
	Budget			Expenditure
Pension	3552.00	3455.37		
Loans & advances	12.00	6.34		
Other projects	Receipts (including opening balance)		Expenditure	Refund
NICRA	110.50		62.33	
CABIN	22.33		19.33	
NASF	62.91		42.99	
ITMU	6.98		0.51	
SIF-EXMU	1.70		0.46	
Fish health	19.00		15.74	
Deposit schemes (Externally funded)	725.84		223.90	1.75
Consultancies				
Revenue receipts				
Head			Target	Achievement
Income form sales / services	0.00	1.00	0.60	
Fee / subscription		2.00	1.81	
Income from royalty, publication etc.		0.00	0.00	
Other income		55.00	53.90	
STD interest		33.00	32.80	
Sale of assets				
Recoveries on loans and advances		20.00	18.38	
CPWD / grants refund				
Total		**111.00**		**107.49**

*Plan Equipment includes 'Other Equipment' of 5.00 lac

MAJOR RESEARCH ACHIEVEMENTS

HIGHLIGHTS

1. Generated and updated database on ecology and fisheries of rivers, estuaries, wetlands, reservoirs and coastal lagoons
2. Prepared e-atlas of Odisha and Himachal Pradesh and delineated seasonal water area fluctuation of 70 reservoirs of Odisha
3. Strategies developed for climate change, vulnerability and adaptation options in inland fisheries
4. Cage culture development in reservoirs of Himachal Pradesh, Telegana, Karnataka and Kerala
5. Fisheries management plans for Chilika lagoon, Odisha
6. Implementation of electronic Data Acquisition System (e-DAS) in reservoirs of Karnataka and Kerala for collection of real-time fish catch data
7. Demonstration of cage culture in PPP mode in a model village in West Bengal
8. Development of low cost fish feed suitable for culture of carps in cages
9. Nutrient profiling of five fish species and estimated micro nutrient composition of 35 fishes
10. Isolated and identified phenol and chlorophenol degrading bacteria from polluted stretches of rivers
11. Identified fish based biomarkers for organic and heavy metal pollution and coliform bacterial contamination
12. Analysis of impact of fish seed stocking on fish production in reservoirs of Chhattisgarh, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh and Odisha
13. E-flow estimation and recommendations for selected stretches of river Ganga and Mahanadi
14. Stock assessment and identification of breeding ground of Hilsa in Hoogly river system
15. Catalogued small indigenous fish diversity of selected stretches of rivers Ganga, Brahmaputra, Gandak and Torsa
16. Nutrient dynamics and quantification of carbon sequestration in mangroves and wetlands
17. Described new fish species and several new records from open waters
18. Developed food web based fisheries management model for Hemavathy reservoir, Karnataka
19. Recorded *Enterocytozoon hepatopeanaei* emerging as a serious pathogen in *Litopenaeus vannamei*
20. Conducted 40 training programmes, benefitting more than 500 farmers and other stakeholders from various States

RIVERINE AND ESTUARINE FISHERIES

FISH AND MACRO BENTHIC DIVERSITY OF MAHANADI ESTUARY

The Mahanadi estuarine system is spread over the districts of Cuttack, Jagatsingpur and Puri, in Odisha, draining into the Bay of Bengal. Ninety eight km of the river stretch from Naraj (freshwater) to Paradip (estuary) was selected for assessment of species diversity and environmental flow estimation. The stretch was classified as freshwater, tidal freshwater and brackishwater zones with six sites each from these zones selected for the study.

Mahanadi estuary: study sites

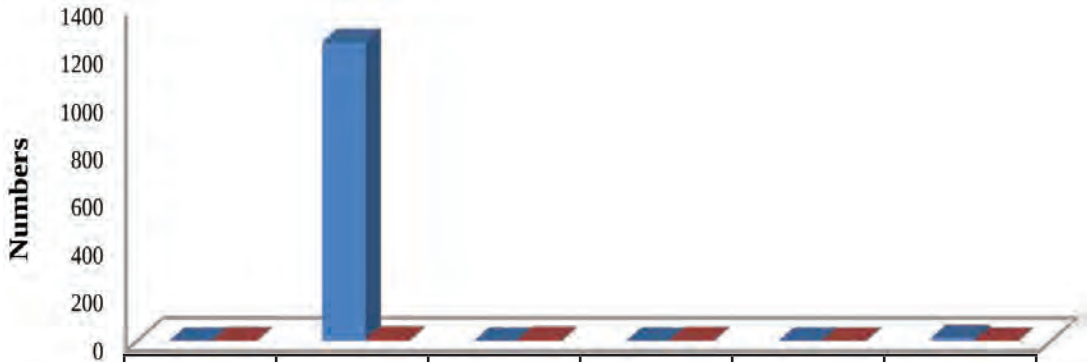
Fish diversity

A total of 37 species belonging to 23 families were recorded from the estuary. Diversity was higher (32 species, 22 families) during monsoon than in summer (lean period) with 12 species among 10 families). During monsoon, the average flow velocity was 1.2 ms^{-1} and salinity 2.0 ppt, while during lean period, the average flow velocity was 0.3 ms^{-1} and salinity 12 ppt. The fish catch was highest (5.1 t) during lean period; dominated by *Eleutheronema tetradactylum*, belonging to family Polynemidae (97.7%), and the second highest catch was of *Tenualosa ilisha*. The major reason for such large catch of *E. tetradactylum* could be influence of water salinity, temperature, plankton productivity and flow velocity.

Macrobenthic communities

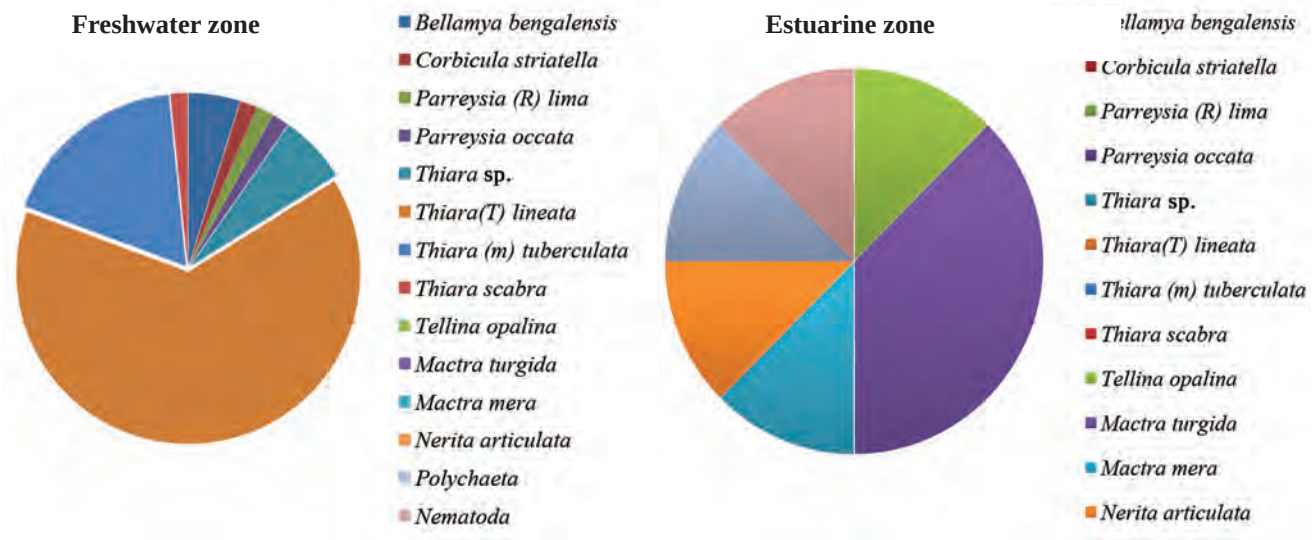
Dominant macrobenthic organisms recorded were *Thiara lineata* (64.5 %) followed by *Thiara tuberculata* (17.74%) and *Bellamya bengalensis* (5%) in freshwater zone,

while in brackishwater zone, *Mactra turgida* (37.5%) followed by *Nerita articulate* (13%), *Polychaeta* (13%), and *Nematoda* (13%). Diversity was higher during pre-monsoon than the monsoon, indicating river flow velocity might be playing a role in controlling abundance.



	Pomadasys argenteus	*Eleutheronema tetradactylum*	*Daysciaena albida*	*Dendrophysa russelli*	*Scatophagus argus*	*Tenualosa ilisha*
Lean	1	1250	1	1	1	13
Monsoon	2	5	4	3	1	1

Seasonal abundance fish species in Mahanadi estuary



Macrobenthic community abundance in Mahanadi estuary

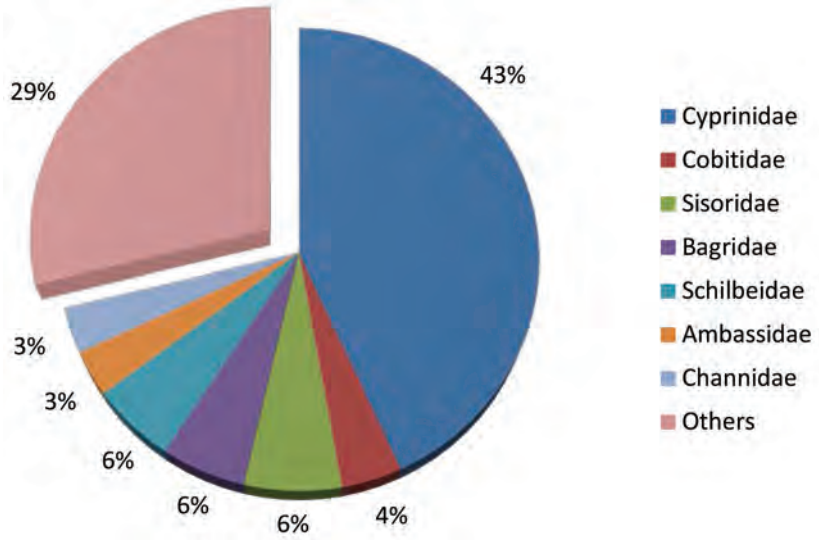
IMPACT OF HABITAT ALTERATIONS ON ECOLOGY AND FISHERIES OF RIVER GANGA

The river Ganga is highly exploited throughout its length for multiple purposes. Construction of dams, diversion of water impairing in natural flow regime. As a result the substratum, morphometry, ecology and fishery of the river altered drastically.

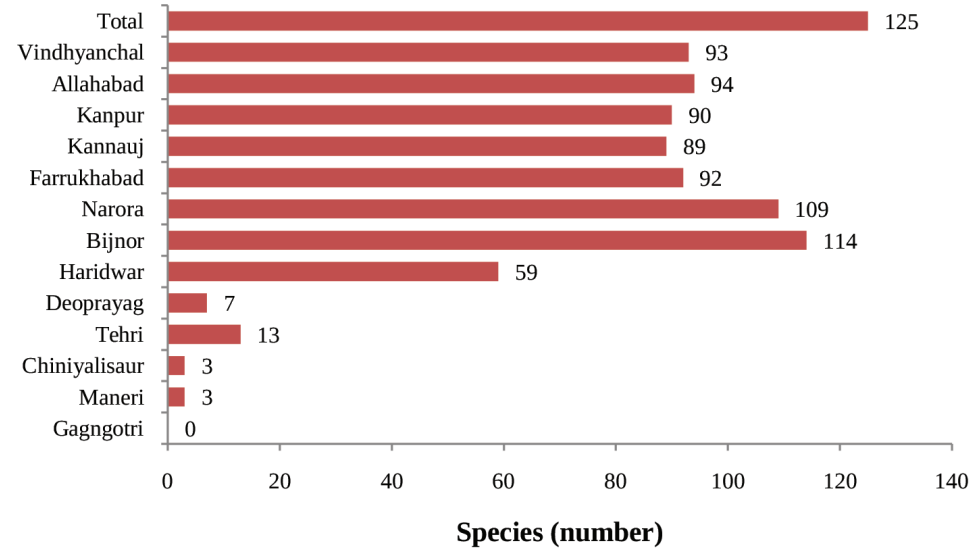
Fish and fisheries

A total of 125 fish species belonging to 77 genera, 30 families and 10 orders were recorded from Haridwar to Vindhyachal stretch of the river Ganga. *Garra lamta*, a hill stream cyprinid recorded from Haridwar was added to the existing list of fishes as

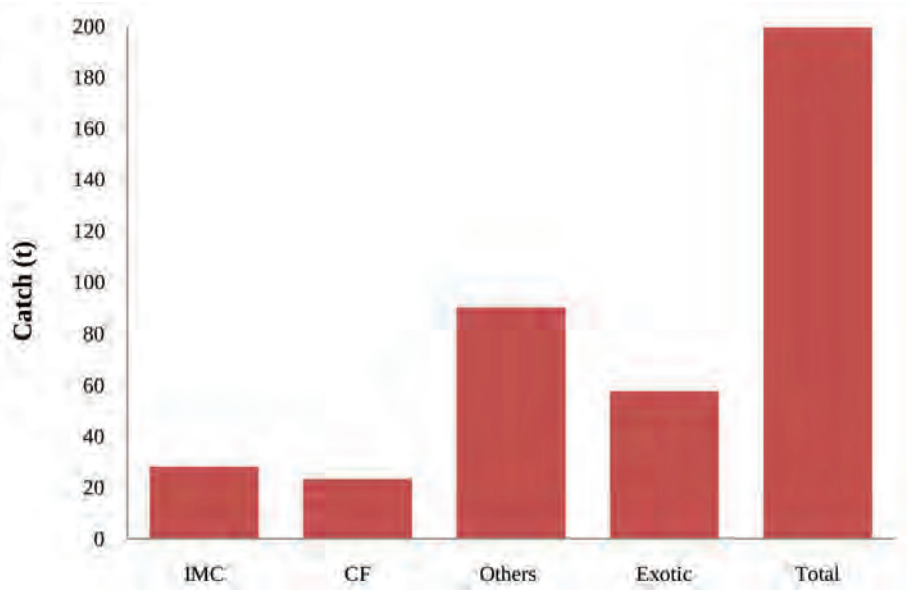
new record. Cypriniformes were the most dominant order represented by 63 species followed by Siluriformes with 31 species and Perciformes with 14 species. Fish landing from Allahabad stretch of the river Ganga was estimated at 199.53 t during 2015-16. Contribution of other group of fishes was maximum (45%) followed by exotic fishes (29%) to the total landing while contribution of IMC and cat fishes were 14% and 12% respectively. Common carp dominated among exotic fish landing. As compared to the preceding year, there was 1.8 % increase in fish catch, but share of IMC and catfish decreased while that of exotic fish species, mainly Tilapia and Common carp, has increased with respect to previous year.



Percentage composition of fish species in each family



Abundance of fish species along Gangotri and Vindhyachal stretch



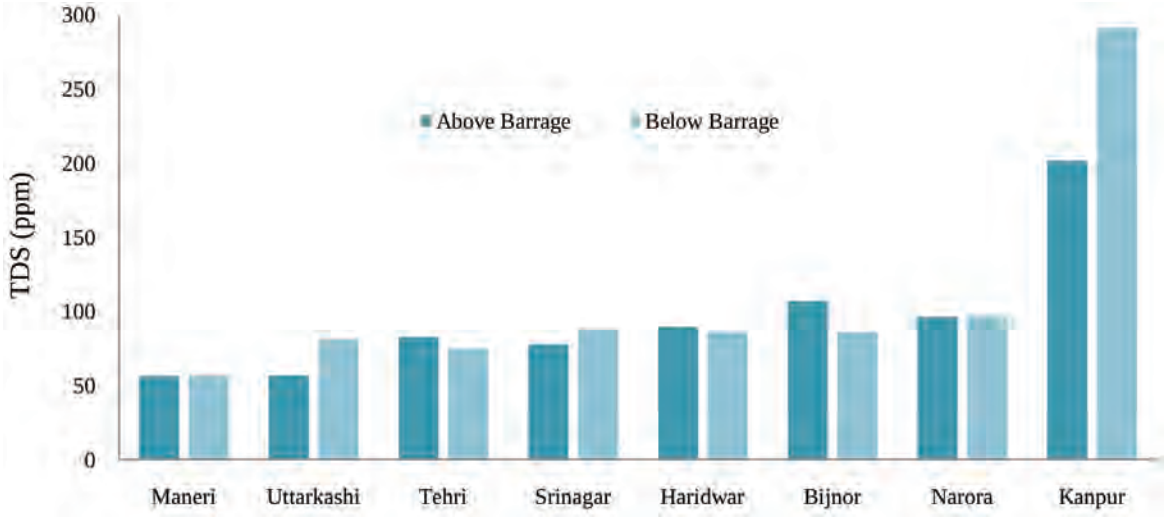
Fish catch from Allahabad stretch of Ganga

Soil

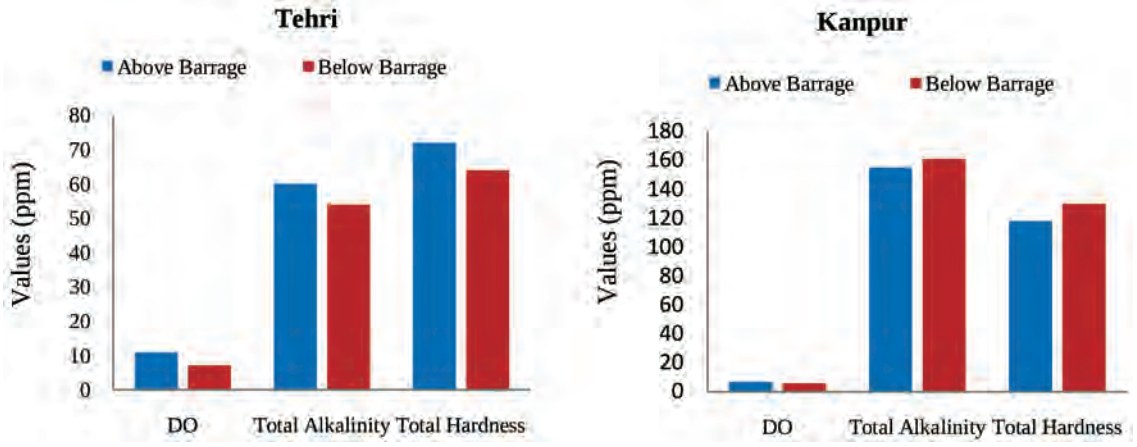
The soil texture of the river Ganga between Gangotri to Vindhyachal stretch was sandy (89.5- 99%), alkaline with pH between 7.0 and 8.2 during summer and 7.0 to 8.0 during monsoon. Free $CaCO_3$ was in the range of 0.13 to 3.50% and 0.63 to 4.0% during summer and monsoon, respectively. Dissolved organic matter was 0.02-0.15% in summer and 0.003-0.36% in monsoon and maximum at Tehri. The nutrient concentration of the entire stretch was low except at Tehri (15.56 mg N/100g) during monsoon season. Specific conductivity showed increasing trend in the upper stretch and irregular pattern in the lower stretch and maximum value recorded from Bijnor followed by Kanpur in monsoon and Bijnor followed by Farrukhabad in summer due to impact of flow regulation and pollution load.

Water

The water temperature varied from 5.0°C (Gangotri) to 33.5°C (Allahabad) during summer. The pH of water was acidic to alkaline pH (6.7 - 8.1); high dissolved oxygen was recorded at Himalayan stretch thereafter a decreasing trend was recorded. Chloride, total dissolved solids, total hardness and total alkalinity exhibited increasing trend towards downstream. BOD and Dissolved Organic Matter showed similar trend in the entire stretch with values ranging between 0.48-3.2 and 0.19-1.84 ppm respectively. The higher values for these parameters were recorded in the middle stretch. This indicated impact of pollution in the middle stretch of the river Ganga (Bijnor to Vindhyachal). In general the variations in water quality from upstream to downstream stretch were minimal owing to moderate flooding of the river during monsoon.Substantial variations in certain key water quality parameters were recorded at upstream and downstream stretches of the modified/polluted segment of the river. The total dissolved solids (TDS) was lowest at Maneri (56.26-56.67 ppm) and highest at Kanpur (56.26-291.7 ppm) along above and below barrage respectively. Average variations in dissolved oxygen (10.88 and 7.2 mgl^{-1}), total alkalinity (60 and 54 mgl^{-1}) and hardness (72 and 64 mgl^{-1}) were recorded at upstream and downstream of Tehri dam. Likewise the variations in dissolved oxygen (6.88 and 6.0 mgl^{-1}), total alkalinity (155 and 161 mgl^{-1}) and hardness (118 and 130 mgl^{-1}) were recorded at upstream and downstream of the Kanpur barrage. The alteration in these water quality parameters could be attributed to obstruction in river discharge.



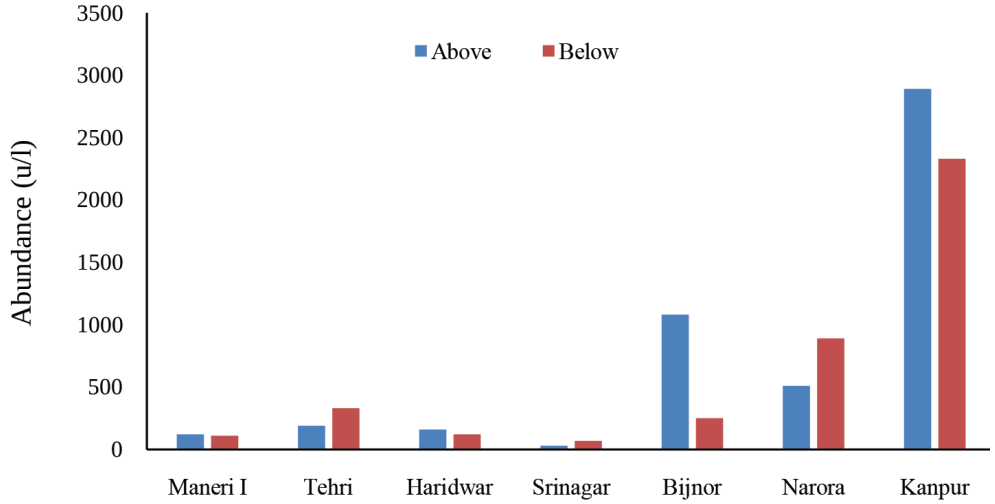
Variation in TDS upstream and downstream of barrage



Variations in water quality parameters upstream and downstream of Tehri and Kanpur barrage

Plankton

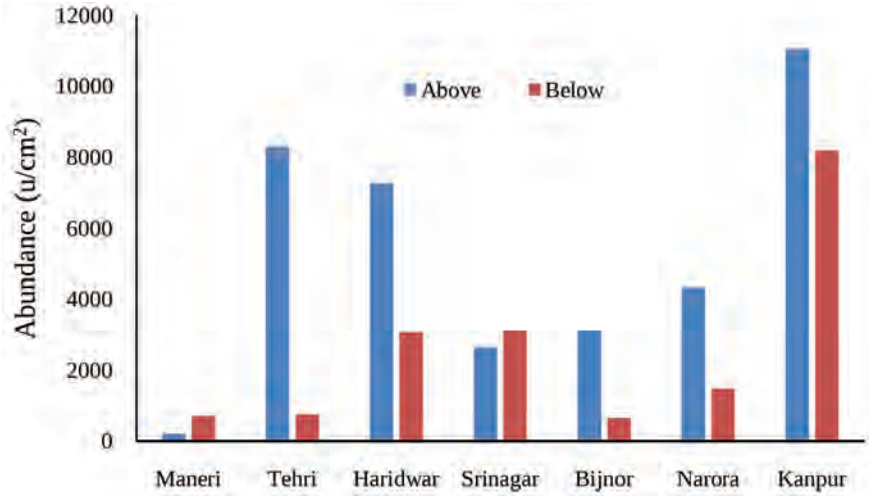
During summer, Bacillariophyceae was the dominant group followed by Chlorophyceae and Myxophyceae along Gangotri, Narora, Allahabad and Vindhyachal stretch; whereas, Chlorophyceae formed the major constituent between Farrukhabad and Kanpur followed by Bacillariophyceae and Myxophyceae. Higher abundance of Myxophyceae between Kannauj to Vindhyachal stretch indicated organic loading; moreover, low Myxophyceae population density between Bijnor to Farrukhabad suggested the stretch is comparatively less polluted than Kannauj to Vindhyancal stretch. However the dominance of Diatoms above Haridwar indicated biologically better water quality. Zooplankton was recorded from lower stretch only and rotifers ranged from 30 (Bijnor) to 380 μl^{-1} (Kannauj). Higher plankton abundance (μl^{-1}) was recorded upstream in comparison to downstream segment.



Plankton abundance above and below barrage during summer

Periphyton

In summer season 48 periphytic taxa were recorded, Bacillariophyceae dominated (60 µcm^{-2} to 9080 µcm^{-2}), followed by Myxophyceae, and Chlorophyceae between Gangotri and Haridwar stretch of the river Ganga. While Myxophyceae dominated between Farrukhabad and Kanpur stretch suggesting the impact of pollution. Higher abundance of periphyton community was observed above the barrage than below the barrage which may be due to the stagnant water above the barrage favored accumulation of algal flora as compared to stretches below the barrage. Conspicuous abundance of Myxophyceae between Narora and Vindhyachal stretch of the river Ganga indicated the impact of the pollution. In general the periphytic abundance was noticed to be higher at above barrage at Bijnor, Narora and Kanpur suggesting dependency of periphyton on incursion of nutrients with flowing water.



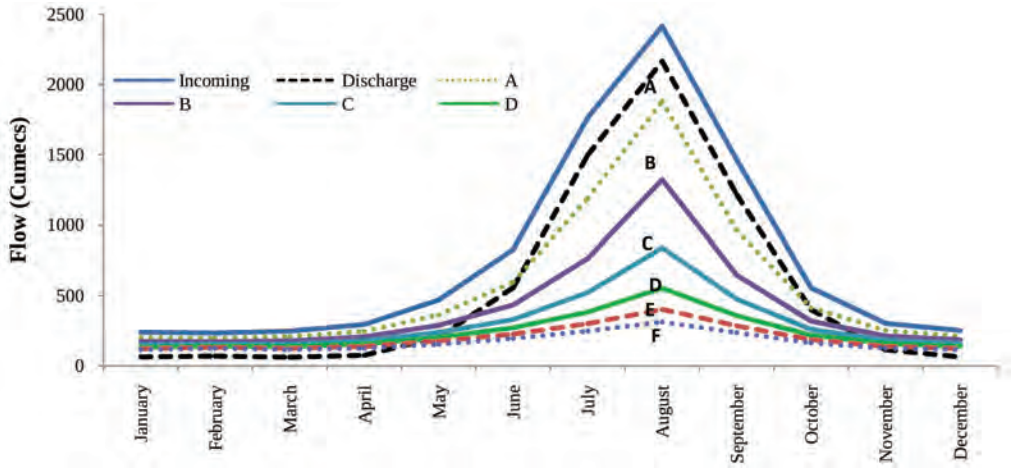
Periphytic abundance above and below the barrage during summer

Macrobenthos

The benthic biota varied from 320-790 nos. m^{-2} in the river with maximum abundance at Kanpur. 24 species of macro benthos were recorded, where molluscs formed dominant forms at all the centers except Kanpur. At Kanpur Chironomous dominated, indicating organic pollution. Shannon-Wiener diversity index (H`) ranged from 0.97 to 2.36 in the summer and from 0.73 to 1.63 during monsoon in the stretch between Haridwar and Vindhyachal of the river Ganga.

ENVIRONMENTAL FLOW ESTIMATION OF RIVER GANGA AT HARIDWAR

Environmental flow pattern of the river Ganga at Bhimgoda barrage was studied. On the basis of past hydrological data using desktop assessment methodology, the calculator suggested 26.6% of MAR (6258.58 MCM) to 76.0% (17875.96 MCM) to maintain the downstream ecology and fisheries between Seriously Modified Environmental Management Class (E) to Natural /Pristine Condition or Minor Modification of In-stream and Riparian Habitats (A) from the barrage. The incoming and discharge pattern from the Bhimgoda barrage showed that water flow during flood season (peak period) and other seasons was sufficient enough to maintain the ecological condition of the river but the discharge during lean season (December to March) remained far below requirement of class F of the EMC. With the objective to revive the depleting fishery in the affected stretch the discharge should be maintained at least in Class D during lean season. Accordingly, the flow requirement at Bhimgoda barrage was estimated between 132.48 and 140.84 Cumecs for lean season (December to March).



Estimated flow distribution of river Ganga at Bhimgoda for different EMC

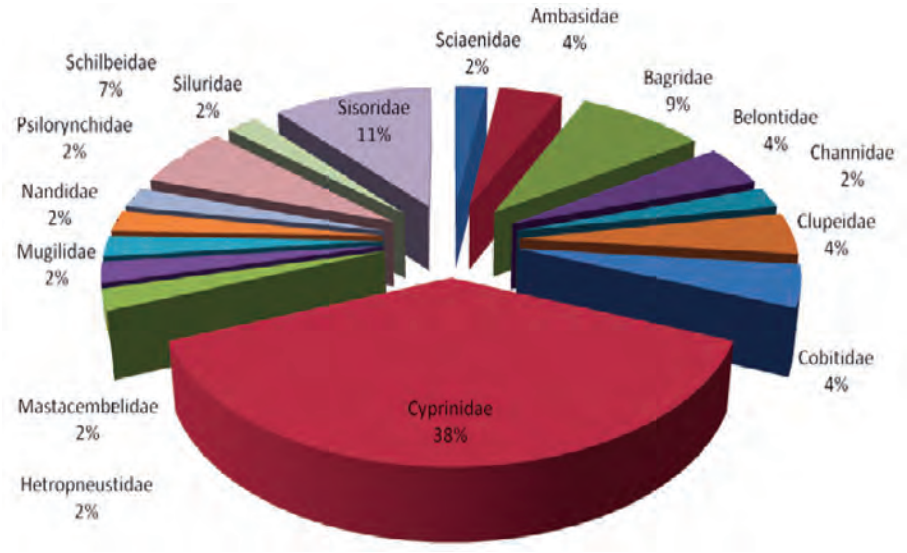
ABUNDANCE AND DIVERSITY OF SMALL INDIGENOUS FISHES

River Torsa (North Bengal) in Brahamaputra Basin and river Gandak (Bihar) in Ganga Basin were surveyed for small indigenous fish (SIF) species diversity, along with water quality and plankton for seasonal changes along with socio-economic evaluation of the fishermen community.

Gandak river, Bihar

A total of 65 fish species were recorded from selected stretches of Gandak River by sampling with cast net and modified barrier net (*Chatijaal*), of these 45 species were SIFs belonging to 16 families and 6 orders and the rest 20 (31%) were non-SIFs. Out of 45 SIFs, 13, 3 and 29 have been categorized as food, ornamental and food-ornamental

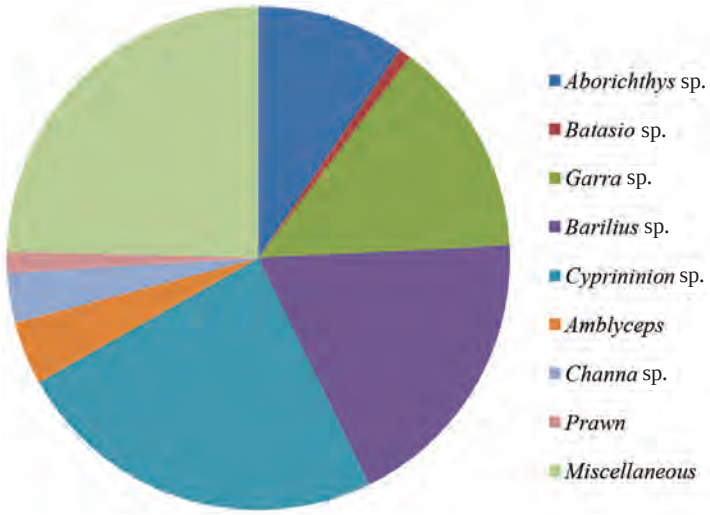
group, respectively. Shannon's diversity index (H´) indicated better SIF diversity at Maheshwarighat (2.8), followed by Rewaghat (2.7) and Tengrahi (2.5). The highest number of species/taxa and families were represented under the family Cyprinidae (38%) and the order Siluriformes (38%) respectively. The most abundant species was *Aspidoparia morar* (21%).



Family-wise percentage composition of SIFs of river Gandak

Torsa river, West Bengal

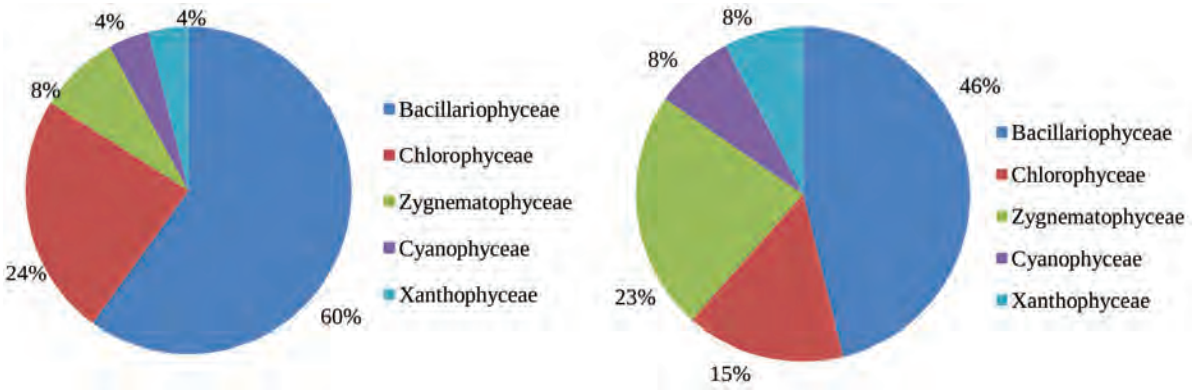
Torsa is a perennial river of Terai-Dooars region of West Bengal; originates from the Chumbi Valley in Tibet, China and meets Kaljani at Balarampur, India and then flows into Bangladesh with the name Kaljani, where it finally meets with Brahmaputra. Surveys conducted in 100 km stretch of river Torsa, during the month of November 2015 and January 2016, for monsoon and winter seasons recorded 53 species belonging to 37 genera, 15 families and 6 orders. Of this, 34 were small indigenous fishes. *Barilius* sp., *Puntius* sp., *Chagunius chagunius* and *Clupisoma* sp. were most dominant in catches. The SIF species recorded were categorised as Least concern (74.19%), Near Threatened (9.67%) and Not evaluated (16.12%) as per IUCN Red List.



Catch composition from river Torsa

Diversity of plankton in Torsa and Gandak rivers

Abundance and diversity of plankton has been recorded from river Torsa and river Gandak.Phytoplankton community in Torsa river dominated by Bacillariophyceae (60%), followed by Chlorophyceae (24%) and total 25 genera of phytoplankton were recorded. Shannon's diversity index (H´) showed higher value (2.362) at Balarampur (lower stretch) during post-monsoon (2.437) in river Torsa. Phytoplankton composition in Gandak river represented by members belonging to the class Bacillariophyceae, Cyanophyceae, Chlorophyceae, Zygnematophyceae and Xanthophyceae. Bacillariophyceae (46%) is the dominant groups followed by Zygnematophyceae (23%). Diversity index (H´) showed higher value in middle stretch Rewaghat station (1.983) and monsoon period (2.207) in river Gandak.



Phytoplankton diversity of river Torsa (left) and river Gandak (right)

Physico-chemical properties of water

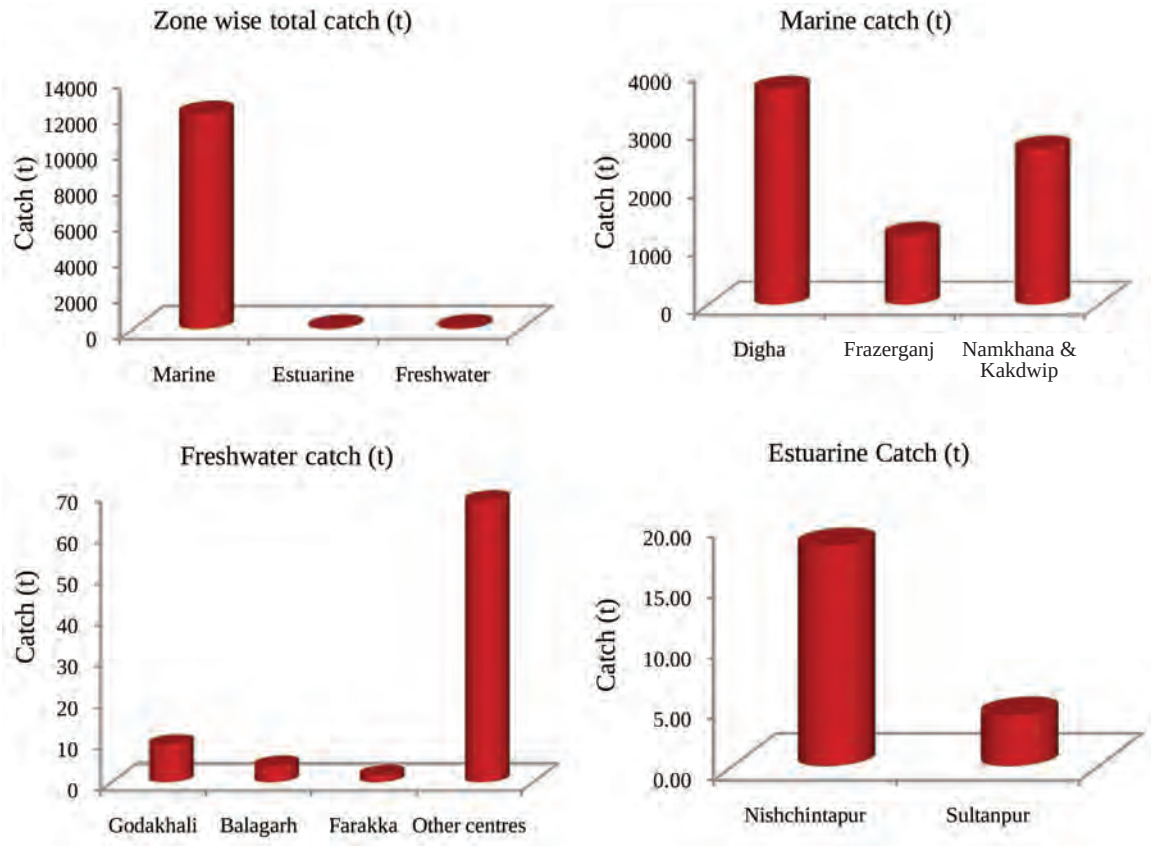
Water quality parameters of river Torsa and Gandak were analyzed for two seasons i.e., during monsoon and winter at selected sampling stations. Dissolved Oxygen concentrations were in the range of 6 to 8.5 ppm in Gandak river and 6.1 to 8.1 ppm in Torsa river. Dissolved oxygen in the two seasons did not vary significantly in both the rivers. Nitrate levels ranged between 0.5 to 1 ppm in Gandak and 0.78 to 1.4 ppm in Torsa; and the levels of nitrate were found less at all the points in monsoon compared to winter. Phosphate levels (0.01 to 0.08 ppm in Gandak and 0.01 to 0.03 ppm in Torsa) at all the stations, except one were more in monsoon; especially in Rebaghat on Gandak. The monsoon sample contained higher amount of phosphate.

FISHERIES, STOCK ASSESSMENT AND CONSERVATION OF HILSA

Hilsa, *Tenualosa ilisha*, is a high value fish. The fish spends its adult life in the marine environment and migrates to freshwater riverine habitats for breeding. The young ones migrate back to marine environment for growth. Hydrological alterations in the form of barrages and dams built across the major east and west coast rivers, especially along the Ganges, Narmada have blocked its migratory routes to breeding grounds in riverine areas, resulting in the collapse of its fishery in the rivers. The lucrative commercial fisheries of the fish along the major estuaries in the country, more particularly in the Hooghly estuary, have also drastically declined due recruitment failure and intensified exploitation of adults and juveniles. The natural stock characteristics of the fish and their dynamics are not clearly understood. The catch of hilsa from Hooghly-Bhagirathi river system and Northern Bay of Bengal; Narmada estuary and Catch Per Unit Effort (CPUE); population structure, habitat preference and breeding grounds were investigated.

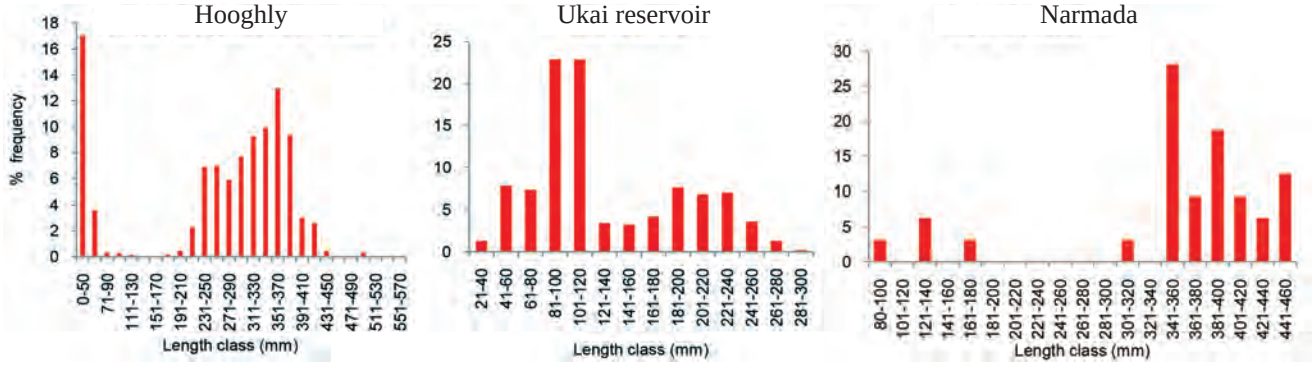
Catch statistics

The catch estimation of hilsa from Hooghly-Bhagirathi river system and Northern Bay of Bengal in the year 2015-16, was made following 'Stratified Multistage Random Sampling' method, involving 51 stations. The total catch estimated was 12191 t during 2015-16, which was 27% of the previous year's landing, indicating drastic decline in current year's catch. Maximum catch (98.6%) was realized from the marine sector. Zone wise catch statistics has also been collected from Ukai reservoir, as well as from Narmada estuary, Gujarat.



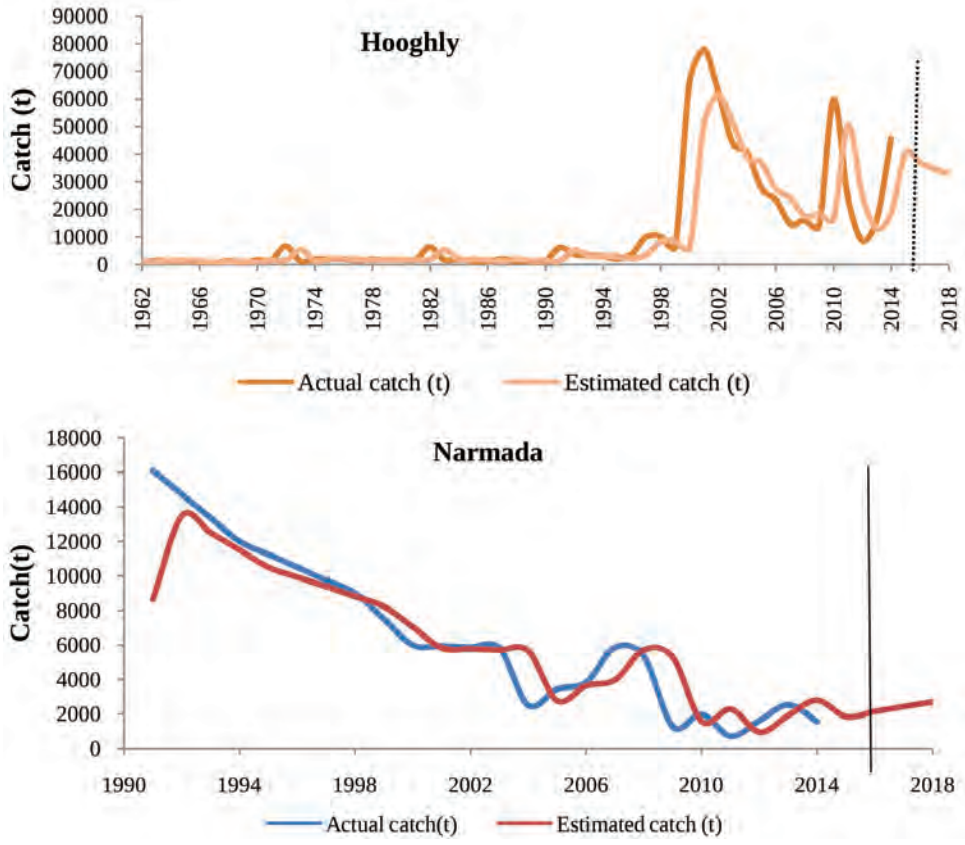
Zone wise catch of hilsa from Hooghly-Bhagirathi system

The Catch Per Unit Effort (CPUE) varied from 37.5-260 kg boat^{-1} day^{-1} for multiday gillnetters in peak fishing months (July-September), whereas in estuarine and freshwater zones, it was 0.4-14 kg boat^{-1} hr^{-1}and 0.08-1.25 kg boat^{-1} hr^{-1} for single day gill netters, respectively. The fishery was dominated by the 231-250 mm length (TL) group. Length frequency analysis showed increasing contribution of smaller size groups or juveniles in the catch, pointing towards growth overfishing. Large occurrence of ripe per oozing fishes (49.53%) in catch also signals recruitment overfishing. The hilsa fishery of river Narmada along the west coast, mainly comprised of 340 mm and above size groups, whereas in Ukai reservoir the catch was dominated by 120 mm and below size class.



Length frequency of Hilsa from Hooghly, Ukai reservoir and Narmada estuary

Based on the population structure analysis and exploitation pattern, there was 20% over exploitation from maximum sustainable yield levels and 72.4% decline in standing stock biomass of the fish. The exploitation ratio was 0.77, showing over exploitation. The spawning stock biomass (SSB) estimated was 23.7% of the virgin stock, indicating that the SSB of the population is currently at minimum sustainable level; further decrease will seriously affect the stock. Bio-economic analysis also showed decline in MEY, with 9.3% decline from maximum value obtained. Length at first capture was 270.5 mm and the corresponding age is 1.03 years. Time series analysis of catch data using ARIMA modeling suggested that if the present fisheries scenario continues, the production is expected to progressively decline in the coming years in Hooghly system; it might slightly increase in the coming years in Narmada estuary.



ARIMA based forecasting of catch from Hooghly and Narmada

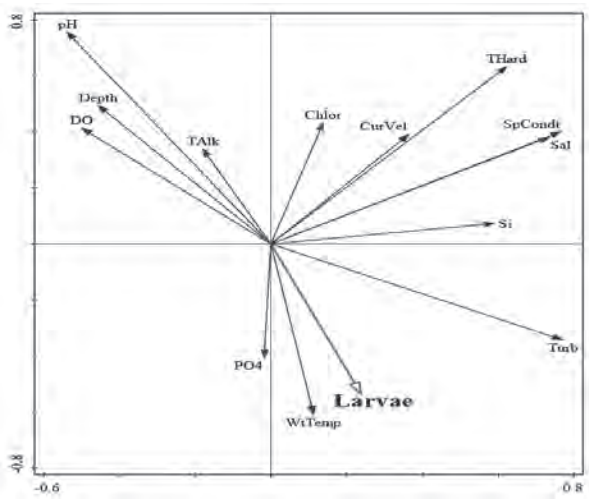
Breeding grounds

Identification of breeding grounds was done through collection of data on brood stock availability, maturity condition, mate size, sex ratio, abundance of fertilized eggs and larva in habitat along with environmental conditions. Highest breeding activities were in freshwater tidal (52%) zone followed by brackish water (22%) and upstream river stretches (22%), while high saline zone (4%) was least important. However, the locations of spawning grounds varied with the seasons. Major breeding grounds identified are at Godakhali on the main stream Hooghly and Kolaghat on Rupnarayan tributary during monsoon, when maturity conditions of both the females and males were optimum, sex ratio was favourable and larvae and post-larvae, fertilized eggs were abundant. During winter the spawning grounds shifted upstream from freshwater tidal to river zone and located along Kolaghat, Godakhali, Dakshineswar, Bichulighat, Kalyani, Balagarh and Farakka.

Stages from eggs to post-larvae were collected by deployment of a specially designed triangular spawn collection net made of 0.3 mm syntactic-mesh cloth, having mouth area of 0.707 m^2 and 1 meter length with a collection bottle at the tail end. Larval abundance was 437 nos/m^3 at Kolaghat, 8 nos/m^3 at Godakhali during monsoon and 143 nos/m^3, 25 nos/m^3, 14 nos/m^3, 6 nos/m^3 and 9 nos/m^3 at Bichulighat, Dakshineswar, Kalyani, Balagarh and Farakka, respectively in winter season.

Larvae collection from river

Post larvae of Hilsa from Hooghly

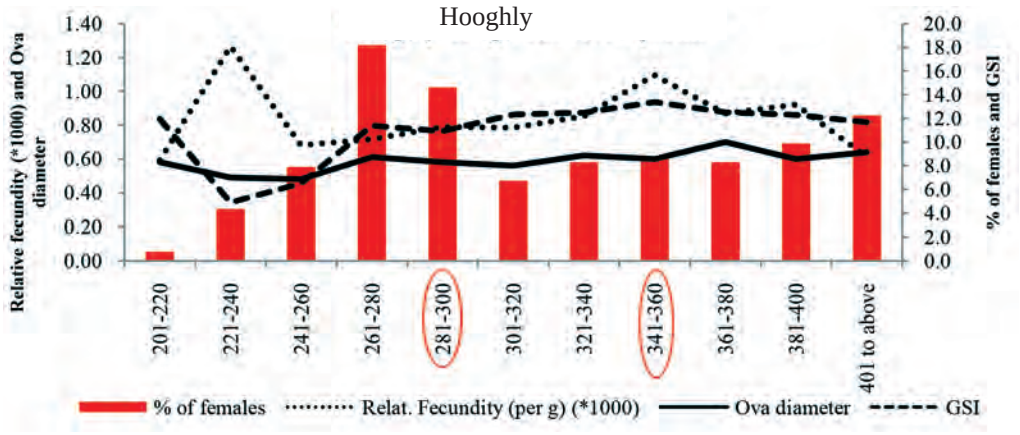


PCA of larva abundance and water quality parameters

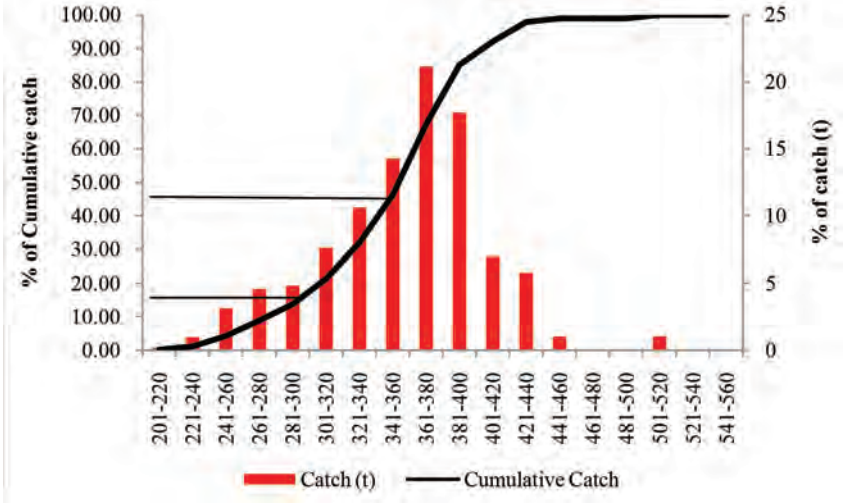
Water current (m s^{-1}), temperature (°C), depth (m), pH, specific conductivity (µS cm^{-1}), turbidity (ppm), dissolved oxygen (ppm), total alkalinity (ppm), total hardness (ppm), chloride (ppm), phosphate (ppm) and silicate (ppm) were recorded in the larvae sampling points. PCA of larvae abundance and water quality parameters showed that PC1 and PC2 explained variance cumulatively at 47.76%. Larvae abundance and water quality parameters indicated water temperature as the most influencing parameter.

Conservation

Reproductive traits of different size groups revealed that females in the size range of 341-360 mm have most reproductive potential. For protecting hilsa this size range, minimum mesh size of gill nets required is 110 mm (based on linear relationship between total length and body depth). As bulk of the catch (45.64%) is contributed by hilsa of this size range, the 110 mm mesh regulation may cause severe economic/ livelihood loss to fishers. Taking this in view the next smaller sizes with comparable breeding potential is 281-300 mm. If this size is protected through mesh size regulation of 90 mm, will protect significant number of breeding population, without significant reduction in catch for fishers (>14%).



Reproductive indices and % of adult hilsa in Hooghly estuary



Size wise cumulative catch contribution in Hooghly estuary

AQUATIC BIODIVERSITY OF MANGROVE ECOSYSTEM

Changes in finfish and shellfish diversities, with the changing environmental parameters, *e.g.*, water and sediment quality, nutrient cycling, plankton and macro-zoo-benthos abundance and diversity, etc. in major estuaries and mangrove ecosystems, like the Sundarban estuary, Narmada estuary and Korapuzcha estuary were studied.

Sundarban estuary

Fish and shell-fish diversity

A total of 156 fish species belonging to 53 families and 16 orders, were recorded; *Gobiidae* was the most common family with 20 species, followed by *Engraulidae* (13 species), *Sciaenidae* (11 species) and *Ariidae* (8 species). Preliminary estimate of fish catch from winter bag net fishing, along the lower Sundarban revealed a major shift in catch composition in comparison to landings during 2009-10. Drastic reduction in landings of *Harpadon nehereus* was recorded in current year, which constituted 27.25% (9927 t) of total catch during 2009-10. High landing of pony fish was recorded, which curently forms the most dominant component of winter bag net fishery. During January 2016 it constituted 92% of the total catch. Non-penaeid prawns (mainly *Acetes* spp.) have emerged as one of the most dominant fishery resource. There is overall reduction in the catch of fin-fishes. The fishery is presently dominated by prawns (58.5% as compared to 10.23% in 2009-10). The bag net catches were dominated by invertebrates (73.5 %) comprising prawns (58.5%), crabs (11.65%), stomatopods (2.10%) and cephalopods (1.26%). *Atypopeneus stenodactylus*, which was a rare component in prawn catches, is now one of the major prawn species with relative abundance of 3% among the prawn landings.

Seasonal variation in fish species richness at various stations of Sundarbans

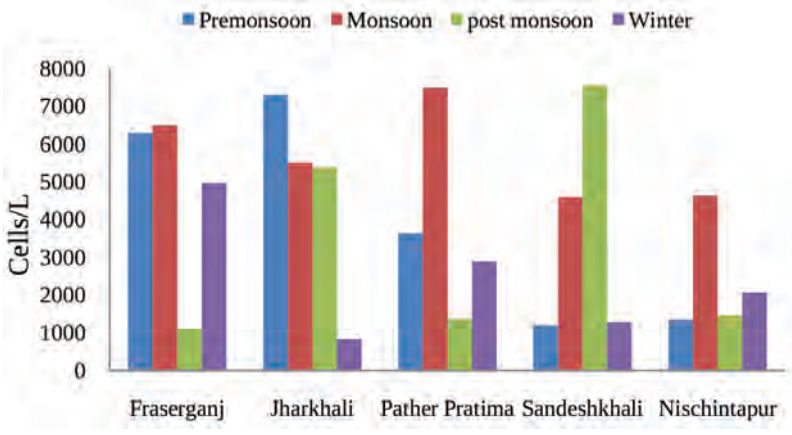
Station	Species (no.)	Season	
		Monsoon	Post-monsoon
Fraserganj	105	61	82
Jharkhali	91	29	39
Nischintapur	72	32	47
Sandeskhali	65	35	41
Patharprathima	62	33	39

Catch of *Secutor insidiator*

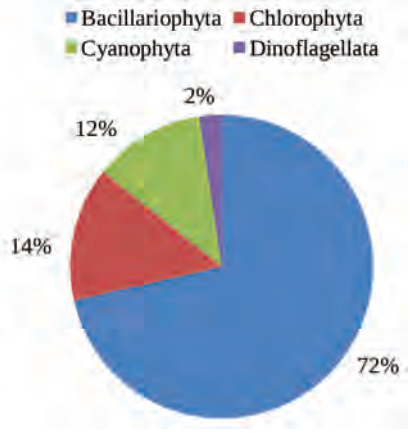
Atypopeneus stenodactylus

Phytoplankton

A total of 42 genera of phytoplankton, belonging to 27 orders and 34 families,were identified till now. Bacillariophyceae dominated in phytoplankton assemblages of Sundarban estuary. Out of 42 genera identified, 17 were pennate diatoms (41%) and 13 were centric diatoms (31%). Phytoplankton cell abundance ranged from 12049-28067 nos./l and the highest abundance was recorded during monsoon. Shannon's diversity index (H′) ranged from 2.16 to 2.62 among different sampling stations and 1.89 to 2.43 for different season.



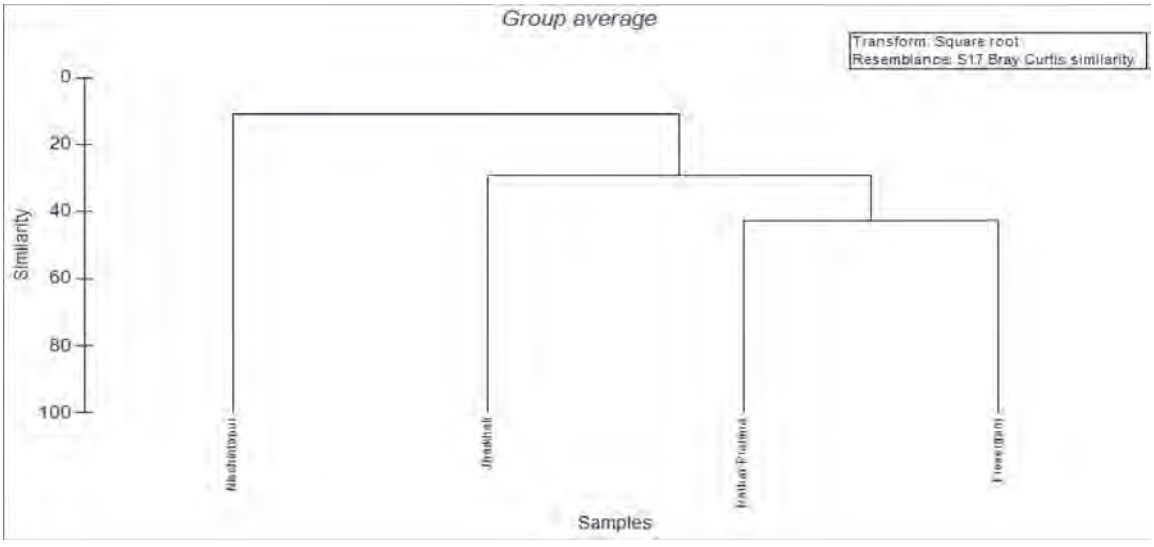
Seasonal abundance of phytoplankton at different stations of Sundarbans



Group wise phytoplankton composition from Sundarbans

Macro-zoo-benthos

Analysis of samples collected from selected stations of Sundarban estuatry showed that molluscs contributed more than 80% of the total benthic biota, followed by *Clitellata* and *Polychaeta*. The class Gastropoda was dominant among Molluscs. Occurrence of *Cerithidea cingulata* was the highest. Nischintapur was predominantly a freshwater zone and thus benthic community was significantly different from other sites. Study of various diversity indices indentified Nischintapur with least diversity in benthic community and Patharpratima with maximum diversity and this may be due to high influx of freshwater at Nischintapur. At Patharpratima, significant salinity regime was maintained, which favourd the existence of many benthic communities. Absence of mangroves in Sandeshkhali and Nischintapur might have a role in low abundance of benthos in those areas.Among selected sites of Sundarban, benthos diversity was highest at Jharkhali with Shannon index value [H´(loge) = 2.00], followed by Fraserganj [H´(loge) =1.96] and Patharpratima [H´(loge) =1.75]. Dominance index (D) was highest in Sandeshkali (D = 0.63) and Freserganj (D = 0.62), while Pielou's evenness was lowest in Sandeshkali (J´ = 0.51). A total of 14 species of benthos recorded from Jharkhali and 12 species from Frazerganj; *Pugilina cochlidium* was present in most sites and *Littoraria scabra* was the most abundant species.



Cluster analysis of distribution of benthos from different sites

Crab diversity and fisheries in Sundarban

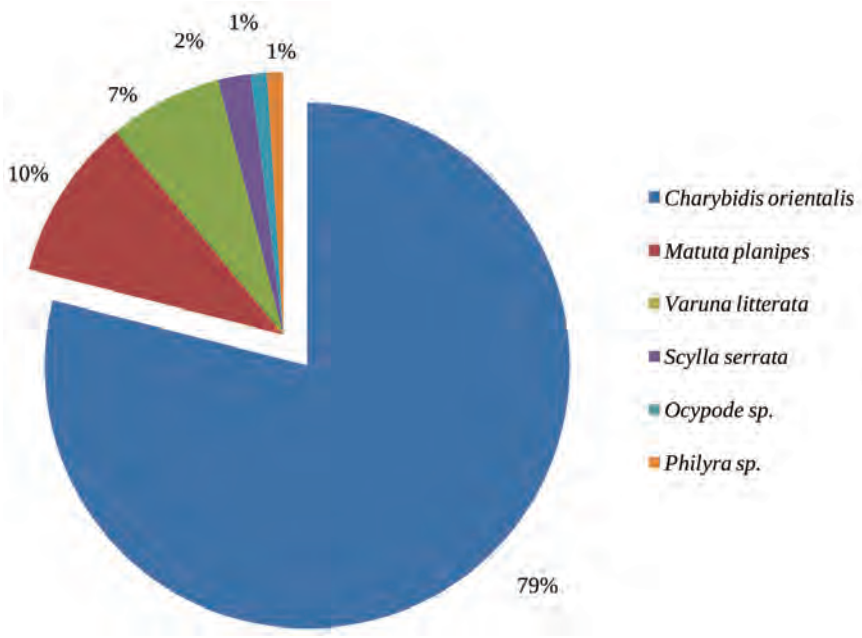
Crab fishery resources of Sundarban are supported by marine, estuarine, brackish water and freshwater species. During November 2015 to March 2016, 9 species of marine and estuarine crabs, belonging to seven genera and five families were recorded from selected stretches of Sundarban *viz*. Nischintapur, Patharpratima, Frazerganz, Jharkhali, Bally, Jatirampur and Pakhirala. *Scylla serrata* represented the largest known edible and highly valued economic species of the Indo-Pacific region, both in domestic and international markets; marketed live. The professional crab fishers employ mainly four types of gears, *viz*., *Sik* or hook, *don* (suti) or baited line, *Chakjaal* (a trap) and monofilament nets with baits exclusively for capturing *Scylla serrata* in the deltaic Sundarban. Hence, *Scylla serrata* was found dominant in commercial catch in all the stretches of Sundarban. However, various types of nets are mainly used to catch fishes in the estuary by the local fishermen, also to trap crabs as supplementary or by-catch. Such nets include bag nets, cast nets, *Charpatajaal* or set barrier net. *Charybidis orientalis* was most dominant (~79% of the total catch composition of crab) in the catch of bag net with size ranging from 0.5 cm to 2.5 cm followed by *Matuta planipes* (10%), *Varuna litterata* (7%), *Scylla serrata* (2%) and *Philyra* sps. (1%) as by-catch and these species do not have any commercial importance.

***Don* (*Suti*) or Baited line**

***Chakjal* trap used for crab fishing**

Monofilament net used for crab fishing

Live *Scylla serrata* at local market

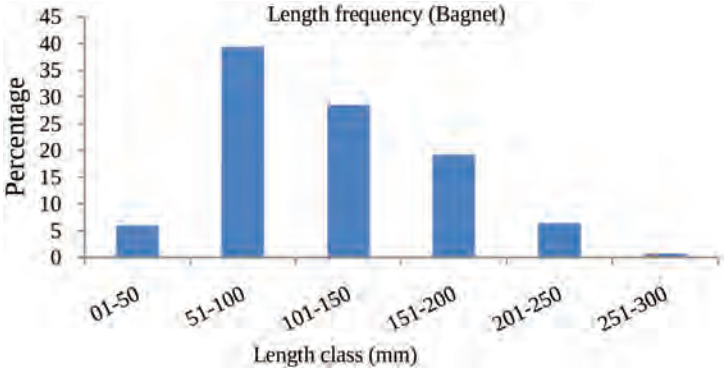


Composition of crabs in Bag net catch

***Charybidis orientalis* in bag net catch**

Harpadon nehereus in Sundarbans

Harpadon nehereus (Bombay duck) is an important resource of the bag net fishery of Sundarban area. The minimum total length in catches was 22 mm and the maximum of 297 mm. Juveniles formed the bulk of the catch; 39% in 51-100 mm, 29% in 100-150 mm, 6% in 10-50 mm size groups. It was observed that 95.7% of the catch was less than the reported length at first maturity of 214.5 mm. Therefore, this could be a cause of concern as the bag net fishery may lead to growth overfishing.



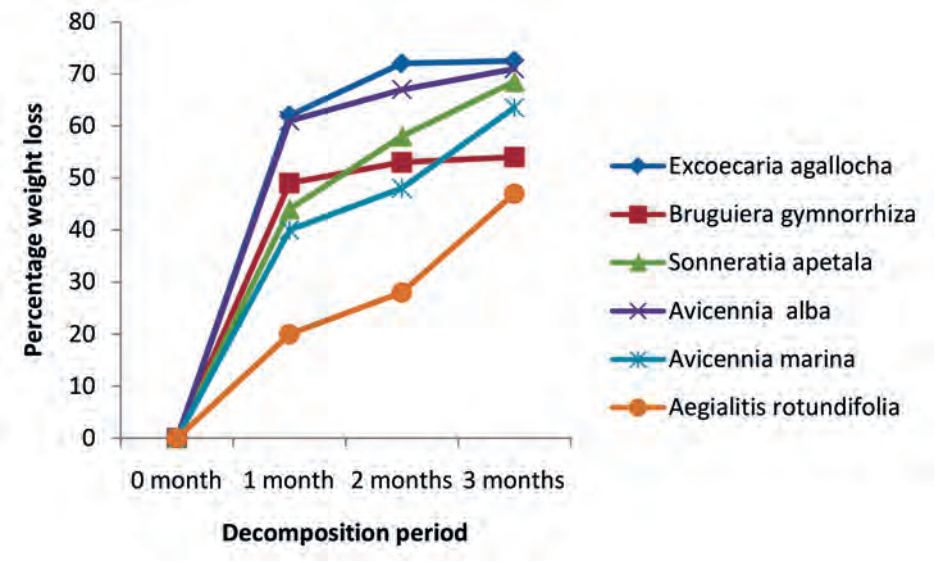
Length frequency in bag net catch of *H. Nehereus*

NUTRIENT DYNAMICS OF MANGROVE ECOSYSTEM IN SUNDARBANS

Nutrient release from mangrove leaf litter

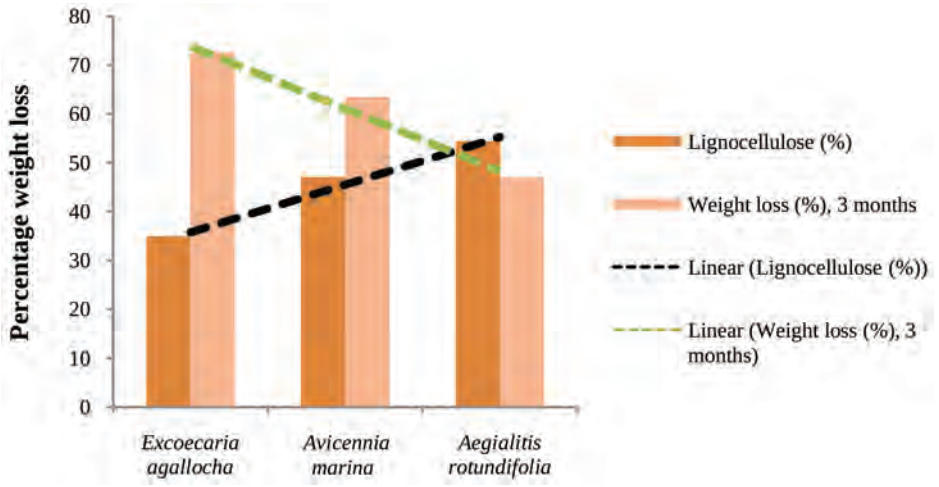
Results from 3 months *in situ* litter decomposition study using selected mangrove leaf litter at Jharkhali revealed that loss of weight of Geon leaf (*Excoecaria agallocha*) was faster in comparison to other five species *viz*., Kankra (*Bruguiera gymnorrhiza*), Keora (*Sonneratia apetala*), Kalbain (*Avicennia alba*), Jatbain (*Avicennia marina*) and

Taura (*Aegialitis rotundifolia*). Geon leaves lost 62% and 72% of its original weight from litter bags after one and two months of decomposition; Kalbain leaves were also susceptible to fast decomposition losing 61% and 67% of original weight after 1 and 2 months. Most resistant litter was Taura, which lost only 28% of its original weight after two months.



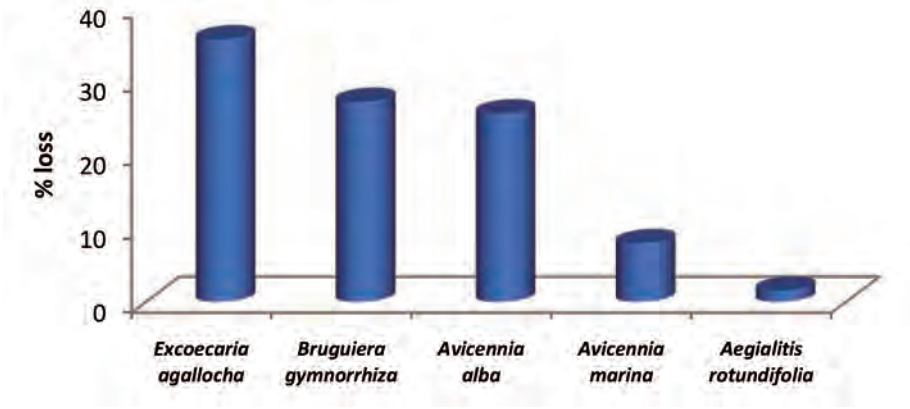
***In-situ* mangrove leaf litter decomposition**

Geon (*Excoecaria agallocha*) leaf, which decomposed at a faster rate contains only 34.95% lignocellulose whereas resistant Taura (*Aegialitis rotundifolia*) leaf contains much higher (54.95%) lignocellulose.



Lignocellulose content vs. decomposition rate

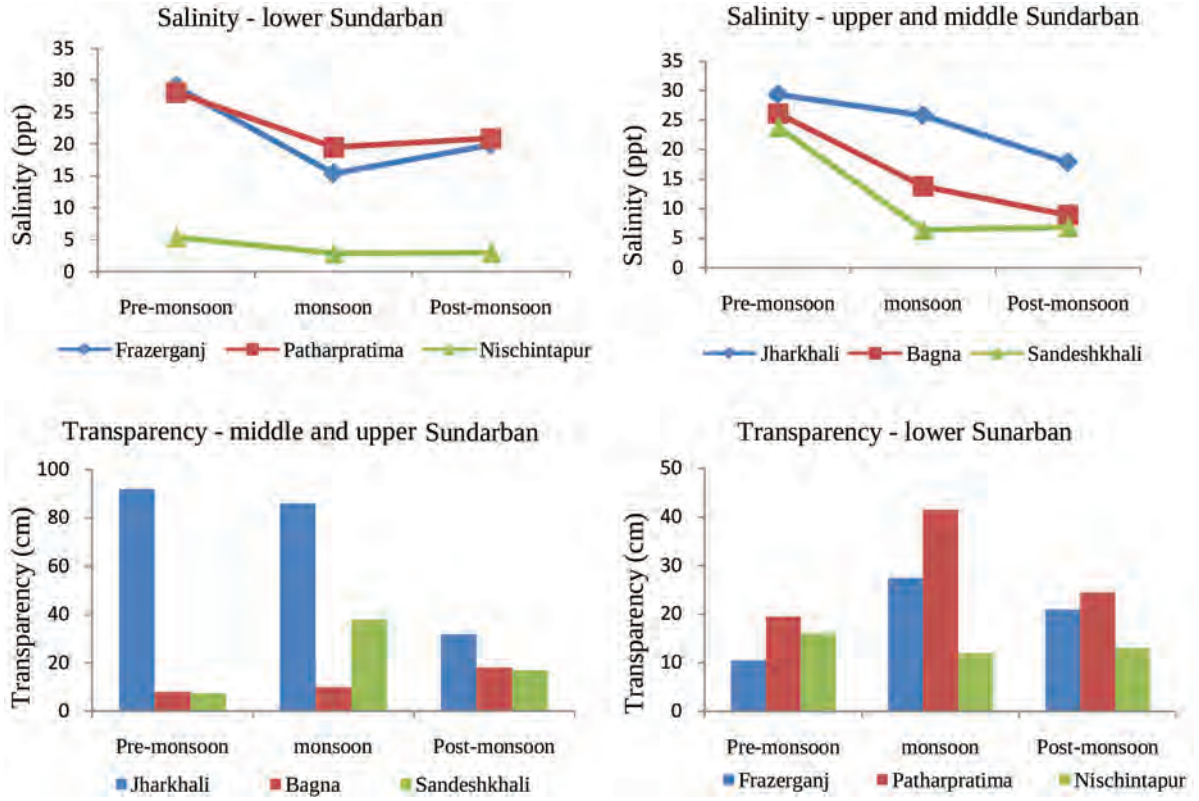
Nitrogen estimation in stock samples and residues after one month decomposition revealed that Geon (*Excoecaria agallocha*) lost 35.69% of the nitrogen present in the leaf litter at the initiation of the experiment. This was followed by Kankra (*Bruguiera gymnorrhiza* 27.14% loss) and JatBain (*Avicennia marina*; 25.55% loss). The shore line at Sundarban is dominated by Bain group of mangroves and thus important in nutrient (N) enrichment.



Nitrogen loss (%) from leaf after one month of decomposition

Soil and water chemistry

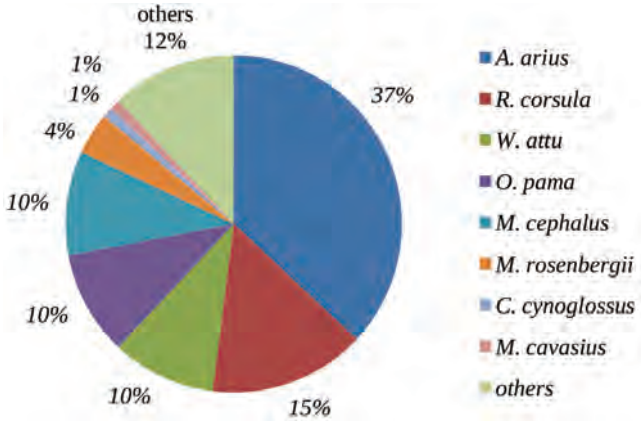
Total nitrogen in soil at Sandeshkhali in upper Sundarban has gone up during pre-monsoon (0.154%); the river (Kalagachhi) sediment also contained 0.140% N. Unlike Jharkhali in middle of Sundarban, where a good population of mangrove plants were available and contained 0.07% total nitrogen in the same season, Sandeshkhali had no or very sparse number of mangrove species. A different picture was observed in accumulation of nitrogen in soil in Patharpratima and lower Sundarban. In mangroves of this zone, soil total nitrogen was more during monsoon than pre-monsoon season; Patharpratima mangrove soil recorded 0.053% and Frazerganj soil 0.048% total nitrogen in monsoon in comparison to 0.036% and 0.031%, respectively for those stations in pre-monsoon. The soil nitrogen mineralization rate was probably higher during pre-monsoon as evident from increased available nitrogen contents (6.05 and 4.48 mg 100 g^{-1} soil) at Patharpratima and Frazerganj respectively. Salinity and transparency were the two important parameters for the Sundarban rivers and their variations at different stations were recorded in different seasons. The salinity attained maximum irrespective of the places during pre-monsoon when the values ranged between 23.8-29.3 ppt. except at Nischintapur, where the maximum salinity was 5.4 ppt., which was diluted to 2.9 ppt. during monsoon due to continuous freshwater discharge from upstream. Amongst the stations, Jharkhali maintained higher salinity values throughout the year and thus exhibits a flatter variation curve. The higher salinity at Jharkhali and adjacent area had an impact on fish and other biota. Transparency of Herobhanga river at Jharkhali during pre-monsoon was very high (92 cm Secchi disc reading), whereas, transparency of river water were very low (around 8 cm) at Bagna and Sandeshkhali in upper Sundarban in the same season. The rivers in lower Sundarban were muddier with highest transparency of only 40 cm Secchi reading at Patharpratima during monsoon was observed. Transparency at Nischintapur was less variable with the season with value never exceeded 15-16 cm due to high turbulence and presence of finer clay particles.



Water quality of Sundarban estuary

ECOLOGY AND FISHERIES OF NARMADA ESTUARY

A total of 86 fin-fish and shell-fish species belonging to 41 families and 11 orders were identified so far from Narmada estuary. Water quality parameters were studied in selected stations, namely Bharuch, Bhadbhut, Mehgam and Ambetha. The study indicated that Narmada estuary is moderately productive with dissolved oxygen 6.08 to 7.76 mg/l, pH 7.74 to 8.17, salinity 0.12 to 34.7 ppt and transparency 4-43 cm. Gross Primary production rate ranged from 50 to 116.67 mg cm^3 hr^{-1}. Salinity ranges were recorded at 0.13 ppt to 19.64 ppt from Bharuch to Ambetha during monsoon period owing to the heavy release of freshwater from upstream Sardar Sarovar dam. Catch composition of Bag net (10 mm code end) showed that *Arius arius* contributed 37% of the total catch followed by *Rhinomugil corsula*, *Wallago attu*, *Otolithoides pama*, *Macrobrachium rosenbergii*, *Cynoglossus cynoglossus*, *Mystus cavasius*, etc. with CPUE of 8-14 kg bag^{-1} $tide^{-1}$. The threatened fishes *Scatophagus argus*, *Brachirus orientalis* and *Taenioides anguillaris* also recorded from Narmada estuary.



Bag net catch composition during monsoon in Narmada estuary

Catches from bag net in Narmada estuary

Sorting of bag net catch

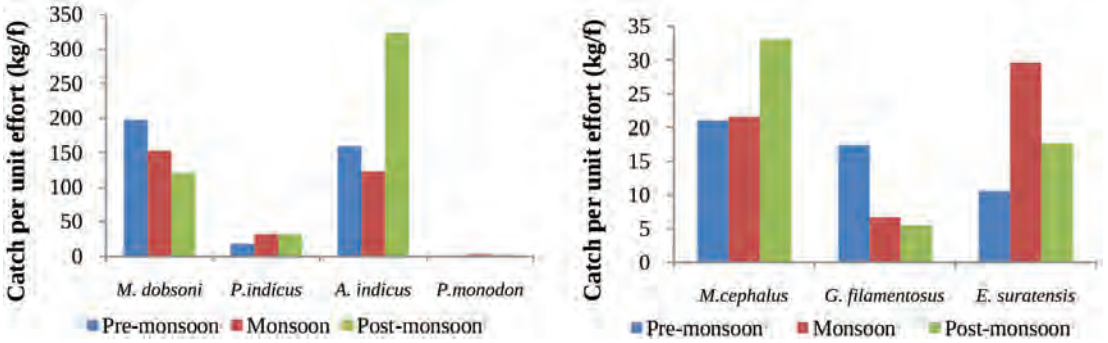
Scatophagus argus

Brachirus orientalis

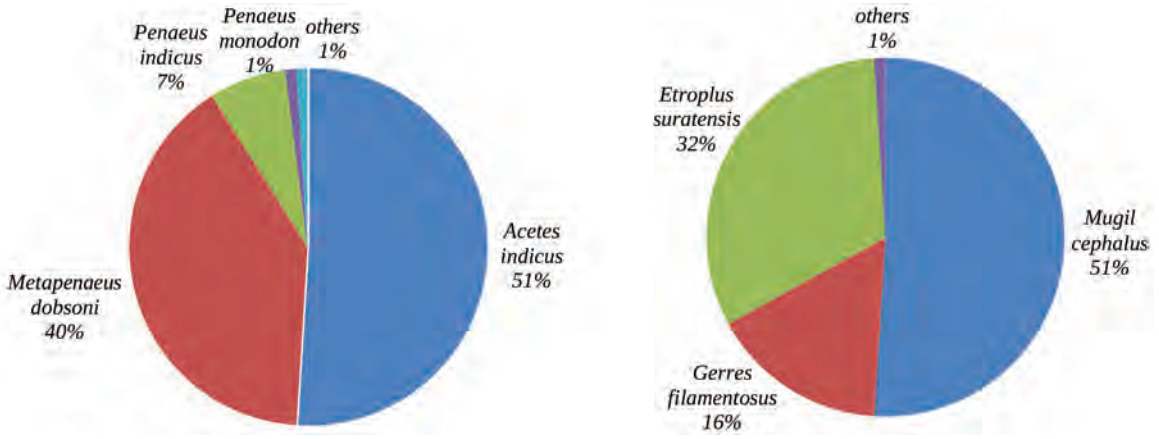
Taenioides anguillaris

ECOLOGY AND FISHERIES OF KARAPUZHA ESTUARY

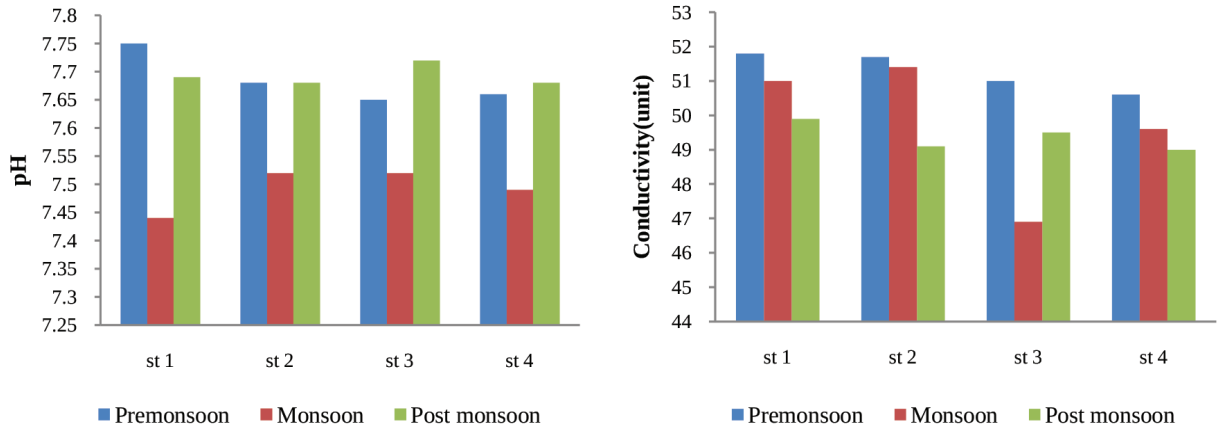
In Korapuzha estuary, major fish catch composed of *Acetus indicus* (51%), *Metapenaeus dobsoni* (40%), *Penaeus indicus* (7%), *Penaeus monodon* (1%) from stake net, and *Mugil cephalus* (51%), *Gerres filamentosus* (16%), *Etroplus suratensis* (32%) from cast net. *M. dobsoni* and *G. filamentosus* catches were high in pre-monsoon season. *P. indicus*, *A. indicus* and *M. cephalus* catches were more in post-monsoon. In monsoon season, *P. monodon* and *E. suratensis* catches were higher. Water quality parameters such as pH, temperature, conductivity and dissolved oxygen in different seasons are depicted in figures. Fish catch data has positive correlation with pH, temperature, conductivity, DO and correlation value 0.62, 0.05, 0.17, 0.12 respectively. There were mainly two mangrove species found, viz., *Rhizophora* sp. and *Avicennia* sp.



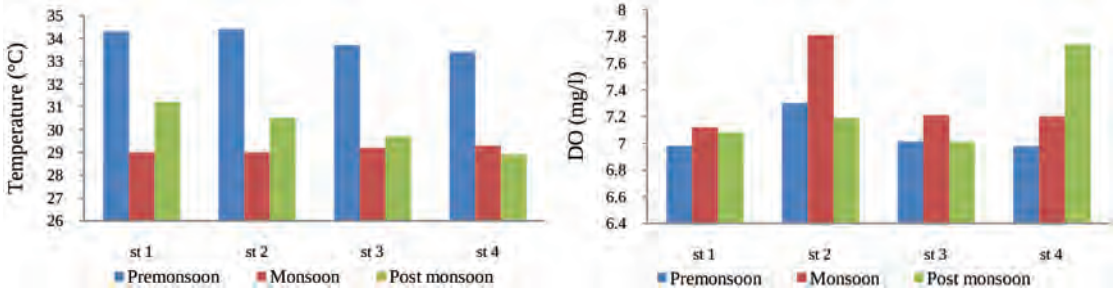
CPUE of major catch – Stake Net (left), Cast Net (right)



Catch composition of Stake Net (left), Cast Net (right)



Seasonal variation in pH (left), in Conductivity (right)



Seasonal variation in temperature (left) and in dissolved oxygen (right)

ASSESSMENT OF THE ECOLOGY AND FISHERIES DIVERSITY OF CHILIKA LAKE

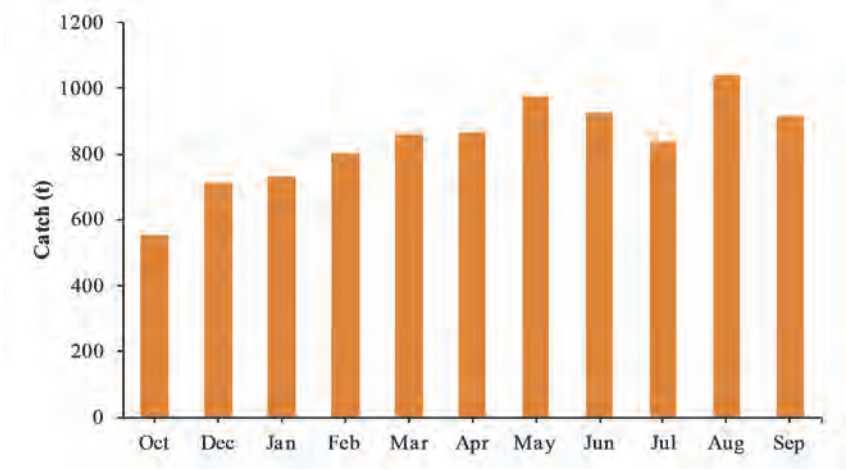
Chilika Lake, Asia's largest brackish water lagoon situated in Odisha, supports livelihood of around 2 million fishers and related people. The fish produced from the lagoon is consumed locally and also has export value. Catch data from major fish landing centers of the lagoon, gear wise catch statistics, CPUE were collected regularly and stock assessment of important fish species were conducted.

Fish catch statistics

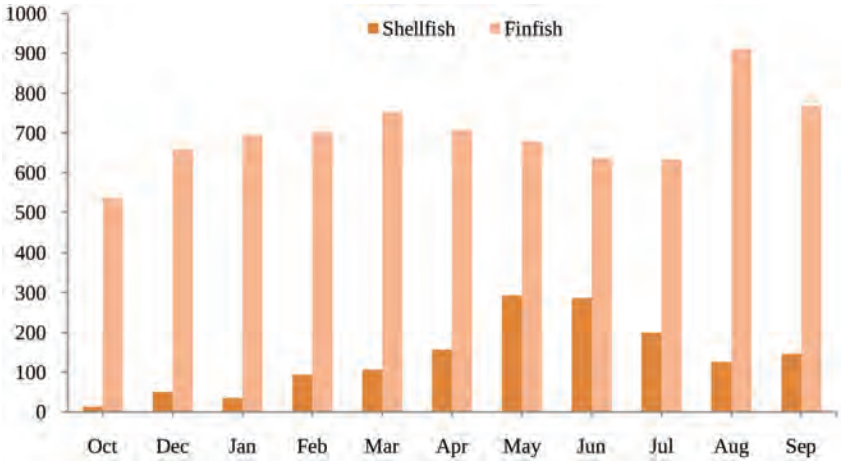
Total catch from four major fish landing centers of Chilika lagoon during the year was estimated at 9184.26 t, with monthly average catch of 834.93 t. Of the total catch recorded, fin-fish contribution was 83.6% (7678.2 t) whereas shell-fish contributed 16.4% (1506.06 t). Family Penaeidae formed the dominant group with a catch of 1428.66 t (15.56%) followed by Engraulidae 1227.822 t (13.37%), Mugilidae 855.17 t (9.31%) and Clupeidae 835.7 t (9.1%). Among fin-fish, highest contribution came from *Stolephorus* sp. 826.64 t (9 %) followed by *Nemata losanasus* 813.05 t (8.85%) and *Plotosus canius* 696.39 t (7.58%). Similarly, among shell-fishes, *Metapenaeus monoceros* recorded maximum catch 431.98 t (4.7 %), followed by *Metapenaeus dobsoni* 423.44 t (4.61%), *Fenneropenaeus indicus* 418.91 t (4.56%) *Penaeus monodon* 154.33 t (1.68%) and fresh water shrimp *Macrobrachium* sp. 77.4 t (0.84%).

Gearwise catch

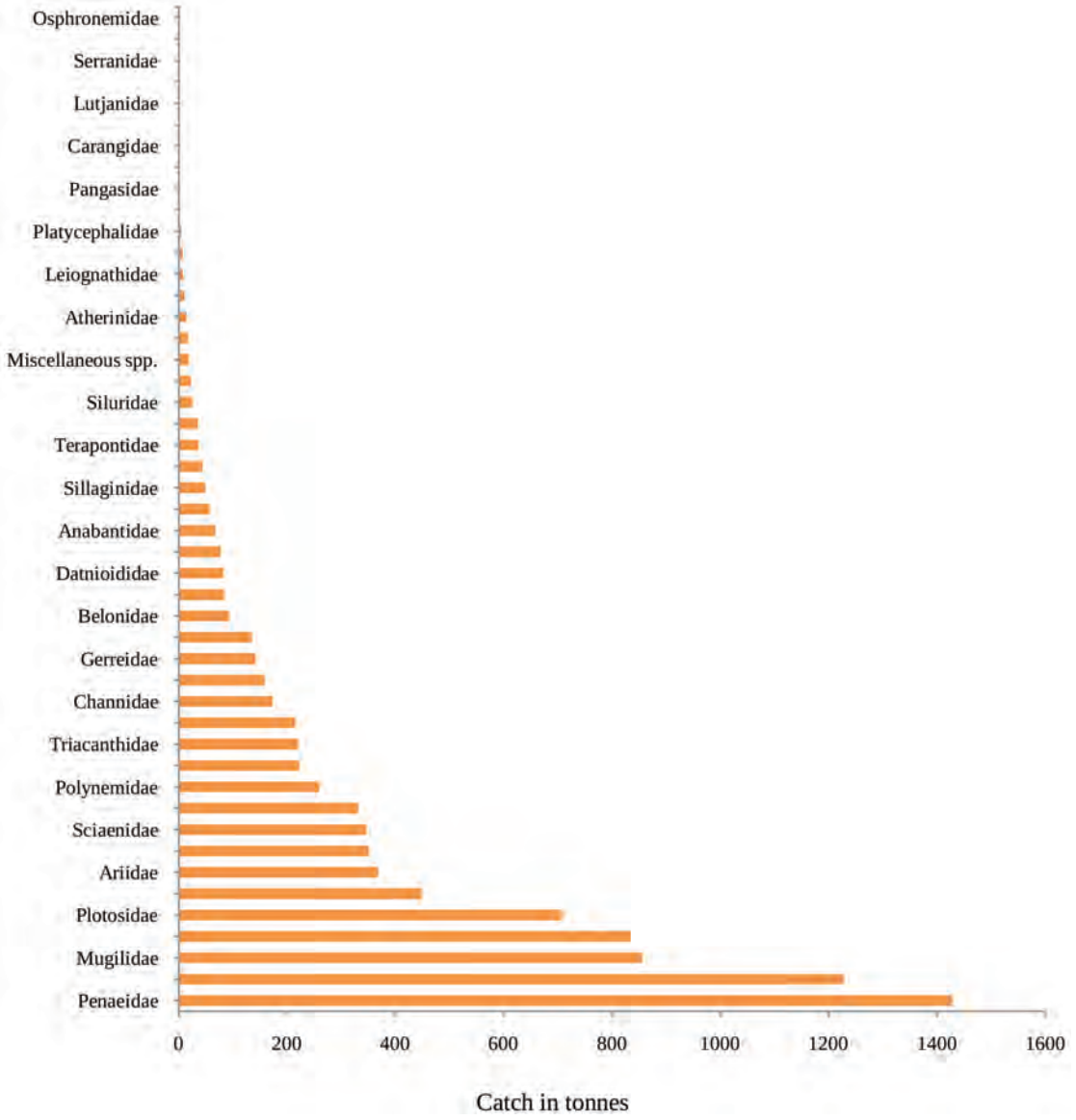
The highest fish catch was recorded from seine nets with 1377.86 t (34.52 %) followed by barrier nets 1123.28 t (28.14 %) and gill nets 980.15 t (24.55 %).



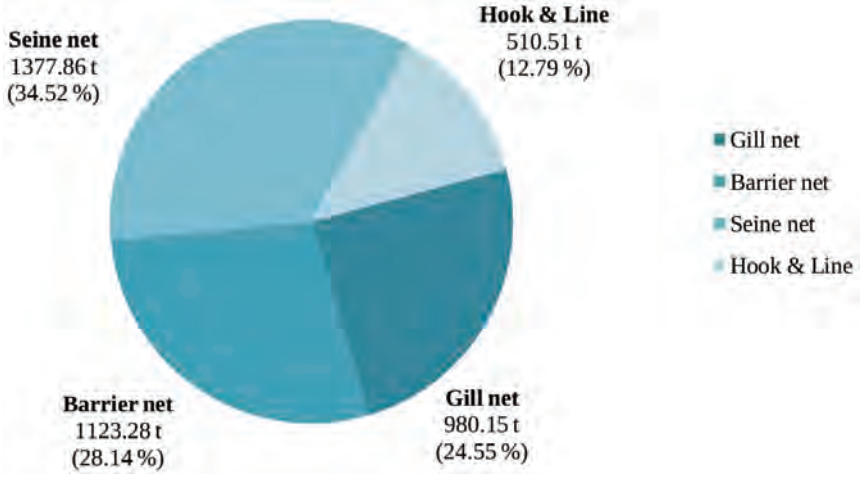
Monthly catch (t) during October 2014 to September 2015



Monthly variation in shell-fish and fin-fish catch from Chilika



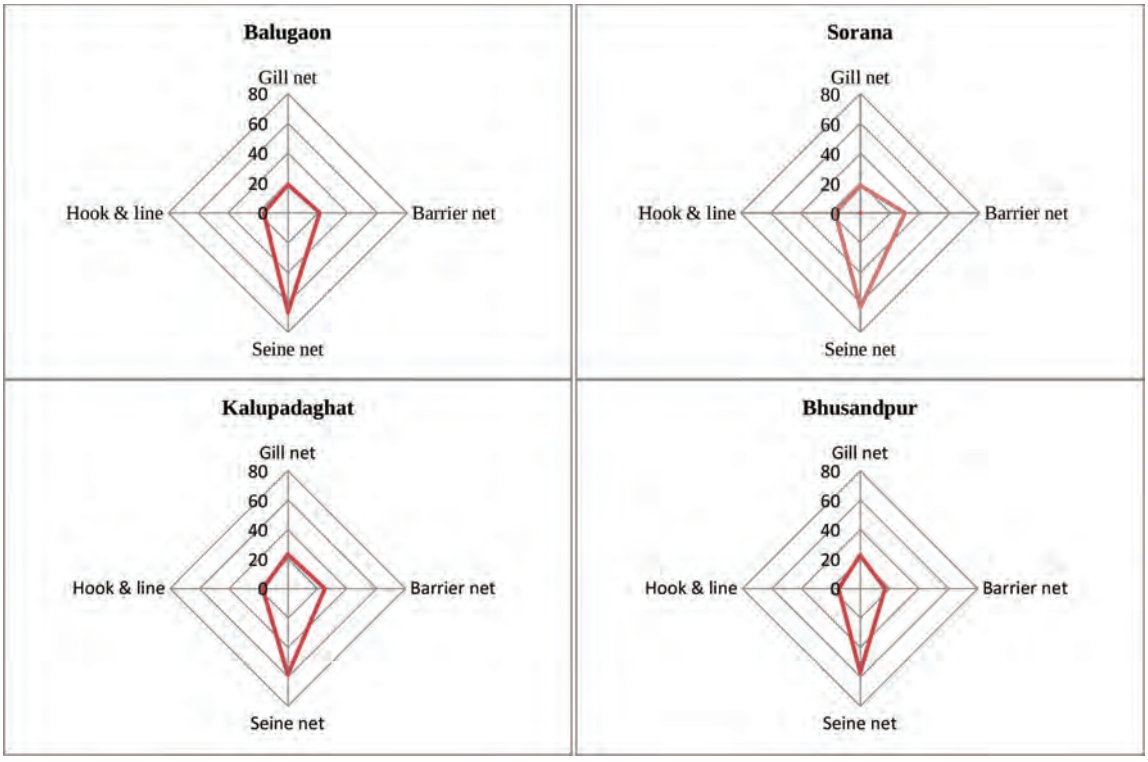
Family-wise total catch



Gear-wise fish catch from Chilika

Catch per unit effort

Maximum CPUE was estimated for seine nets. In Balugaon landing center, the CPUE of seine net was 66.68 kg whereas of gill net was 18.97 kg. In barrier net and hook and line, the CPUE was estimated at 21.29 kg and 16.18 kg, respectively. In Sorana landing center, the CPUE of gill net, barrier net, seine net and hook and line were 18.37 kg, 29.98 kg, 63.32 kg and 16.78 kg respectively. Similarly, the CPUE recorded from Kalupadaghat landing centers were 23.25, 25.2, 58.43 and 17.08 kg in gill net, barrier net, seine net and hook and line respectively. In Bhusandpur landing center, the CPUE of gill net, barrier net, seine net and hook & line were 22.64 kg, 16.86 kg, 57.02 kg and 14.78 kg, respectively.



Gear-wise CPUE (kg boat^{-1}day^{-1}) from Chilika lagoon

Population status and stock assessment

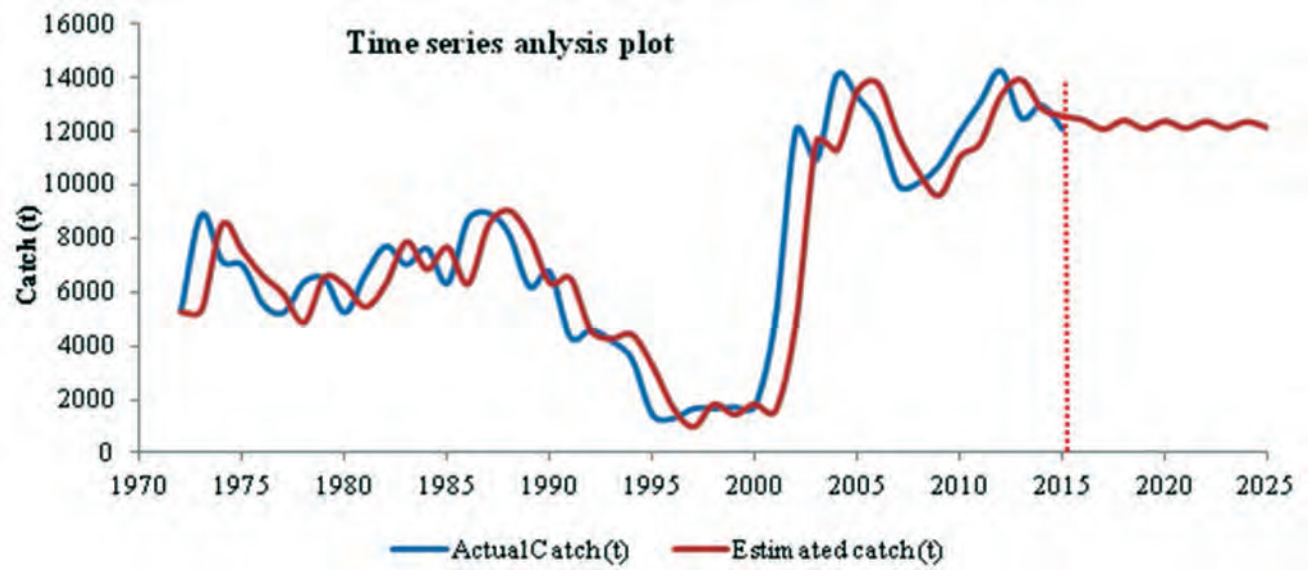
Estimation of population parameters and stock assessment were carried out using structured monthly length frequency data for the species, *Daysciaena albida*, *Eleutheronema tetradactylum*, *Etroplus suratensis*, *Chelon macrolepis* and *Mugil cephalus*. The population parameters are estimated using length frequency and catch data. The results showed that a large numbers of juveniles of species like *D. albida* and *E. tetradactylum* are being captured by fishers. There is high fishing mortality in the case of all the species in the lagoon.

Population parameters of five commercially important fish species

Parameters		*E. tetradactylum*	*M. cephalus*	*D. albida*	*E. suratensis*	*C. macrolepis*
L max. (mm)		613	592	575	243	532
Growth						
Length-weight relation	'a'	0.008	0.008	0.005	0.025	0.011
	'b'	2.95	3.04	3.23	3.01	2.95
Asymptotic length, L∞ (mm)		646	620	592	277	590
Growth coefficient, K ($year^{-1}$)		0.48	0.37	0.25	0.7	0.49
Mortality						
Total mortality, Z ($year^{-1}$)		1.99	1.24	1.45	2.26	1.37
Natural mortality, M ($year^{-1}$)		0.92	0.42	0.33	0.79	0.51
Fishing mortality, F ($year^{-1}$)		1.07	0.83	1.13	1.47	0.87
Selection						
Length at recruitment, Lr (mm)		80	200	60	40	170
Length at capture, LC (mm)		150.5	330.5	70.5	130.5	300.5
Exploitation						
Exploitation ratio (E)		0.54	0.67	0.78	0.65	0.63

Time series fish catch data analysis

Fish catch data of Chilika lagoon from 1972 to 2015 was analyzed using ARIMA based forecasting model. Spearman's rank correlation showed existence of definite trend in the catch pattern ($p<0.05$). Dickey-Fuller test showed that the data is non stationary ($p>0.05$). Shapiro-Wilk Normality Test showed that the data set is normal. Analysis of the data set using ARIMA (1, 1, 1): $yt= (1+\phi_1)yt-1 - \phi_1 yt-1 - \theta_1 et-1+et$, where ϕ_1 = ar (1) and θ_1 = ma(1); $yt= (1-0.9432)y_{t-1} +0.9432y_{t-1} - 0.8822\ e_{t-1}$, showed that, within the current fishing scenario, the catch is expected to fluctuatemarginally from the level of 2015 for at least coming 10 years. There is need for maintaining at least the current level of fishing effort; increasing the fishing effort may result in decline in catch.



ARIMA (1, 1, 1) model fitted for fish catch from Chilika lagoon

RESERVOIR ECOLOGY AND FISHERIES

HABITAT CHARACTRSTICS AND FISHERIES OF RESERVOIRS

Increasing fish production to meet the challenges of nutritional security has drawn the attention of planners and policy makers. In this context, fish production from inland open water bodies is considered as a promising sector for high quality protein food and providing livelihood to the rural populace. India is blessed with more than 3 million ha of reservoirs with a scope for further exploitation and enhancement. Scientific management of fisheries in these water bodies can significantly boost inland fish production from open waters. Formulation of scientific fisheries management policy necessitates the study of ecology and fisheries of these reservoirs.

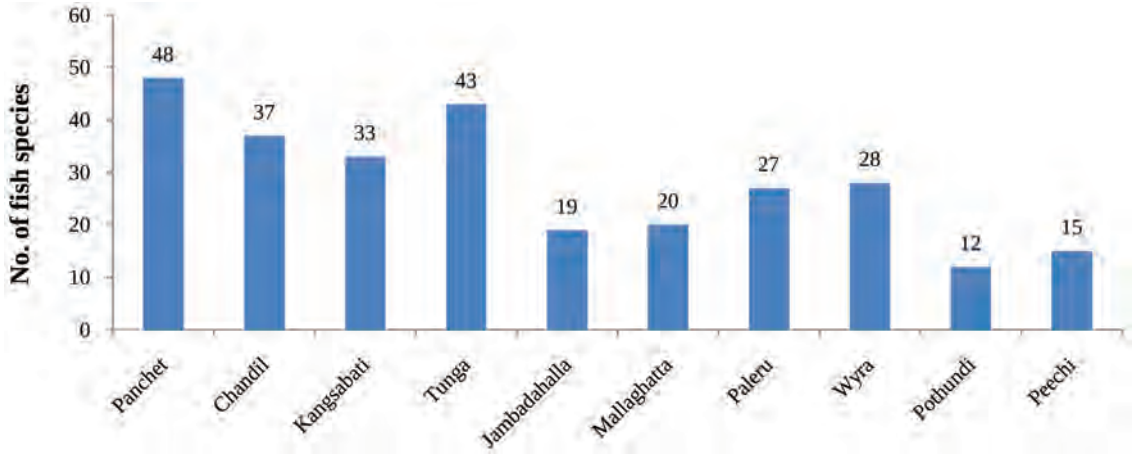
Habitat characteristics, fish assemblage and stock dynamics of seventeen reservoirs (Mallaghatta, Tunga, Jambadahalla, Thippagondanahalli (T G Halli), Nagavara, Krishnaiahnakatte in Karnataka; Wyra and Paleru in Telangana; Pothundi, Peechi and Malankara in Kerala; Ukai in Gujarat; Kangsabati in West Bengal; Chandil and Panchet in Jharkhand; Bhatghar and Dhom in Maharashtra) belonging to seven states were carried out.

Habitat characteristics

Based on physico-chemical characteristics, T G Halli, Nagavara, Jambadahalla, Wyra and Malankara were estimated to be highly productive, while other 12 reservoirs were found to be moderately productive. Morpho Edaphic Index (MEI) suggested higher fish yield potential of Panchet (114.65 $kgha^{-1}yr^{-1}$) followed by Kangsabati (90.6 $kgha^{-1}yr^{-1}$) and Chandil reservoir (58.6 $kgha^{-1}yr^{-1}$).

Fish species diversity and assemblage

From the three reservoirs studied in eastern India (Panchet, Chandil, Jharkhand) and Kangsabati, West Bengal), overall fish diversity pattern showed Panchet reservoir supports maximum number of species, followed by Chandil and Kangsabati. Species diversity indices showed diversity was highest in Kangsabati (H´=2. 34) than Panchet (H´=2.25) could be due to the more even distribution of the species as revealed from the high value of Pielou's evenness index (J´) in Kangsabati as compared to other two reservoirs. From the spatial pattern of fish assemblage the lotic zone supported more species diversity in Panchet and Kangsabati where as in Chandil maximum diversity was observed in the intermediate zone which may be attributed to the suitable habitat as evidenced from the large occurrence of aquatic macrophyte in this zone. Cluster analysis of the diversity indices of fish abundances indicated that Panchet and Kangsabati reservoir are having more similar nature of fish abundance, whereas Chandil reservoir has distinct pattern of fish abundance.



Fish species diversity of reservoirs

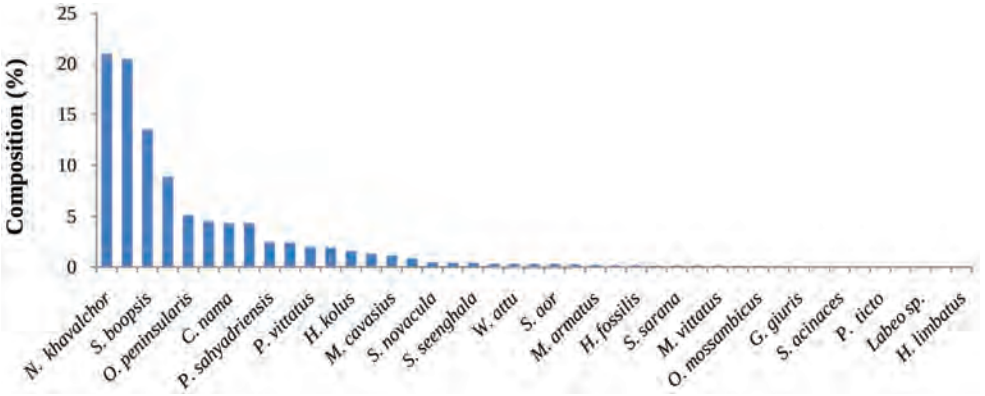
Observed and expected number of species based on the non-parametric method of estimations (Chao 1) in different peninsular reservoirs was close to expected number of species in all reservoirs except Wyra. The species richness was highest in Tunga (43 species) and lowest in Mallaghatta (20 species). The α diversity (H´, Shannon-Weiner diversity) for Tunga and Wyra was higher than 2.50. The H' was around 2.3 in rest of reservoirs. Pielou's index ranged from 0.29 in Tunga to 0.51 in Mallaghatta. Taxonomic distinctness (Warwick and Clarke, 1995) was highest in Jambadahalla (3.79) and lowest in Tunga (2.98). The α-diversity values of the community in all reservoirs reflect good health.

Species richness, diversity indices and taxonomic distinctness in different reservoirs

Values	Tunga	Jhalla	M.Ghatta	Paleru	Wyra	Panchet	Chandil	Kangsabati
No. of families	9	7	8	9	11	17	13	12
Taxa (S)	43	23	20	27	31	48	37	33
Individuals	4827	663	474	1693	2195	2929	3561	1363
Shan. Wei. Index (H´)	2.52	2.25	2.31	2.37	2.58	2.25	1.74	2.34
Pielou's Evenness Index	0.29	0.41	0.51	0.40	0.43	0.58	0.48	0.67
Taxonomic distinctness	2.98	3.79	3.63	3.17	3.19	2.83	2.78	2.66
Native species (%)	90.0	63.9	77.2	89.2	88.7	81.25	92.0	81.8

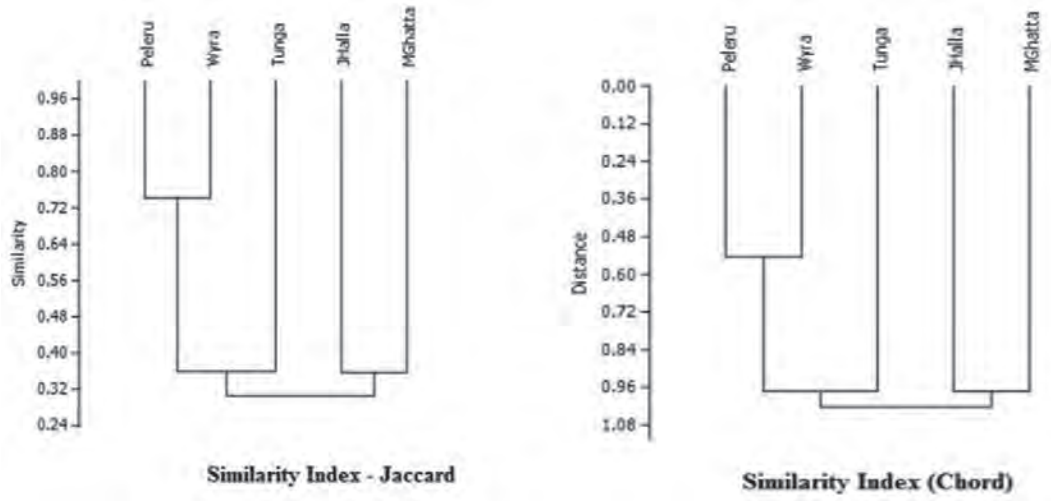
Cyprinids were most abundant group, 23 species in Tunga to 10 species in Paleru. Abundance distribution showed a typical left skew in all reservoirs. Native species were predominant in all reservoirs (77.2% in Mallaghatta to 90.0% in Tunga).

Commercially important native food species belonging to cyprinid group were *Hypselob arbuskolus* (Endangered – IUCN status), *Puntius jerdoni* (Vulnerable) and *Osteobrama cotio* in Tunga, *H. kolus* in Jambadahalla, *Cirrhinus reba* and *Puntius sarana* in Mallaghatta, *Schismato rhynchosnukta* and *C. reba* in Paleru and *S. nukta* and *O. cotio* in Wyra. In Tunga, rampant fishing is practiced for Puntius Sahyadriensis due to high demand as ornamental fish and this species needs immediate attention for conservation and artificial propagation. *Osteobrama neilliis* at low risk in Tunga reservoir as per the present study; however it is categorized as an endangered species by IUCN.



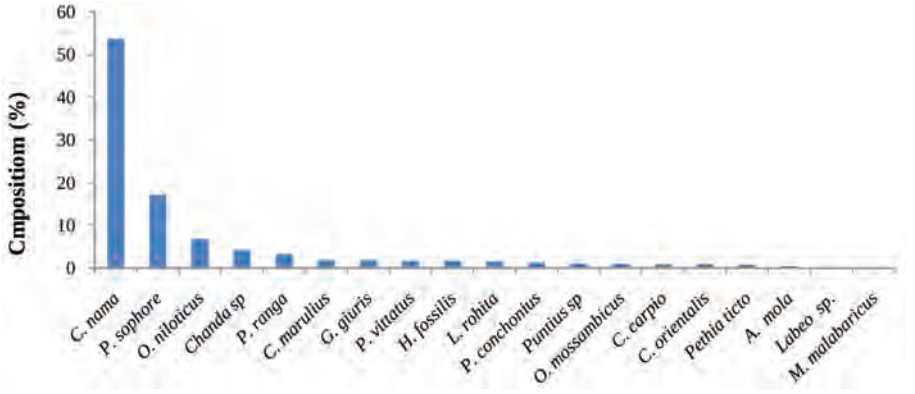
Fish species composition in Tunga reservoir

Differences in species composition among the reservoirs were analysed by Jaccard index (presence-absence data) and Chord distance. Jambadahalla & Mallaghatta and Paleru & Wyra showed maximum similarity in species composition by both methods.



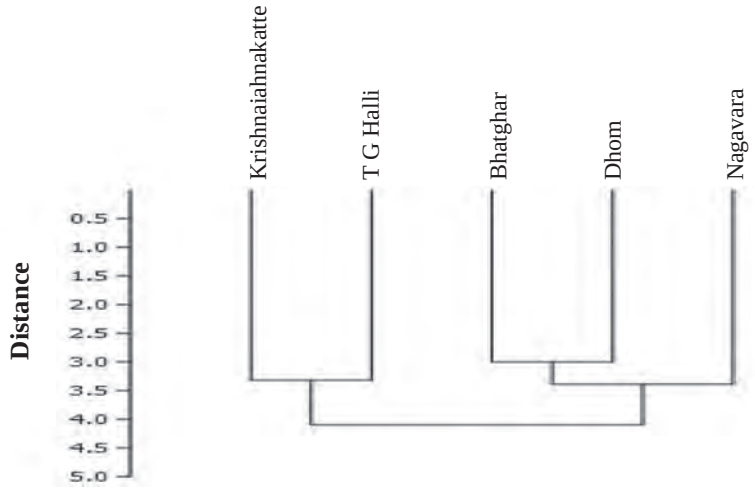
Similarity in species composition of peninsular reservoirs

The analysis revealed that the fish diversity is moderate; the ecosystems are not stressed and healthy in all the reservoirs. Species richness varied from 19 in T G Halli to 6 in Bhatghar reservoir.



Fish species composition in T G Halli reservoir

The α diversity (H´, Shannon-Weiner diversity) was moderate in Krishnaiahnakatte, T G Halli and Nagavara (2.26) and low in Bhatghar and Dhom reservoirs (0.55). The Pielou's index, a measure of evenness, was moderate in Krishnaiahnakatte (0.69) and Nagavara (0.67) and low in Bhatghar (0.29) and Dhom (0.35) reservoir. Taxonomic distinctness (Warwick and Clarke, 1995) did not vary muchand was highest in T G Halli (3.4) and lowest in Bhatghar (3.0). Bhatghar & Dhom and T G Halli & Krishnaiahnakatte showed greatest similarity in species composition



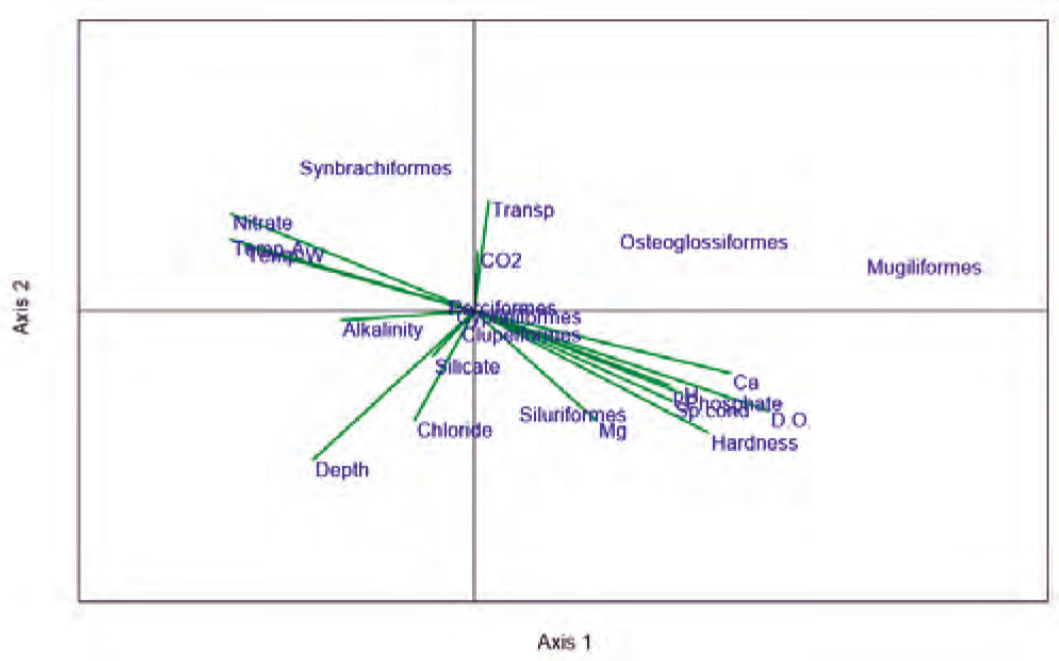
Similarity in species composition in reservoirs

Cyprinids were the most abundant group: 9 species in T G Halli to 3 species in Bhatghar. Abundance distribution shows a typical left skew in all the reservoirs. The proportion of native species by number in Bhatghar, Dhom and T G Halli is very high (>90%) and very low in Nagavara (<10%). Higher number of fish species was recorded in Peechi (17) compared to Pothundi (13) reservoir in Kerala. Cypriniformes dominated in Peechi while Perciformes in Pothundi reservoir.

From the three reservoirs studied, overall fish diversity pattern showed that the Panchet reservoir supports maximum number of species, followed by Kangsabati and Chandil. Species diversity indices showed highest diversity in Kangsabati (H´=2.34) followed by Panchet (H´=2.25) and this can be attributed to more even distribution of the species in Kangsabati as compared to other two reservoirs as revealed from the high value of Pielou's evenness index (J´). From the spatial pattern of fish assemblage, the lotic zone supported more species diversity in Panchet and Kangsabati, whereas in Chandil maximum diversity was observed in the intermediate zone which may be attributed to the suitable habitat as evidenced from the large occurrence of aquatic macrophytes in this zone. Cluster analysis of the diversity indices of fish abundance indicated that Panchet and Kangsabati reservoir are having more similar nature of fish diversity, whereas Chandil reservoir has distinct pattern of fish diversity.

Relationship between habitat parameters and fish assemblage

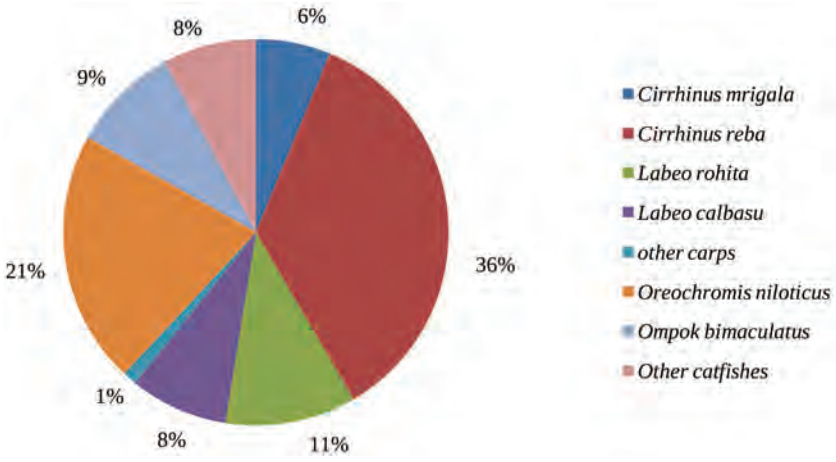
The CCA indicated that DO, Hardness, Temperature, Nitrate, Depth and transparency were the most important environmental parameters influencing the abundance and fish distribution in Panchet reservoir. Whereas, in Chandil reservoir pH, DO, conductivity, alkalinity and depth were the important environmental parameters associated with the abundance of fish. However, temperature, phosphate, silicate and pH were the most important parameters for the fish composition in Kangsabati reservoir.



CCA for environmental parameters and fish abundance in Panchet reservoir

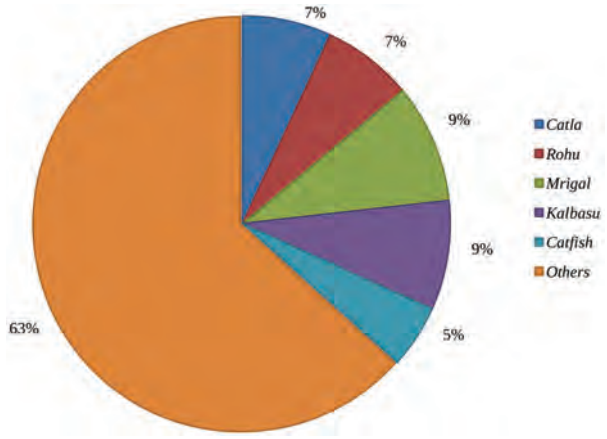
Fish catch composition

In Panchet reservoir a total of 48 species was reported with maximum species belonging to Cyprinidae (20 species). Conservation status (IUCN) indicated 5 species in the near threatened category. *Sperata seenghala* (17.7%), *Oreochromis niloticus* (14.4%), and *Labeo calbasu* (12.9%) contributed around 45% of the total catch in Panchet. Most abundant species in catches at Kangsabati was *Cirrhinus reba* (36%) followed by *Oreochromis niloticus* (21%).



Fish catch composition in Kangsabati reservoir

Although 37 fish species reported from the Chandil reservoir, the major portion (32%) of the fish landing was contributed by the Indian major carps and *Labeo calbasu*. Analysis of data indicated that about 9.3% of the total catch was contributed by *C. mrigala* followed by *L. calbasu* (8.5%), *L. rohita* (7%) and *C. catla* (6.9%). The estimated fish production from Chandil reservoir was 116.2 t with an average productivity of 19.04 $kgha^{-1}yr^{-1}$.

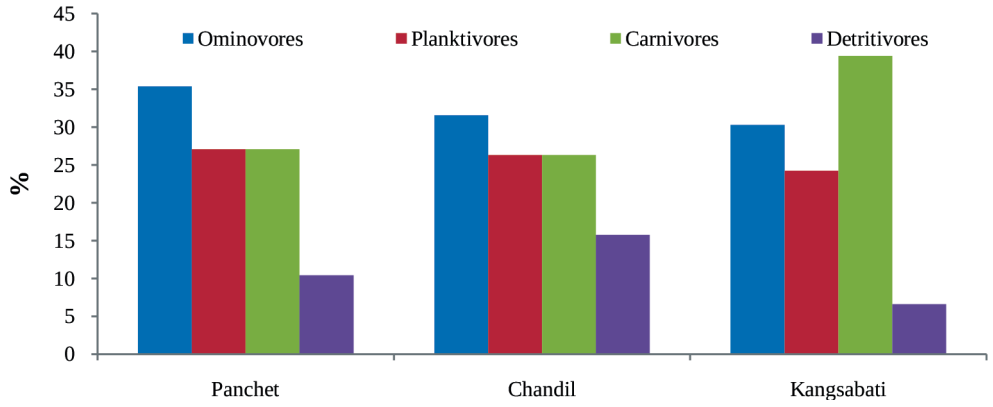


Fish catch composition in commercial landing from Chandil reservoir

A total of 47 species belonging to 9 orders, 15 families and 35 genera were identified from the Ukai reservoir. The order Cypriniformes was found dominant with 21 species followed by Siluriformes with 12 species. The most dominant species in commercial catch of the reservoir were *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Labeo calbasu*, *Wallago attu*, *Sperata seenghala*, *S. aor*, *Systomus sarana*, *Clupisoma garua*, *Macrobrachium rosenbergii* and *Ompok bimaculatus*. The fish catch during 2013-14 was 1000 MT (72 kgha^{-1}).

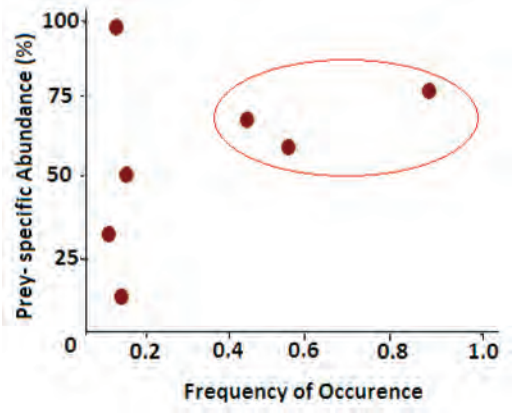
Trophic state utilization and feeding history of fishes

Feeding biology of twelve commercially important species (*Dawkensia filamentosus*, *Ompok bimaculatus*, *Notopterus notopterus*, *Heteropneustes fossilis*, *Oreochromis mossambicus*, *Amblypharyngodon mola*, *Labeo calbasu*, *Osteobrama cotiocotio*, *Cirrhinus reba*, *Oreochromis niloticus*, *Sperata seenghala* and *Gudusia chapra*) from Chandil, Panchet and Kangsabati reservoirs were studied. The trophic utilization pattern based on feeding habits indicated that the fish community in Panchet reservoir were constituted by omnivorous fishes (35.4%), followed by planktivores (26.31). Similar pattern was also reported from Chandil reservoir with dominancy of omnivores whereas trophic utilization pattern in Kangsabati reservoir revealed that majority of the fish community are carnivores. The feeding biology of *Dawkensia filamentosus* from Peechi reservoir revealed that the species is planktivore. *Ompok malabaricus* is an omnivore and diet composition includes insect and algal matter in 3:1 ratio. The diet of *Puntius sarana* comprised of insects (40%), filamentous algae (40%) and undigested parts of insects (20%). The gut content analysis of fishes from Wyra was carried out to study



Trophic utilization pattern in Panchet, Chandil and Kangsabati reservoir

the trophic guild structure. The feeding niche of each fish species was differentiated on the basis of the percentage occurrence of the ingested food material; seven feeding guilds were found with planktivore (35.61%) being predominant as plankton abundance increases following nutrient availability. But, trophic specialists like obligate detritivore, piscivore, planktivore, malacovore, phytivore and insectivore fishes were also found in good proportion.



Feeding strategy of *Notopterus notopterus* in Wyra reservoir

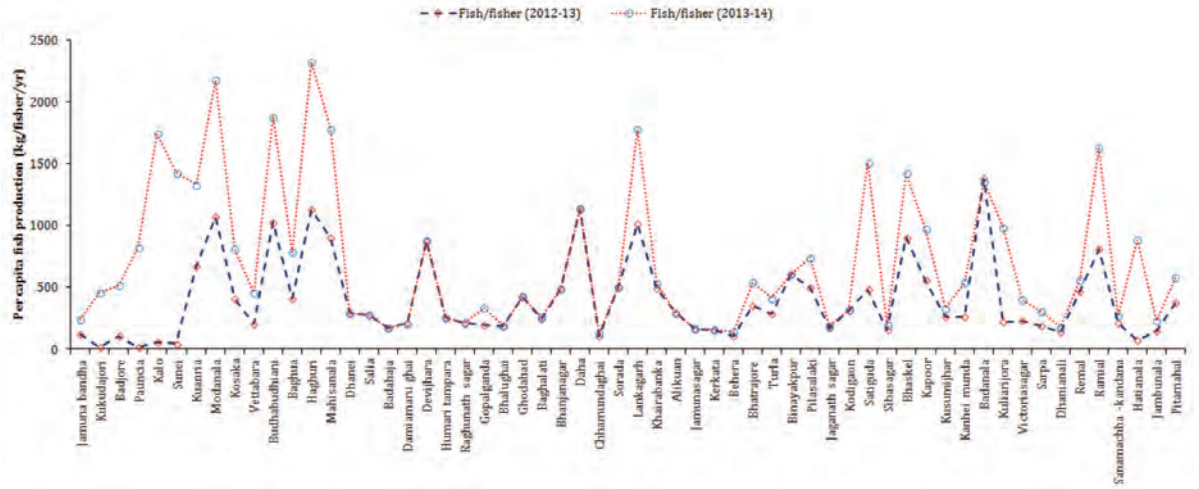
[Inside the circles are the most frequent fishes (0.97), insects (0.56), and plant matter (0.44)]

Stock dynamics

Study on stock dynamics of *Gudusia chapra* from Panchet reservoir revealed that it is a fast growing, short lived species. The stock of *G. chapra* is underexploited (E=0.33) in Panchet reservoir. However, further increase of fishing effort is not recommended as it may lead to over exploitation of other commercially important large sized fishes.

IMPACT OF STOCKING ON RESERVOIR PRODUCTIVITY

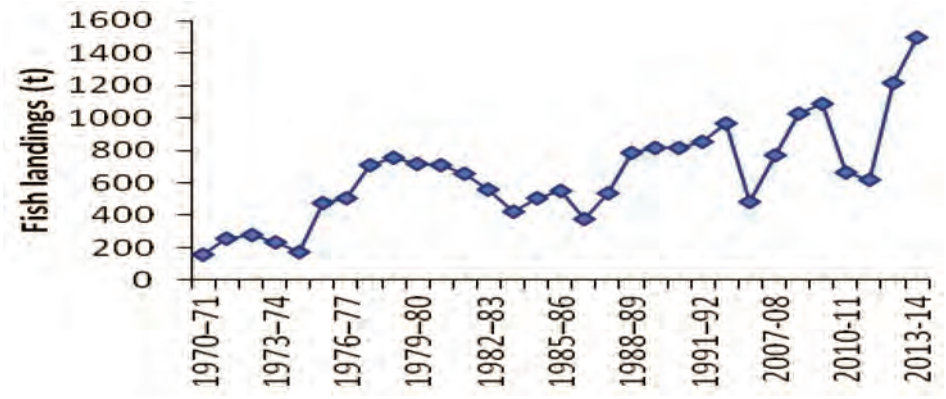
India has vast reservoir resources, but with low fish production. ICAR-CIFRI has developed reservoir fisheries management protocols for small, medium and large reservoirs in the country. The fisheries enhancement protocols based on stock enhancement and culture based fisheries developed by the Institute are increasingly being adopted by different states in many reservoirs for fish production enhancement. In this context, surveys were conducted to assess the impact of seed stocking on fish production in a few reservoirs.



Shift in fish catch due to fingerling stocking in reservoirs of Odisha

The productivity of 58 small reservoirs from Odisha increased to 158%, while the fish production per fisher increased to 176%, as a result of fingerling stocking from 2012-13 to 2013-14. Total fish production from these reservoirs increased from 1714 to 2742 t during 2012-13 to 2013-14.

The fish production from Gobind Sagar reservoir, Himachal Pradesh increased from 707 tonne during 1977-78 to 1492 t during 2013-14 with an average annual increased productivity from 16 to 149 $kgha^{-1}yr^{-1}$ through regular stocking of carps seeds and management. The total fish landing from Pong reservoir, Himachal Pradesh increased from 98 to 307 t from 1976 to 2014. The average annual productivity of the reservoir increased from 20 to 28 $kgha^{-1}yr^{-1}$ during 1970's through regular stocking of Indian Major Carps and management. The productivity of small reservoirs (n=23) of Chhattisgarh has increased 13 folds from 97 to 1221 $kgha^{-1}yr^{-1}$ from 2009 to 20 $kgha^{-1}yr^{-1}$ 15 that added 5,485 tonnes of fish to the national food basket.



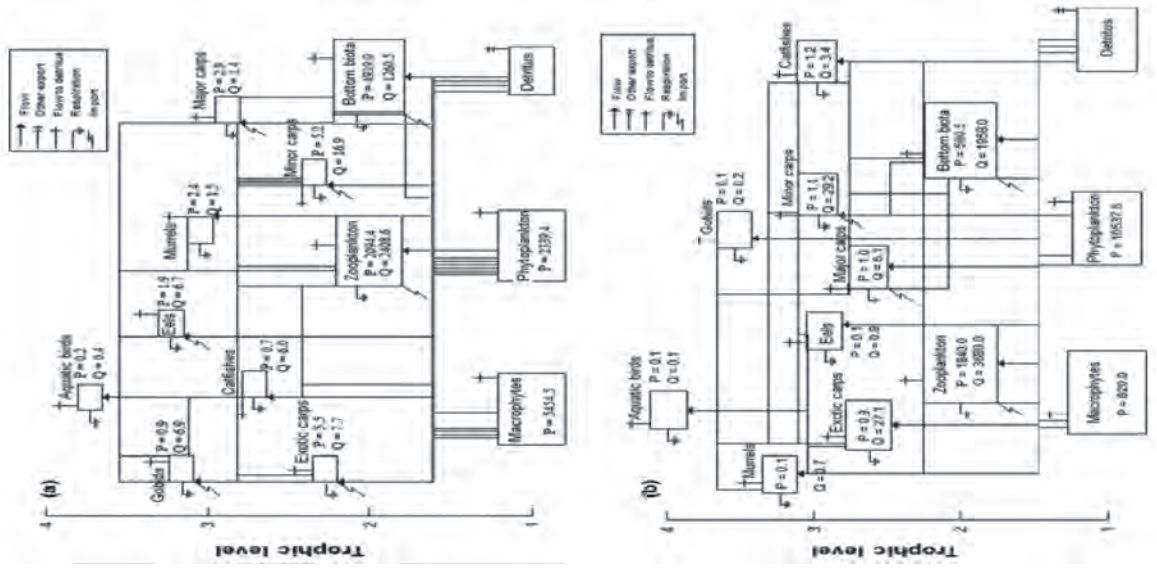
Annual fish landing from Gobind Sagar reservoir

The mean landing of fish in Rihand reservoir, Uttar Pradesh during the last 20 years (1995-96 to 2014-15) was 115.0 t approximately. Minimum catch of 7.03 t was observed in the year 1996-97 and maximum (23.09 t) was observed in the year 2011-12. The average yield per hectare per year increased from 2.7 kg during the previous decade (1995-2005) to 4.92 kg during the last decade (2005-2015) registering an average growth of 81.73%. The yield per hectare per year during 1980-81, 2008-09 and 2014-15 were 2.64, 4.65 and 5.07 kg respectively.

Hemavathy reservoir, Karnataka was modelled to study the impacts of stocking of Indian major carps on the native fishes of the reservoir. Although stocking can cause dramatic effects on existing fish community, supplementation of a species such as major carps which are already present and generally adapted to a particular reservoir ecosystem may also cause some changes in ecosystem properties. Ecotrophic modelling can be used as an important tool for fishery management, because it gives an insight into prey-predator interactions between the exploited (fishery resources) and unexploited potential fishery resources of the system. The study showed that changes in ecosystem stability can be caused by trophic interactions due to stocking with major carps.

Total biomass/total system throughput ratios tended to be low in the development phase of an ecosystem which enhanced as the system matured and conserved energy by storing it in its components. Hence, the summary of indices of the two phases showed higher maturity and stability in the post-stocking phase. The ecosystem in the post-stocking phase was found to be more mature than in the pre-stocking phase as there was a decrease in the Total Primary Production/Total Respiration ratio (TPP/TR). The ratio TPP/TR increased to almost double the value (112.72%) in the post-stocking phase.

The connectivity index (CI) and system omnivory index (SOI) values decreased after the fish stock supplementation in the reservoir, and the change in SOI values indicates that the post-stock phase of the ecosystem displayed less web-like features. The total number of pathways and mean path length increased by 35 % and 14 %, respectively, in the post stocking phase, which showed that the system was more mature and more complex after systematic fish stocking in the reservoir. A substantial increase in overhead (29%) in the post-stock phase was found. This implied that the post-stock food web was more resistant, and the pre-stock food web was less resistant to perturbations.



Food web interactions in Hemavathy reservoir indicating biomass and production of each group (a) before and (b) after the fish stock supplementation. (Flows are expressed in t km^{-2} yr^{-1}. The size of the boxes represents relative abundance, P indicates production and Q indicates consumption.)

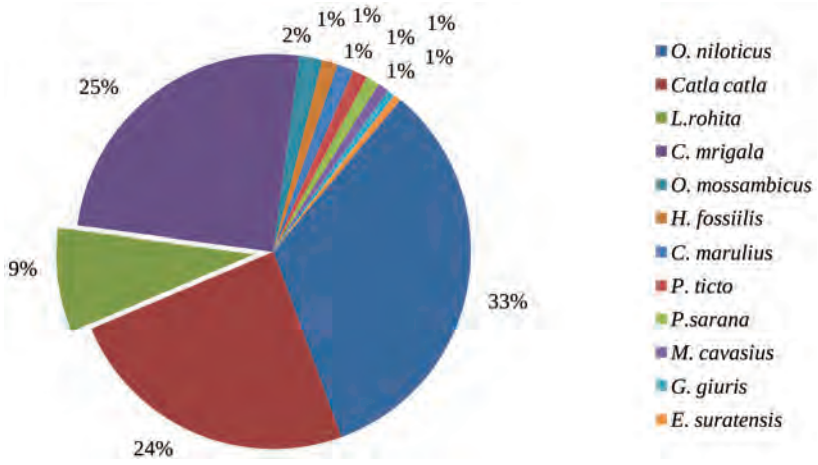
The 'health' of the ecosystem has improved which was indicative of a positive impact of stock supplementation. Moreover, negligible (0.2%) increase in total system throughput was observed in the post stocking phase, which indicated decreased detritus accumulation, resulting in less tendency for eutrophication and a positive impact on the environmental management activity of the reservoir.

Karapuzha reservoir

Results of mixed trophic impact routine illustrated the importance of lower trophic levels, particularly phytoplankton and detritus in the ecosystem suggesting the existence of 'bottom up' control in the ecosystem. These groups have the most pronounced positive impacts on other groups in the system, providing an important food source for the later groups and hence emphasizing the importance of detritus as the base of the food web in the reservoir. If the biomass of African Catfish (a predator for this particular model) increases, the fish exerts a direct negative impact on its prey–indigenous barbs, Major carps and crustaceans, etc. However, it has a cascading positive impact on zooplankton which is the prey of eels, minnows and crustaceans. If Mozambique Tilapia is more, it exerts a positive impact on zooplankton. The impact of Tilapia was positive on snakeheads. If phytoplankton increases, its impact would be positive to Carps, Barbs and Tilapias. However, zooplankton showed a negative effect on Nile Tilapia, barbs and minor carps, not due to direct prey–predator relationship, but possibly due to the interaction between an eels and African catfish. Phytoplankton had a positive impact on minnows, barbs and major carps. All the functional groups except detritus had negative impact on themselves and this may show within group competition for resources.

Manchanbele reservoir

A total of 30.66 t of fish landed during April 2015 to Mar 2016 with a CPUE of 9.97kg from Manchanbele reservoir, Karnataka. The maximum fish catch and CPUE was recorded in May. There is an intermittent fishing ban implemented by the fishermen Cooperative Society. *Oreochromis niloticus* dominated the catch forming 33.3% of the total fish catch followed by *Catla catla* (24.2%), *Labeo rohita* (8.51 %), *Cirrhinus mrigala* (2.5 %), *O. mossambicus* (1.89 %), *Heteropneustes fossilis* (1.27 %) and *Channa marulius* (1.4%). *Puntius ticto*, *P. sarana*, *Mystus cavasius*, *Glossogobius giuris* and *Etroplus suratensis* were also recorded in meager quantities.



Fish species composition of catch at Manchanbele reservoir

OPTIMIZATION OF STOCKING DENSITY IN CAGE CULTURE

Cage culture for raising table fish in reservoir of Jharkhand was taken up with cage designing, installation, release of fry of *Pangasianodon hypophthalmus* and regular monitoring. One battery of 16 floating cages each of 5m × 5m × 3.5 m supported by G.I. make frame with iron drums used as float have been installed in Maithon Dam (Av. Area 6260 ha). The netlon cages made up of HDPE plasto-nets with 4.0 mm mesh size were used as cage hapas, covered on all sides barring little flap opening on the top for stocking, feeding, removal and cage maintenance being stretched with ropes and kept them hanging from G.I. frame under water maintaining proper shape using sinkers. Fish seeds of *P. hypophthalmus* (31.500 nos, 3.8-4.0 g) were released in end of August, 2015 in 7 cages initially and segregated them at 40, 60 & 80 nos m^{-3} stocking density in two cages each @ 3000, 4,500 & 6,000 nos $cage^{-1}$ respectively.

The fish seeds were regularly fed with commercial floating feed. The basic feed was soya-based extruded floating feed (2.0-3.0 mm granule) having 32% crude protein, 4% fat at initial stage with lowering protein content (26% CP & 5% fat) in the advantage stage being used applying @ 7% body weight of the fingerlings. Overall survival was around 94% till March, 2016 and no mass mortality occurred.

The study on exotic catfish *Pangasianodon hypophthalmus* for a period of 165 days, stocked in 3 stocking densities (40 nos m^{-3}, 60 nos m^{-3} and 80 nos m^{-3}) in a battery of 16 cages, each having 75 m^3 area in duplicate treatments was carried out. The results revealed that growth performance was better at lower stocking density. The average weight gain was 46.5 ± 0.48g, 35.8 ± 0.52g & 33.5 ± 0.36g respectively in order of lower to higher densities. Specific growth rate & food conversion ratio ranged from 0.17 to

0.23 and 1.42 to 1.77 respectively. The protein efficiency ratio was in the range of 1.67 to 2.12. Over all, the fish biomass was increased from 105 kg to 1000 kg.

The limno-chemical profile inside and outside of the cages revealed no significant changes with little reduction in water pH and alkalinity (ppm) (pH & alkalinity : inside -8.30 and 56; outside -8.52 and 63) during end Sept, 2015 which got changed to 8.80 and 84 in inside cages with outside values (8.84 and 88) at the end of March, 2016. Increment in dissolved nutrients was also encountered inside cages: nitrate-N and Phosphate P -335 ppb and 100 ppb during end September 2015, 40 and 300 ppb during end March 2015 respectively while the values were comparatively in low order in outside the cages.

DEVELOPMENT OF ACOUSTICS SURVEY

Quantitative assessment of fish stock poses many difficulties in large water resources like reservoirs. This study aimed to apply acoustic technology for estimation of fish stocks in reservoirs.

Acoustic survey

Hydroacoustic surveys were conducted in Karapuzha Reservoir using Portable Simrad EY60, split beam echo sounder with frequency 120 kHz and elliptical transducer. The pulse duration was set to medium (0.3 ms), the ping repetition rate to 5 Hz, and the Target Strength and Sv thresholds to –33 dB and –70 dB respectively. Target strength frequency distributions were received by the automatic track analysis of ER60. The water parameters, dissolved oxygen, temperature, conductivity were measured at surface using portable instrument and from conductivity salinity was estimated and incorporated in SIMRAD ER60 software. 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 done in lotic, intermediate and lentic zones. Fish distribution pattern showed 52 numbers and a maximum of 108 fishes in the selected transects.

Target strength estimation for different fish of Kpalli reservoir was carried out. Target strength of *C. catla* varied from -39.4 decibel for a fish weighing 1.5kg to -45.0 decibel for a smaller fish weighing 770g. *L. rohita* weighing 520g recorded target strength of -45.8 decibel. *Channa marulius* of size 210mm had target strength of -44.7 decibels. Target strength varied from -41.5to -40.3 decibel for *Heteropneustes fossilis* measuring 160 mm.

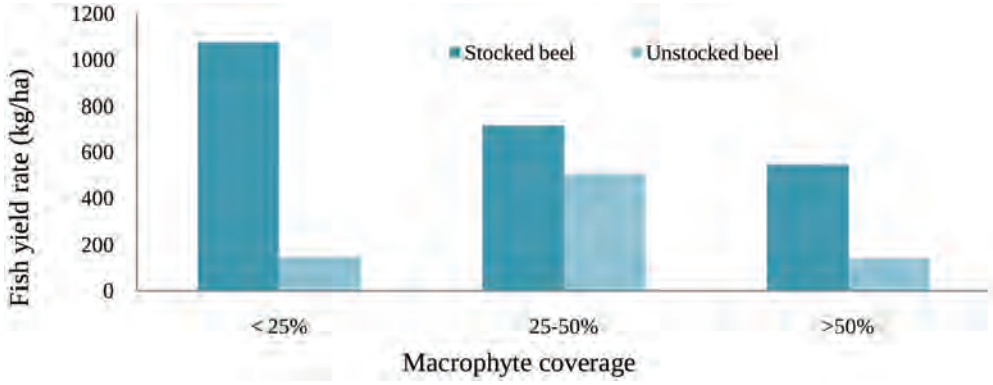
WETLAND ECOLOGY AND FISHERIES

MACROPHYTE VIS A VIS WETLAND FISHERIES

Floodplain wetlands comprising 0.5 million ha water area are important resource, repository of valuable biodiversity and cater livelihood and nutritional need of millions. They are spread mainly across the states of West Bengal, Assam and other NE states, UP and Bihar Large majority of wetlands are covered with macrophytes which are often cleared for enhancing fish production from these resources. However, role of macrophytes in fish species diversity and production are poorly understood.

Macrophyte communities and its relation with fish production

Macrophyte communities were assessed in ten stocked (closed/ seasonally open) and ten nonstocked (open) *beels* of Assam. Macrophyte coverage in the *beels* ranged from 5 to 80%. Floating macrophyte were mainly constituted by *Eichhornia* sp. (>90%) in majority of the *beels* followed by *Salvinia* sp., *Azolla* sp., *Pistia* sp., *Lemna minor*, etc. Other important macrophyte groups were submerged (*Hydrilla* sp., *Vallisneria* sp. and *Ceratophyllum* sp.), rooted emergent (*Nymphea* sp., *Nelumbo* sp., *Nymphoides* sp., *Trapa* sp.), marginal (*Ipomea* sp., *Colocasia* sp., *Christella* sp.). In the stocked *beels*, lowest average fish yield (547.31 $kgha^{-1}yr^{-1}$) was observed in *beels* with heavy macrophyte infestation (>50%) and the highest average fish yield (1076.59 $kgha^{-1}yr^{-1}$) in low macrophyte infestation (<25%). Average fish yield in the *beels* with medium macrophyte infestation (25-50%) was 714 $kgha^{-1}yr^{-1}$.



Relation between fish yield and macrophyte coverage in *beels* of Assam

Among the unstocked ones, *beels* with medium macrophyte infestation was found to have the highest average fish yield rate (507 $kgha^{-1}yr^{-1}$). Low and high macrophyte-infested *beels* had low average fish yield rates (147.0 and 139.6 $kgha^{-1}yr^{-1}$, respectively). Overall results suggested that 25-50% of macrophyte coverage is linked to high fish

productivity of the *beels*, because the macrophytes serve as feeding, breeding and hiding grounds for the fish.

Macrophyte-associated fauna

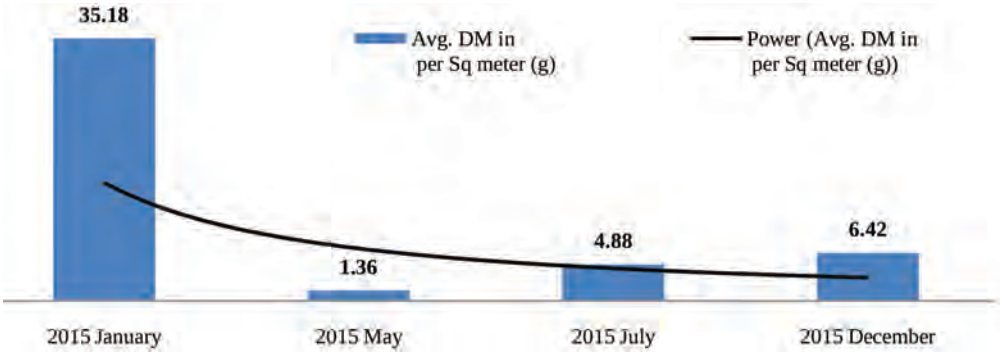
Macrophyte-associated fauna (MAF) was assessed in six *beels* of Assam, which comprised of nine species of food/ ornamental fish, three species of mollusk, and four species of insect and small prawns. These organisms not only serve as food for larger aquatic animals, but also support nutritional security of large number of people residing near the *beels* and generate occasional income for them. These included small food/ ornamental fishes, mollusks, insects, frog and spider.

Macrophyte associated fauna in *beels* of Assam

Beels	Macrophyte associated fauna
Sorbhog *beel*, Barpeta district	Fish (*Channa punctata, Lepidocephalus guntea, Trichogaster chota, T. lalius, T. fasciata, Danio rerio, Puntius ticto, P. sophore, Badis badis*), insect (*Belostoma* sp., *Nepa* sp.) and mollusk (*Gyraulus convexiusculus*).
Tamranga *beel*, Bongaigaon district.	Fish (*Chanda ranga*), small prawns, insect (*Libellula* sp., *Hagenius*.), mollusc (*Campeloma* sp., *Vivipara* sp.),
Kenduguri *beel*, Nagaon district.	Fish (*Xenentodon cancila, Glossogobius giuris, Leiodon cutcutia, Pethia phutunio, Pethia conchonius, Puntius terio, Parambassis lala, Badis badis*) and small prawns.
Barpeta *beel*, Nagaon district	Fish (*Trichogaster fasciata, Badis badis, Chanda nama, Esomus danricus, Rasbora daniconius, Macrognathus pancalus, M. aral* and *Mastacembelus armatus. Danio* spp., *Channa punctata, Polyacanthus fasciatus, Chanda* spp.), insects (*Belostoma* sp., *Nepa* sp.).
Borphaka *beel*, Nagaon district	Fish (*Nandus nandus, Parambassis lala, Trichogaster fasciata* and *Puntius terio*).
Damal *beel*, Morigaon district	Fish (*Channa punctata, Channa gachua, Mastacembelus armatus, Macrognathus pancalus, Chanda nama, Parambassis ranga, Mystus tengra, Badis badis, Trichogaster fasciata*), frog.

Macrophyte associated fauna in wetlands of West Bengal

Abundance, biomass, degree of infestation and diversity of aquatic macrophytes were found to be highly influenced by fisheries management interventions across the seasons. The degree of macrophyte infestation vis-a-vis biomass in Khalsi beel was significantly reduced due to their removal by fishers' society as part of their management measure. Change in management practice in the current year have significantly reduced biomass and diversity of macrophytes and associated fauna, and increased occurrence of Cyanophycean *Microcystis* sp in Khalsi beel. In closed wetland, Akaipur, Cyanophyceaean *Microcystis* sp. persistently dominates throughout the season.

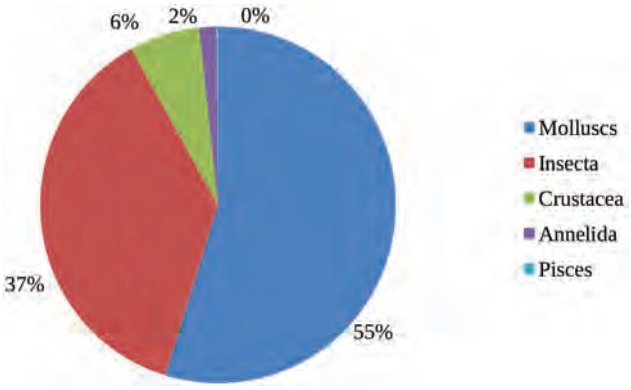


Reduction of macrophyte biomass on dry matter (DM) basis in Khalsi *beel*

Macrophyte coverage, biomass and diversity in Khalsi *beel*

Season	Abundance (nom^{-2})	Biomass (gm^{-2})	Coverage (%)	Diversity Shannon (H´)
Summer	43	1.36	< 1	1.16
Monsoon	103	4.88	1-2%	1.24
Winter	122	6.42	<1	1.06

Analyses of taxa comprising macrophyte-associated fauna revealed dominance of mollusks followed by insects. Juveniles of important fish species such as *Clarias magur* and *Mystus* sp. were recorded as associated fauna.



Major taxa associated fauna in Khalsi *beel*

The relative abundance of most species of fishes were higher in the macrophyte covered zones compared to clear zones in both the *beels* even though the diversity were similar in both the zones. Removal of macrophytes from Khalsi beel influenced communities of associated fauna. The most significant influence was drastic reduction of species belonging to family Planorbidae which was replaced by the tolerant species under Chironomidae family.

ASSESSMENT OF FISHERIES POTENTIAL OF UNEXPLORED WETLANDS

Floodplain wetland constitutes one of the major fisheries resources in Uttar Pradesh, Bihar, West Bengal and North Eastern states. Although these resources are increasingly being utilized for fish production, many areas still remain unexplored. In present study few wetlands of Meghalaya and Uttar Pradesh were investigated for ecology and fisheries.

Wetlands of Meghalaya

Wetlands were characterized based on physico-chemical properties of water and sediment, trophic state, plankton, benthos and fish diversity.

Limnological parameters and biotic communities

Assessment of limnological parameters in selected wetlands of Meghalaya i.e. Boro *beel* in West Garo Hill district and Katuli and Kumligaon *beels* in South-West Garo Hill district indicated moderately productive environment for fish production (e.g., temperature-29-32°C, DO-4.8-6.6 mgL^{-1}, free CO_2-1-14 mgL^{-1}, specific conductivity-35.0-50.9 μScm^{-1}, ammonia- 0.021-0.058 mgL^{-1}, phosphate- 0.02-0.08 mgL^{-1}) except for slightly acidic pH (6.0-6.3) and low total alkalinity (14-34 mgL^{-1}).

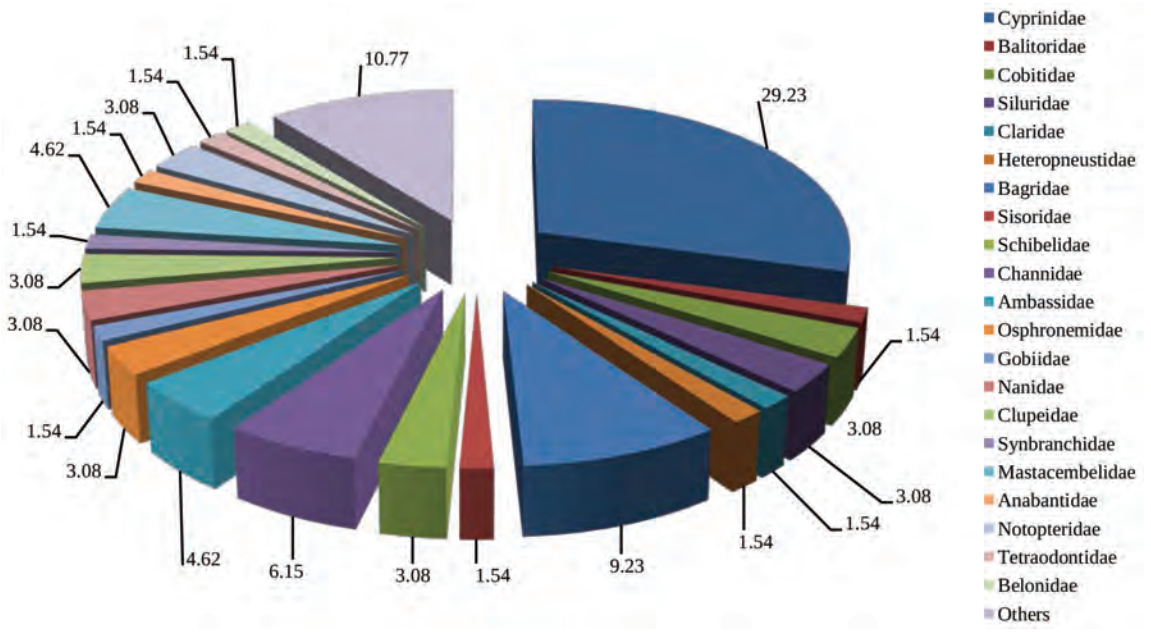
Bacillariophyceae (45-61%) dominated the plankton populations in all the *beels*, followed

by chlorophyceae (23-30.6%) and myxophyceae (12.7-21.7%). Zygnemophyceae (3.7%) was also found in Kumligaon *beel*. Periphyton population was similar with plankton population in all the *beels* with Bacillariophyceae being the dominant group. Plankton density was highest in Katuli and lowest in Boro *beel* whereas, the periphyton density was highest in Boro and lowest in Katuli *beel*. A number of macro-benthic organisms were observed in the three *beels* of Meghalaya with the density ranged between 28-44 no m^{-2}. Katuli beel (avg. density 44 no m^{-2}) was mainly represented by *Pila globosa*, *Corbicula* sp., *Anisus vorticulus* and Chironomid larvae, whereas Boro *beel* (avg. density 32 no m^{-2}) was represented by *Gyraulus convexiusculus*, *P. globosa*, *Bellamya bengalensis*, *Lamellidensmarginalis*, *Corbicula* sp. and *Chironomid* larvae) and *Kumligaon* (28 no m^{-2}) by *P. globosa*, *G. convexiusculus*, *Potamanthus* sp. and *Chironomid* larvae.

Macrophyte infestation was low (approximately 5-10%) in Boro *beel*, medium (30-40%) in Katuli *beel* and high (60-80%) in Kumligaon beel. Boro *beel* is an open wetland with an average area of 80 ha and influenced by the connecting river, Jinjiram which floods during every monsoon season. The macrophytes prevalent in the *beel* included *Eichhornia crassipes*, *Valisneria spiralis*, *Potamogeton crispus*, *Trapa natans*, *Nymphoides* sp., *Nymphaea* sp., etc. The other two *beels* are seasonally open. The macrophytes prevalent in Katuli *beel* included *Eichhornia crassipes*, *Valisneria spiralis*, *Hydrilla* sp., *Trapa natans*, *Nymphoides* sp., *Nymphaea* sp., *Ceratophyllum* sp., etc. while in Kumligaon beel *Eichhornia crassipes*, *Valisneria spiralis*, *Hydrilla* sp., *Trapa natans*, *Nymphoides* sp., *Nymphaea* sp., *Ceratophyllum*, *Pistia* sp., *Azolla* sp., etc were observed.

Fish diversity

Explorations were carried out to record the diversity of fishes in Boro *beel* of Meghalaya. The *beel* is managed under capture fisheries regime and leased by Garo Hills Autonomous District Council. A total of 65 numbers of fish species were recorded belonging to 41 genera, 20 families and 8 orders. Cypriniformes (22 species) was the most dominant followed by Siluriformes (13 species) and Perciformes (12 species). Cyprinidae (19 species) contributed highest numbers of species followed by Bagridae (6 species) and Channidae (4 species). Sporadic landing of *Tenualosa ilisha* was reported during June-July, 2015 indicating migration of anadromous Hilsa to the *beel* connected with river Brahmaputra.

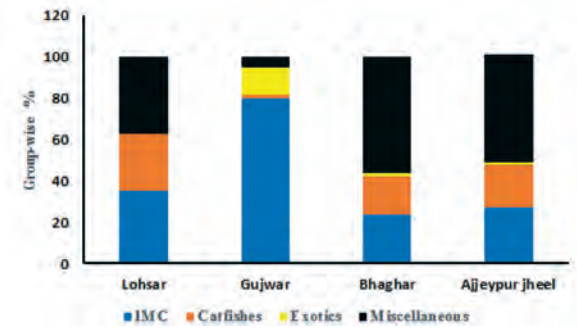


Family-wise contribution of fishes in Boro *beel*

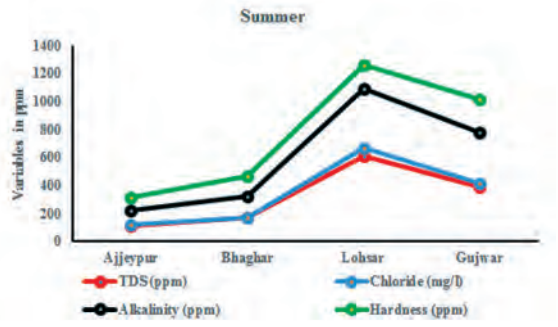
Wetlands of Uttar Pradesh

Surveys were conducted in two closed wetlands namely Lohsar *tal* (80 ha) and Gujwar *tal* (40 ha) in Pratapgarh district and two partiallyopen wetlands namely Baghar tal (80 ha) in Barabanki and Ajjeypur *jheel* in Sitapur district of U.P. The wetlands under lessee operations were managed under culture-based capture fishery regime. Number of fish species recorded were 41, 42, 30 and 25 in Baghar, Ajjeypur, Lohsar and Gujwar *tals* respectively with Shannon-Wiener Index (H´) and Evenness index (J´) as 3.398 and 0.7291, 3.323 and 0.6623, 3.008 and 0.6749 and 2.754 and 0.6225, respectively. Gujwartal showed higher productivity in terms of fish yield (1550 $kgha^{-1}yr^{-1}$) than Lohsar, Baghar and Ajjeypurjheels (80-140 $kgha^{-1}yr^{-1}$) which may be attributed to scientific stocking and adoption of improved management practice. Nom^{-2}

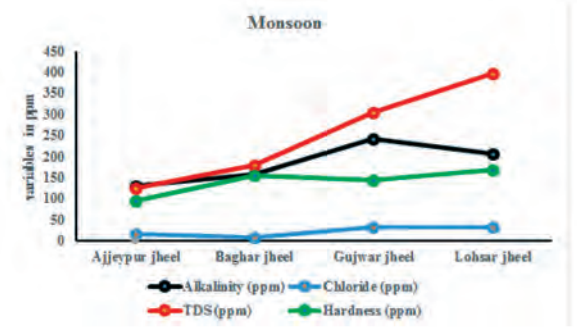
The concentration of decaying organic matter contributed to the richness of the bottom soil, as a result of which organic carbon (0.69-1.17%), available nitrogen (5.04 to 10.64 mg $100g^{-1}$) and available phosphorous (0.8 to 5.2 mg $100g^{-1}$) were in the range of moderate to high values. These wetlands were alkaline in nature (pH 7.3 -8.21) and rich in dissolved organic matter (3.3-7.2 ppm). The wetlands of Pratapgarh district showed significant difference with respect to alkalinity, conductance, total dissolved solids, chloride and hardness, all being exceptionally high in Lohsar taland were observed to be higher in summer compared to monsoon. Abundance ofbenthos ranged between 230-260 and 170-300 no m^{-2} during summer and monsoon respectively. Mollusks were the dominant community followed by insects, crustaceans and annelids in all the four wetlands. Plankton abundance ranged from 130 to 1093 and 650 to 1145uL^{-1} during summer and monsoon seasons. Primary productivity (mg $cm^{-2}h^{-1}$), net primary productivity (mg $cm^{-2}h^{-1}$) and fish production potential (kg ha^{-1}) was estimated to be 216.67, 200 and 1630.5 for Ajjeypur jheel, 150, 133.3 and 1086.73 for Baghar, 333.3, 300.0 and 2445.8 for Gujwar and 266.67, 220.0 and 1793.6 for Lohsar tals, respectively.



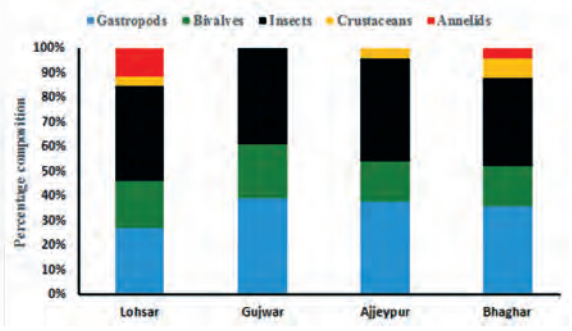
Group-wise percentage composition in fish catch from different wetlands



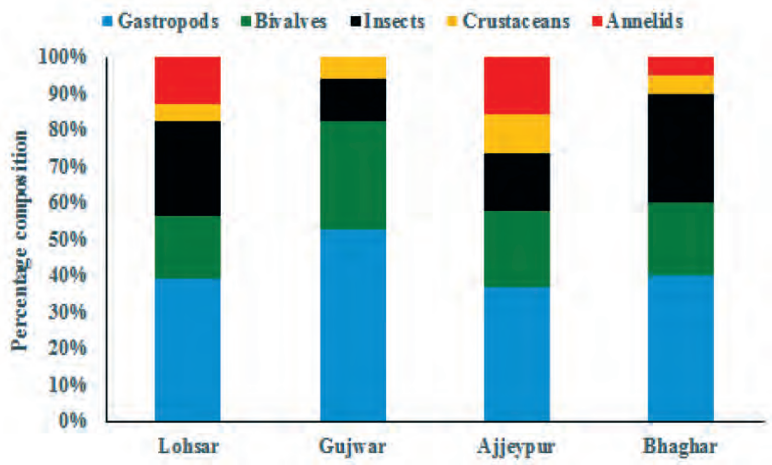
Important water quality parameters in different wetlands (summer)



Key water quality parameters in various wetlands (monsoon)



Macro-benthic composition in different wetlands (summer) season



Benthic population in various wetlands (monsoon)

IMPACT OF STOCKING ON ECOLOGY AND FISHERIES

Culture based fisheries is an effective management tool in enhancing fish yield from wetlands when recruitment of desired species is lesser than the carrying capacity of the water body Floodplain wetlands are increasingly being used for fish production enhancement, mainly through stocking of fish seed. This study focuses on impact of such stocking on ecology and fisheries of wetlands.

Limno chemistry

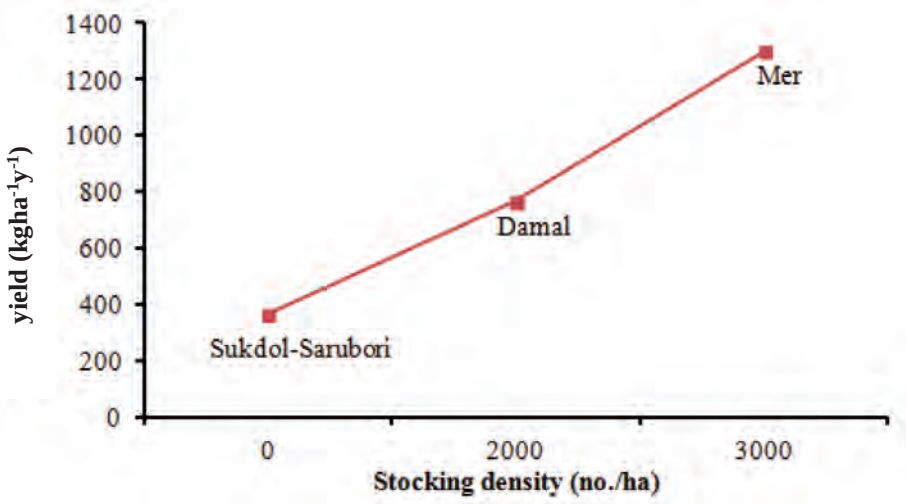
Limno-chemical parameters in the selected *beels* of Assam indicated productive environment for fish production and did not show significant variations in response to stocking. Water quality parameters of the selected *beels* were characterized as near neutral to alkaline pH (6.6-7.6), moderate to high DO (4.8-9.6 mgl^{-1}), moderate alkalinity (62-126 mgl^{-1}) and low free CO_2 (Nil to 6.5 mgl^{-1}). Sukdol-Sarubori, a shallow (0.85-0.91 m depth) *beel* recorded with higher free CO_2 / alkalinity and lower DO concentrations than the other two *beels*.

Biotic communities

Lower plankton population and higher macrophyte infestation was observed in the unstocked *beel* than that in the stocked *beels* apparently because of macrophyte management by the lessee in the latter. Density of macro-benthic organisms in the three *beels* of Assam ranged between 20-32 no m^{-2}. Average density of macro-benthic organisms in Sukdol, Mer and Damal was recorded as 32, 23 and 20 no m^{-2} respectively.

Fish catch and species composition

A higher fish yield rate was noted in stocked wetlands than that in non-stocked ones. Fish catch data for the year 2015-16 indicated fish yields were 1300 $kgha^{-1}yr^{-1}$ for Mer *beel*, 768 $kgha^{-1}yr^{-1}$ for Damal and 367 $kgha^{-1}yr^{-1}$ for Sukdol-Sarubori. Lower fish yield in Sukdol-Sarubori *beel* was recorded since it is managed under capture fisheries regime without any supplementary stocking. On the other hand, supplementary stocking was practised at moderate rates (2000 no ha^{-1}) in Damal and at high rate (3000 $noha^{-1}$) in Mer *beel*. In the stocked *beels*, 60-80% of the catch is contributed by the stocked fish (IMCs, minor carps and exotic carps) with the remaining comprising of natural fish population, whereas in the nonstocked (Sukdol-Sarubori) *beel*, more than 30% of the catch was comprised of *Puntius* spp. alone.



Stocking density vs fish yield rates in three *beels* of Assam

The present study revealed significant improvement in fish production due to fish seed stocking in selected wetlands of eastern region of the country. But there exists a gap between estimated fish production and potential of these water bodies. Habitat quality of studied wetlands was mostly in favour of fish production enhancement. However complete clearance of macrophytes and irrational feeding in pens poses threat to sustainability and integrity of wetland ecosystem.

ECOSYSTEM AND FISH HEALTH

CONTAMINANTS IN AQUATIC ECOSYSTEMS

Toxic heavy metals and pesticides often find their final place into aquatic systems through effluents, run-off, etc., and may affect health of aquatic organisms, as well as human. The ecosystem health and pollution status for trace metals and pesticide residues were assessed in River Gomti, Torsa and Ganga. River Gomti is one of the major tributaries of the Ganga, originates from Gomti *Taal*, a natural reservoir in the swampy and densely forested area in Pilbhit in Uttar Pradesh. The river travels 900 km through different districts of UP and finally merges with the Ganges in Ghajipur. On its course it comes across discharges of many industrial and domestic waste waters and run off from agricultural fields.

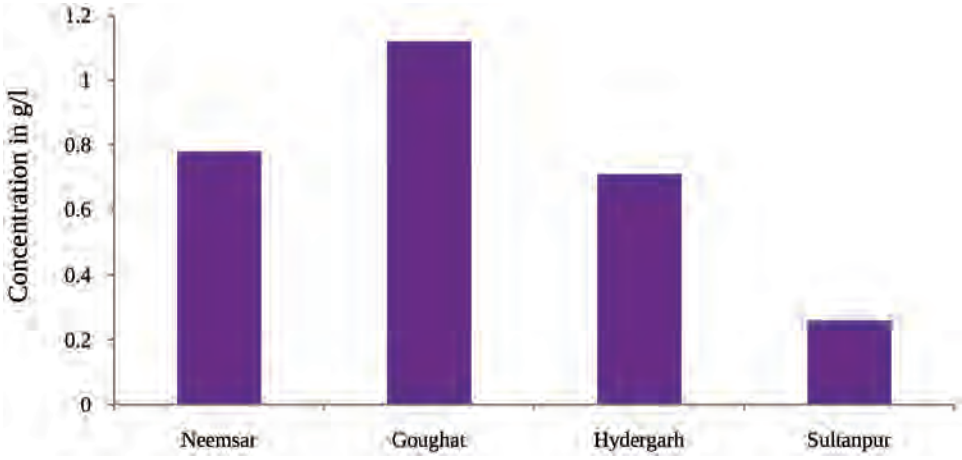
River Gomti at *Goughat* (Lucknow)

Pesticide residues and heavy metals in River Gomti

The water phase of river Gomti was free from metal (Cd, Cu, Pb, Zn) contaminations. In sediment phase also the metal accumulation was low and below the pollution limits. In fish fleshes presence of Cu and Zn was recorded but these were in safer limits for human consumption.

Water samples of the river were contaminated with pesticide residues. Contamination was up to 51% of the analysed samples. Among the 16 targeted persistent organochlorinated pesticide (OCP), residues of HCH isomers (α, β, γ, δ), op' and pp' DDE, op' and pp' DDD, op' and pp' DDT and endosulfan (α, β) were detected. The total average load of OCP residues in water was highest in samples of Goughat (Lucknow) and lowest in Sultanpur.

The flesh and gill samples of fishes collected from the sampling sites also contained residues of different pesticides and out of 76 samples analysed, 36 (47.36%) were contaminated. All the four isomers of HCH were detected and total HCH concentration varied from 0.02-0.93 mg kg^{-1}. Among DDTs, the most stable metabolite pp' DDE was recorded with maximum frequency in flesh as well as in gill samples and in many instances concentration in gill was higher than that in flesh samples. Total DDT concentration in fish samples ranged between 0.012-1.78 mg kg^{-1}. Concentration of α-HCH in one and γ-HCH in two samples exceeded the MRL of 0.25 mg kg^{-1}, while DDT level exceeded its MRL of 7 mg kg^{-1} as recommended by Food Safety and Standard Authority of India (FSSAI) in none of the samples. Beta-endosulfan and endosulfan sulphate were detected in flesh of *Mystus cavasius*; endosulfan sulfate in flesh of *Wallago attu* and gill of *Mystus seenghala* were also detected. Residues of dicofol were recorded in flesh and gill of *W. attu* and *M. seenghala* and also in *M. vittatus*. Among the organophosphates, chlorpyriphos (0.03-0.04 mg kg^{-1}) and parathion residues were also found in fish samples. Among other group of pesticides, carbaryl and buprofezin were also detected in one sample each. None of the targeted synthetic pyrethroid residue was found in water or in fish samples.



Organochlorine pesticide residues in water of River Gomti

Pesticide residue in river Torsa

The water samples from river Torsa were analyzed for residues of eight synthetic pyrethroids (SPs) and 16 organochlorines (OCs) in gas chromatography by electron capture detector (GC-ECD). There was no SPs residue found in any sample, among the OCs, lindane (0.2-0.65 ng ml^{-1}) in Balarampur and Hasimara sample, Dicofol (2.53 ng ml^{-1}) in Balarampur samples and Endosulfan sulfate (6.65 ng ml^{-1}) in Totopara sample were recorded. All the values were well below the maximum residue limits (MRL) of the concerned pesticides. But as sample from Totopara contained a metabolite of insecticide Endosulfan and also there are reports of fish harvesting by use of pesticides in the area. Therefore there is a need to analyze fish samples from these sampling points for pesticide residues in food chain.

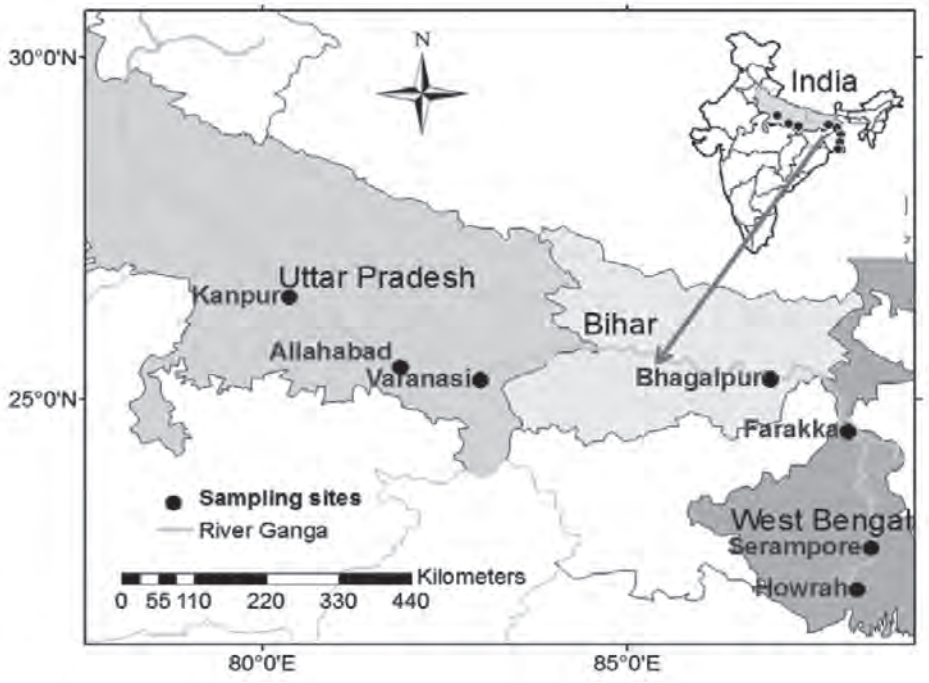
Triclosan in river

Triclosan is an antimicrobial widely used in personal care products and consumer articles, but has toxic effects on biota. Triclosan was monitored in water and fish samples collected from River Gomti. In the river water triclosan was detected at a level of 1.62-9.65 µg l^{-1} and may be toxic to algae, protozoa, macrophytes, some crustaceans and molluscs. In fish, it was found in the range of (0.36-1.12 mg kg^{-1}). However, accumulation of TCS in fish at this level is quite safe considering the acceptable daily intake (0.05 mg kg^{-1} body wt day^{-1}) and USEPA reference dose (0.3 mg kg^{-1} body wt day^{-1}) for human.

DEVELOPMENT OF EIA PROTOCOLS

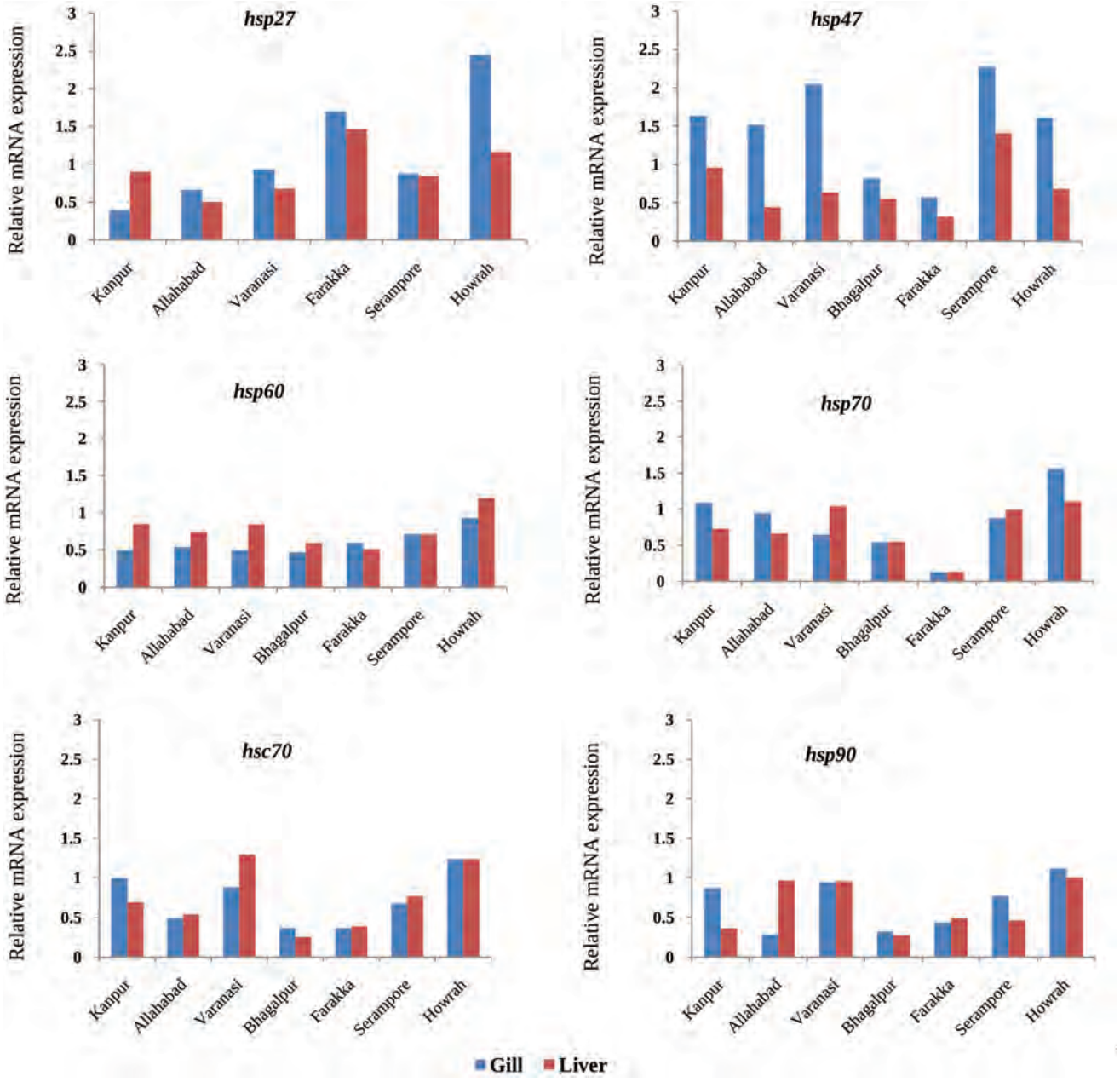
Evaluation of *hsp* transcript profiles as pollution biomarker

Pollution management in large river system like Ganga primarily requires periodic monitoring and quantitative assessment of pollutants in different stretches. Environmental quality is often assessed in terms of physical and chemical parameters only. However, there is growing concern that only chemical data of pollutants in environmental matrices is not sufficient to predict how it can affect the biotic components. Therefore, the need to detect the effects of chemical contaminants at low concentration and in complex mixture on several molecular and cellular processes has increased. This has led to the idea of using biological markers (biomarkers) to indicate the presence of contaminants and to unravel their effects on organisms. In this context, we carried out gene expression analysis of a battery of heat shock proteins *(hsp27, hsp47, hsp60, hsp70,* and *hsp90*) and their regulatory molecules (*hsf1*) in gill and liver tissues of catfish *Rita rita* collected from different stretches of river Ganga (both polluted and reference sites) with the objective of identifying specific biomarker(s) for aquatic pollution monitoring in tropical rivers like Ganga. *Rita rita* specimens were collected from different sampling sites viz. Kanpur, Varanasi, Allahabad, Bhagalpur, Farakka (reference zone), Serampore and Howrah. The sampling sites were chosen considering the vulnerability of the river to received high amounts of sewage and other industrial effluents as these locations are at the outskirt of major cities/townships.

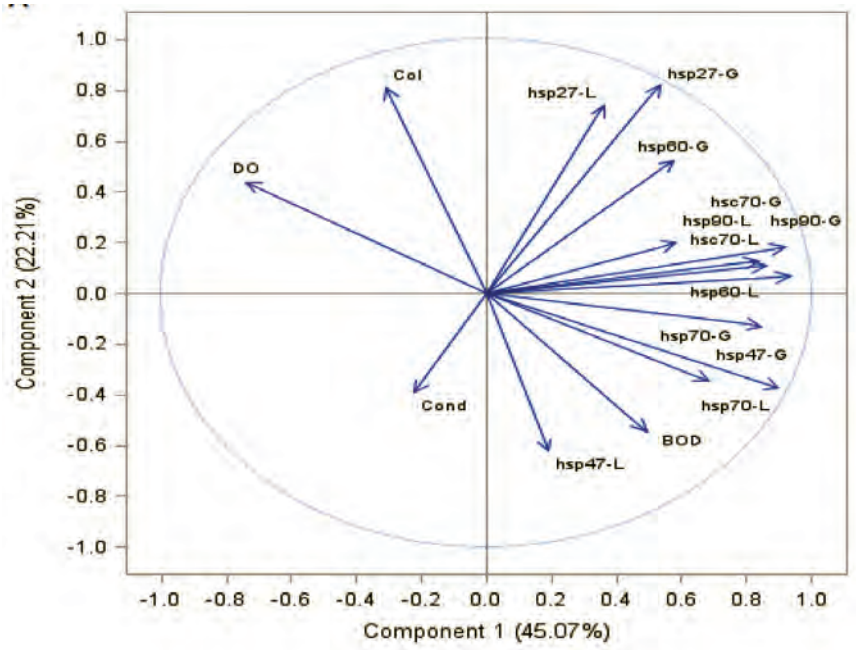


Map showing sampling sites in different stretches of river Ganga

Gene expression profiling of a battery of *hsps*, *viz*. *hsp27, hsp47, hsp60, hsp70, hsc70, hsp90* in liver and gill tissues of riverine catfish *Rita rita*, collected from different stretches of river Ganga were carried out by semi-quantitative RT-PCR.The *hsps, hsp47, hsp70, hsc70* were found to be up-regulated, while *hsp27* was down-regulated in all the stretches.Correlation between gene expression pattern and water quality parameters was carried out by principal component analysis (PCA). Up-regulation of *hsp47, hsp70* expression was correlated with decreasing dissolved oxygen content which could be mediated by organic pollutants and heavy metal pollution, suggesting *hsp70 and hsp47* could be possible biomarker for contamination of organic pollutants and heavy metal in aquatic environment. *Hsp27* could a potential biomarker for coliform contamination.



Heat shock protein (*hsp*) gene expression profile in gill and liver tissues of *Rita rita*

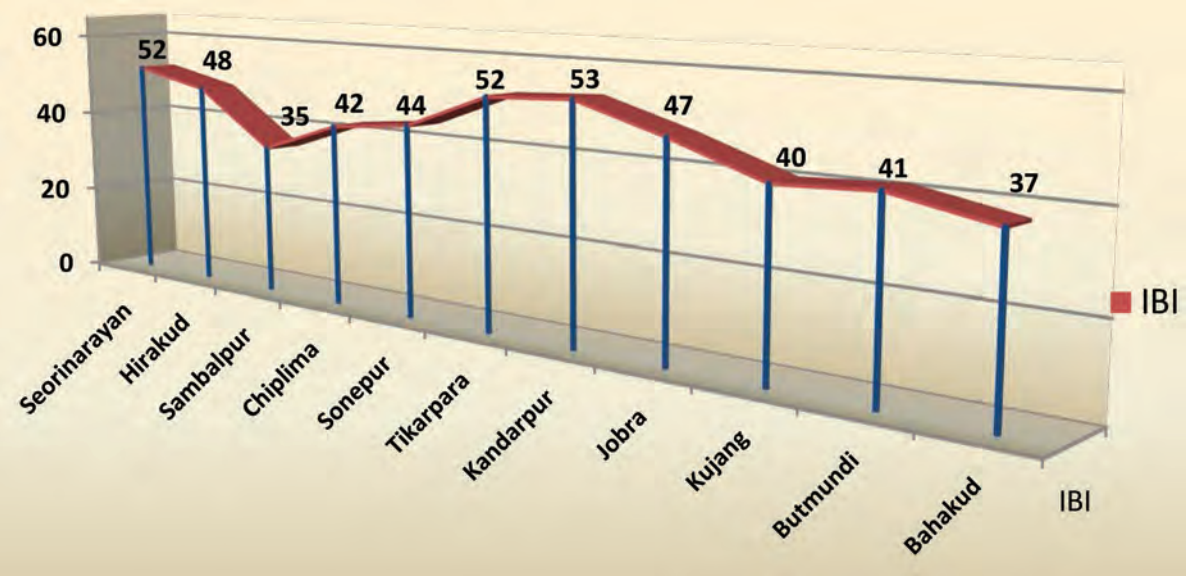


Principal component analysis of *hsp* genes expression and water quality parameter

ECOSYSTEM HEALTH OF RIVER MAHANADI

The project aims to monitor the stressors of the ecosystem and assess the ecological health and integrity of river systems. The study covers habitat profiling, assessment of water and sediment quality, study on aquatic health and contaminations of heavy metals and pesticides. Eleven sampling stations of river Mahanadi, viz., Seorinarayan, Hirakud dam (Zero point), Chiplima, Sambalpur, Sonepur, Tikarpara, Kandarpur, Jobra, Kujang, But Mundi and Bahakuda Ghat, covering a total distance about 650 km were assessed for the study. Sampling was carried out in pre-monsoon, monsoon, post-monsoon and winter seasons to account for the seasonal variations in the ecosystem. The fish-based index of biotic integrity (IBI) has been chosen for understanding aquatic health status. The metrics selected in IBI are related to taxonomic richness, abundance and community structure and the fish species were classified accordingly. Based on the ecological and ichthyofaunal characteristics of the River Mahanadi, the metrics were modified and developed in order to adopt the IBI for the river ecosystem. One of the major environmental stressors on the river is impaired river flow due to dams and barrages constructed across the river. To know its extent of impact on the biotic integrity, ethological traits like migration and rheophilic nature of fishes as well as population doubling time as a measure of species resilience were incorporated as metrics. A total of 13 metrics were included for calculating the IBI scores

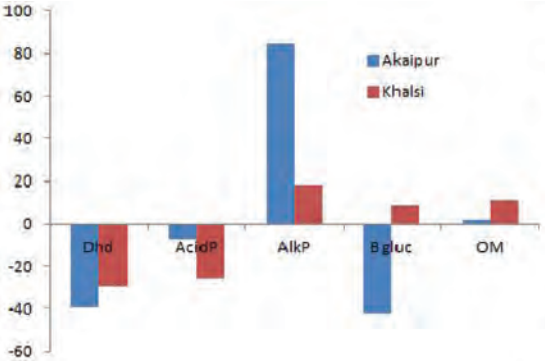
The scale of IBI score ranges from 13 (maximum impairment) to 65 (pristine condition). Based on the IBI score, the sites were classified into 4 levels of integrity classes: (i) acceptable (<10% deviation from pristine condition), (ii) slightly impaired (10-25% deviation from pristine condition), (iii) moderately impaired (25-50% deviation from pristine condition) and (iv) severely impaired (>50% deviation from pristine condition). The estimation of IBI of the sampling sites revealed that in 8 out of 11 sites of the studied river stretch was moderately impaired while only 3 sites were slightly impaired and none of the sites classified for near natural condition. The lowest IBI score was obtained for Sambalpur (35) due to the deterioration of river stretch with stagnant water, less flow and discharge of sewage and untreated industrial effluents. The highest score was for Kandarpur (53) and Tikarpara (52), Tikarpara being located inside Satkosia sanctuary.



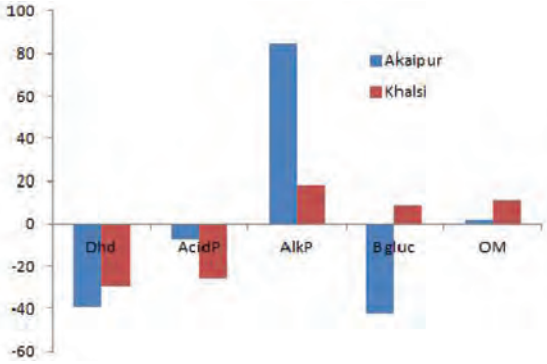
IBI scores of the sampling sites of river Mahanadi

IMPACT OF FISH STOCKING ON BIOCHEMICAL AND MICROBIOLOGICAL PROPERTIES OF WATER AND SEDIMENTS

In order to assess the impact of stocking and macrophyte management on sediment enzyme activity involved in organic matter decomposition and nutrient cycling, two wetlands in West Bengal, namely, Akaipur (enhanced stocking and macrophyte management) and Khalsi (relatively lesser stocking and macrophyte management) were studied. Sediment enzyme activity showed change (%) in activity during winter 2014 to winter 2015 with decrease in activity of acid phosphatase and dehydrogenase and increase in activity of alkaline phosphatase and organic matter in both the beels. However, carbon mineralization increased in Khalsi and decreased in Akaipur. The change in activity during monsoon 2013 to monsoon 2015 revealed more increase in carbon mineralization, alkaline phosphatase activity and organic matter and less increase in acid phosphatase activity in Akaipur than Khals. Variation of sediment enzyme activity in two wetlands may be attributed to higher management pressure in terms of higher macrophyte, higher organic matter and lower stocking density in Khalsi than Akaipur. Temporal changes (year wise) in the wetlands may be due to anthropogenic aging of the wetlands caused by change in pattern of organic matter deposition in sediment, macrophyte biomass and stocking management.



Change (%) during winter 2014 to winter 2015



Change (%) during monsoon 2013 to monsoon 2015

FISH HEALTH

Surveys were conducted in 63 fish farms of Bellary, 106 in Raichur and 80 in Shimoga Districts of Karnataka to examine drugs/chemicals used and economic loss incurred from fish diseases in the state. The fishes are reared in earthen ponds of 0.1 to 2 ha. No major issues in fish health encountered at the farms other than ectoparasitic infestation with *Argulus* and *Lernea*. Dichlorvos, Deltamethrin, Quinolphos were the main drugs used in the state. About 80% of farmers are using pesticides. Enrofloxin, Glutaraldehyde, Formaldehyde, $KMnO_4$, Calcium Peroxide, Cypermethrin, were also used in small quantities.

Surveys were conducted in Nagaon and Cachar districts, and in Nagaon and Morigaon districts of Assam to assess the economic loss from fish diseases in pond/ tank, and floodplain wetlands respectively. Beels surveyed in Morigaon (17 out of 30 nos.), Nagaon (21 out of 30 nos.) and aquaculture farms surveyed in Nagaon (12 out of 30 nos.) estimated economic loss from fish mortality @ ₹ 5,000.0 per ha in beels of Morigaon and ₹ 14,000.0 per ha in Nagaon. The estimated economic loss in beels of Nagaon varied from 13-18% of the gross income. Fish mortalities in beels were reported to be mainly due to ulcerative diseases; however, large scale fish mortality without any clinical symptoms takes place due to water quality deterioration, effluent discharges from domestic or commercial activities including washing from tea gardens, jute retting practice etc. in beels, and from higher stocking density, higher rate of fertilization & feeding, production of obnoxious gases etc. in ponds. Drug use in beel fisheries was reported to be negligible; however, while undertaking pen culture (e.g., Merbeel) for raising stocking material, liming was commonly practiced. Drugs/ medicines used in fish culture were reported to be large in number (>90 commercial products under different trade names) and a bulk of these constituted medicines intended for veterinary use

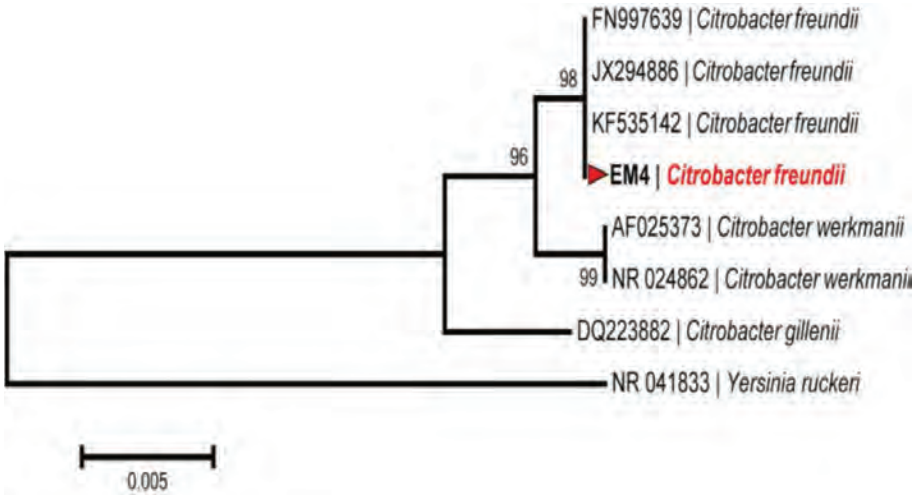
SURVEILLANCE FOR AQUATIC ANIMAL DISEASES

To identify prevalent fish diseases and pathogens, diseased samples of IMC (*Labeo rohita*) from the freshwater aquaculture ponds of East Midnapur, West Bengal were collected for the isolation of pathogenic bacteria. The moribund fish was showing reddish lesions near the pectoral fins and also having ulcer on the mouth was used for bacterial isolation. Fishes were sacrificed by using anesthesia, MS222 @ 75 mg l^{-1}. Blood samples were taken aseptically from different diseased fishes and plated directly on TSA Agar (Hi-media) and then fresh tissues were preserved in neutral buffered formalin (NBF) for histopathology. Single colony isolates were selected and re-streaked on fresh TSA plates to obtain a pure culture. Then the single colony was grown in TSB (Tryptophan Soya Broth) media for bacterial mass culture. The biochemical test revealed that, the *C. freundii isolate* was Gram negative motile rods. The other biochemical tests revealed that, it was positive for H_2S production, methyl red, citrate, ONPG, catalase, arabinose, rhamnose, lactose, sorbitol, manitol, sucrose, glucose, raffinose, whereas it was showing negative for indole, Voges-Proskauer, adonitol, inositol. Further, bacterial DNA was isolated and PCR amplification of the 16S rRNA gene was performed. The amplified 16S rRNA gene from isolated bacteria was sequenced and was analyzed using BLAST tool. The results revealed 99% homology with *Citrobacter freundii* (GenBank Accession Number: KP872908). The biochemical tests and molecular sequence analysis confirmed that the isolated bacterial sample was *Citrobacter freundii*. Antibiogram study of *C. freundii* revealed that, it was resistant towards the different antibiotics such as amoxycilin, dicloxacillin, ampicillin and susceptible towards doxycycline, streptomycin, ofloxacin, tertracycline, nitrofurantion and erythromycin. A challenge study was conducted to confirm Koch's postulate. The clinical sign of moribund fish were observed as reddish lesions with ulcer on the mouth and hemorrhages in the belly region. In the histopathological examination, the kidney sample showed damaged glomerulus. The liver sample showed necrosis of hepatocytes.

Salient morphological and biochemical properties of Strain EM 4 isolated from *Labeo rohita*

Characteristics	Strain EM 4	*Citrobacter freundii**
Gram reaction	-	-
Shape	Rod	Rod
Motility	+	+
Indole	_	V
Methyl red	+	+
Voges-Proskauer	-	-
Citrate	+	V
ONPG	+	+
Catalase	+	+
Arabinose	+	V
Xylose	+	+
Adonitol	-	-
Rhamnose	+	V
Lactose	+	V
Sorbitol	+	+
Manitol	+	+
Sucrose	+	+
Glucose	+	+
Raffinose	+	V
Inositol	-	V
H_2S	+	V

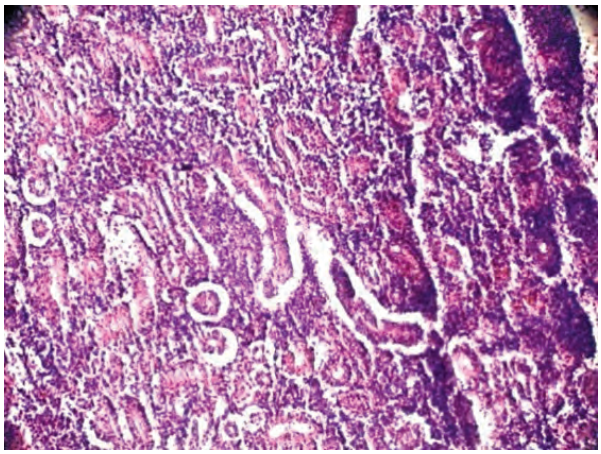
* Reference strain data compiled from Bergey's manual (Frederiksen, 2005), +, positive, - , negative,,V= variable (positive or negative)



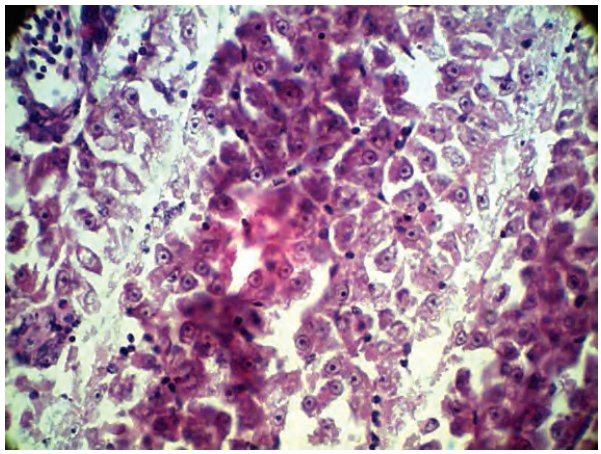
Phylogenetic tree analysis of *Citrobacter* sp. based on 16S rRNA nucleotide sequences. Unrooted tree was generated using neighbour-joining method by the MEGA 5 software. The numbers next to the branches indicate percentage values for 1000 bootstrap replicates. Bootstrap values above 50% are shown at the nodes. The isolate EM 4 identified in this study are indicated by the shaded triangle

Antimicrobial susceptibility analysis of *Citrobacer freundii* isolates from Indian Major Carp, *Labeo rohita*

Antibiotics (µg)	*Citrobacer freundii*
Ampicillin (25)	R
Tetracycline (10)	S
Nitrofurantion (200)	S
Erythromycin (10)	S
Dicloxacillin (1)	R
Doxycycline (10)	S
Streptomycin (254)	S
Ofloxacin (2)	S
Amoxycilin (30)	R



Kidney tissue section reveals damaged glomerulus with interstitial hemorrhages



The liver tissue section of infected fish exhibited inflammatory responses with hepatocytes necrosis

ECO RESTORATION

Control of algal bloom

Algal bloom is a serious problem in many inland water bodies, especially in urban and periurban lakes. With aim to develop fish-based algal bloom control for management of eutrophic lakes, different carp species were stocked in East Kolkata Wetlands and their grazing on different algal species were studied. The gut contents of sampled fishes namely silver carp (*H. molitrix*), Kalbasu (*Labeo calbasu*), Bata (*Labeo bata*) and Rohu (*Labeo rohita*) studied microscopically. The highest number of phytoplankton of sixteen was found in the gut of Silver carp. Fifteen phytoplankton species were found in the gut of Kalbasu and fourteen phytoplankton species were identified in the guts of Rohu.

The phytoplankton species, namely *Microcystis aeruginosa, Oscillatoria amphibia, Oscillatoria splendid, Oscillatoria curviceps, Pandorina morum, Scenedesmus quadricauda, Scenedesmus bijugatus, Spriorogyra maxima, Navicula radiosa* and *Navicula microspora* were dominantly present in the fore gut but absent in the hind gut of Silver Carp (*H. molitrix*) throughout the year.

The food of Kalbasu (*Labeo calbasu*) consisted mainly of phytoplankton species *Microcystis aeruginosa, Oscillatoria amphibia, Oscillatoria splendid, Oscillatoria curviceps, Scenedesmus quadricauda, Selenestrum gracile, Closterium moniliferum, Closteriun parvulum* and *Spirogyra maxima*. A total of fifteen phytoplankton species

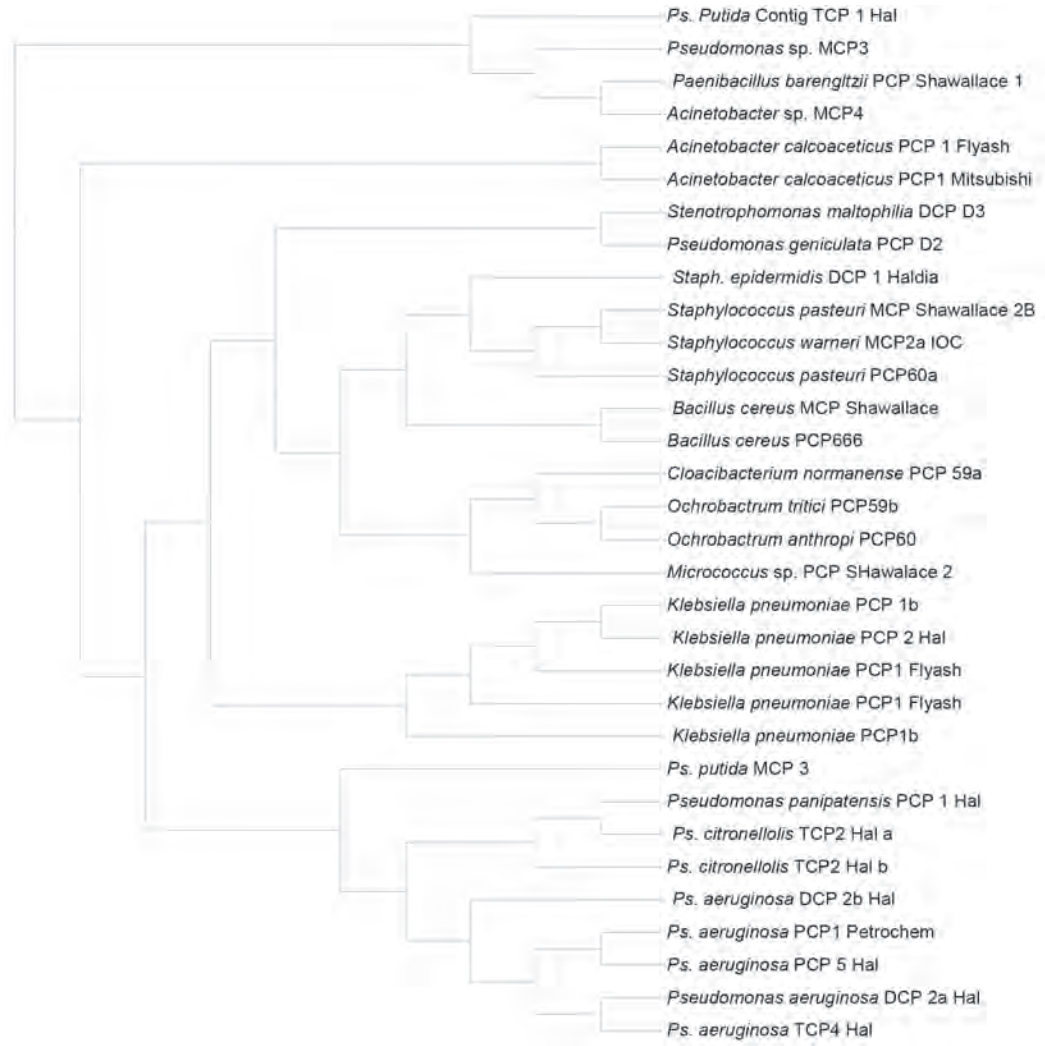
found to be consumed and digested by the species in the annual cycle due to their presence in the fore gut but absent in the hind gut.

Analysis of gut contents of indicated that *Labeo bata* consumed mainly the phytoplankton species *Microcystis aeruginosa, Oscillatoria amphibia, Oscillatoria splendid, Oscillatoria curviceps, Selenastrum gracile, Scenedesmus quadricauda, Closterium moniliferum, Closteriun parvulum, Spirogyra maxima, Euglena viridis* and *Phacus curvicauda*. However, a total of fifteen phytoplankton species were traced in the fore gut and digested by the species in the annual cycle.

The phytoplankton species identified in the fore gut but absent in the hind gut of *Labeo rohita* through out the year are *Microcystis aeruginosa, Oscillatoria amphibia, Oscillatoria splendid, Oscillatoria curviceps, Scenedesmus quadricauda, Closterium moniliferum, Closteriun parvulum, Spirogyra maxima* and *Euglena viridis*. A total of fourteen phytoplankton species found to be consumed and digested by the species in the annual cycle.

Phenolic compound degrading bacteria

Most of the Indian rivers, urban lakes etc. are polluted. Bioremediation has been found to be an effective and less costly method of pollution abatement. Harvesting pollution



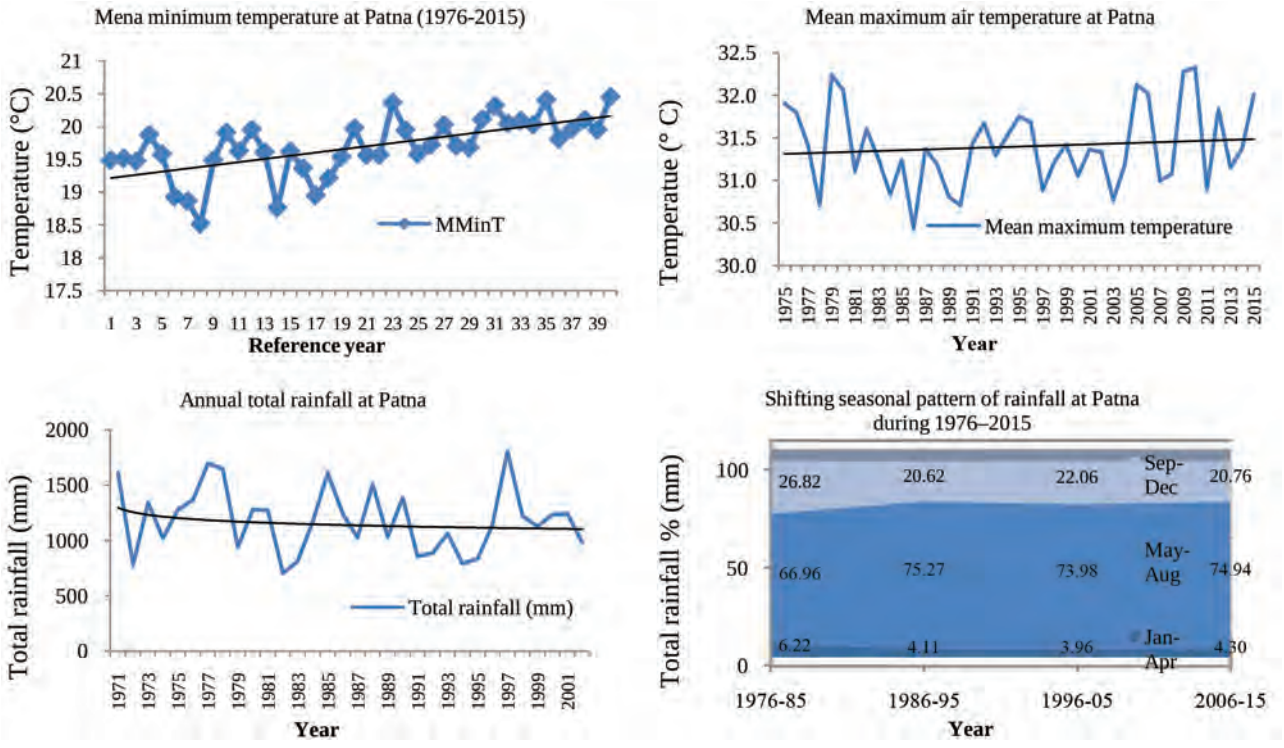
Diversity of chlorophenol degrading bacteria

degrading microorganisms from degraded ecosystems and their reapplication would provide effective means for pollution bioremediation. The phenol, chlorophenol and triclosan degrading bacteria isolated from various polluted aquatic environments were identified as: *Pseudomonas putida, Pseudomonas geniculata, Pseudomonas citronellolis, Pseudomonas aeruginosa, Pseudomonas panipatensis, Acinetobacter calcoaceticus, Acinetobacter soli, Acinetobacter junii, Acinetobacter baumannii, Acinetobacter pittii, Stenotrophomonas maltophilia, Bacillus cereus, Bacillus licheniformis, Bacillus flexus, Paenibacillus* sp., *Cupriavidus* sp., *Cloacibacterium normanense, Ochrobactrum anthropi, Ochrobactrum tritici, Ochrobactrum intermedium, Ochrobactrum pseudointermedium, Klebsiella pneumonia, Comamonas terrigena, Comamonas testosteroni, Cupriavidus* sp., *Chryseobacterium teaenense, Chryseobacterium geocarposphaerae, Flavobacterium* sp., *Alkaligenes faecalis,* and *Citrobacter freundi*. Some of these bacteria may have great potential in pollution remediation in degraded environments.

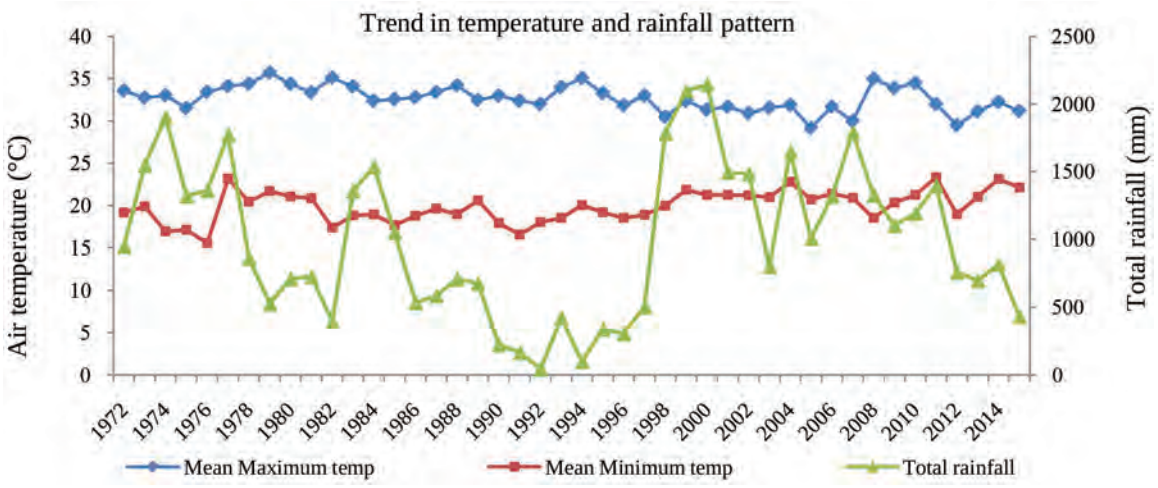
CLIMATE RESILENCE IN FISHERIES

River Ganga

The climate change trend was studied in selected stretches of river Ganga. The study revealed that the rainfall pattern at Patna showed a decreasing trend in the last four decades. The annual rainfall in Patna has decreased by 52.58 mm during time period 1976-2015. Rainfall pattern has decreased pre- (January-April) and post-monsoon (September-December) and increased during monsoon (May-August) from 1976 to 2015. The mean maximum temperature at Patna district has increased by 0.54ºC and minimum increased by 0.66ºC in last three decades. In Farakka stretch rainfall has decreased during monsoon (May-August) but shows increasing trend in both pre-monsoon and post-monsoon in the last four decades (1985-2014). The mean maximum temperature at Farakka has increased by 0.32ºC and minimum temperature increased by 0.54ºC in last four decades.



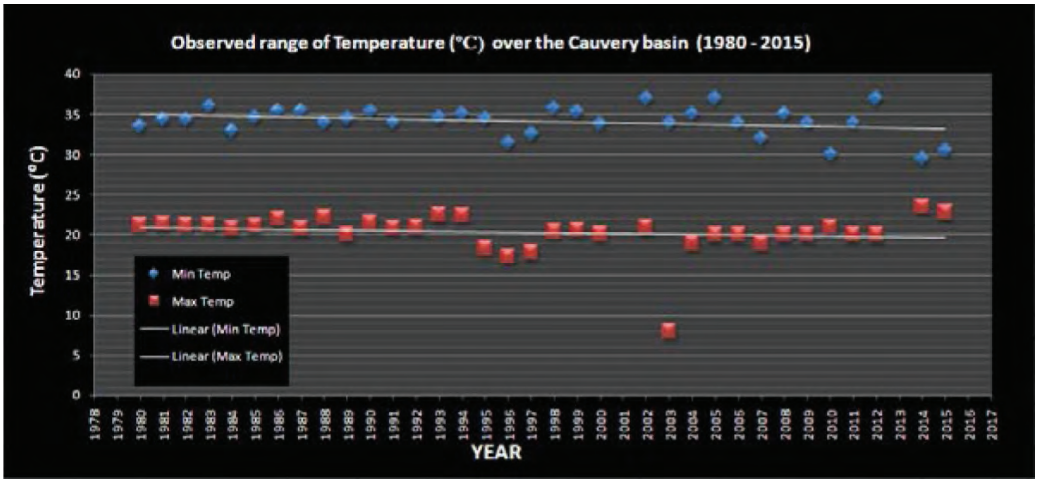
Trend in temperature and precipitation regime at Patna during 1975-2015 (Source: IMD)



Trends in temperature and precipitation regimes at Farakka (Soruce:IMD)

River Cauvery

Analysis of rainfall trend in Cauvery basin from 1830 to 2016 and trend line obtained reveals that the onset of South West monsoon has advanced by 6 days and date of end of monsoon is delayed by 8 days. The annual trend of rainfall is increasing, but it is statistically insignificant. Though the rainfall in each season had increased, their trend was statistically insignificant. The seasonal pattern of rainfall during the period from 1830 to 2005 has shown that the average rainfall has been increased by 80 mm in the monsoon period and the duration of monsoon (number of days) has increased by 10 days. The decadal differences of year-wise seasonal rainfall and duration of monsoon varied sinusoidally. The annual trend of rainy days has increased, but the trend was statistically insignificant. The mean rainy days were 53.61 days.



Decadal difference in mean maximum and mean minimum air temperature for Cauvery River basin (Source: IMD)

Fish breeding periodicity in relation to climate change

Assessment of spawning behavior of 8 target fish species in relation to climatic variations were studied in selected stretches of river Ganga and in floodplain wetlands of West Bengal and Assam. Preliminary results indicate region (stretch)-specific variations in periodicity of breeding seasons. Some species showed reduced breeding period,

while some showed extended breeding season. A few species exhibited shifting of their breeding season while in other species breeding period remained unchanged as compared to historical records.

Changes in breeding season of target fish species in specific stretches in Ganga river basin

Fish species	Present observations	Earlier records
Channa punctatus	Reduction in post-monsoon phase of breeding. Breeding Season: June to August	June to August and October to December June to October (Ref: Parameswaran and Murugesan, 1976; Prasad *et al*., 2011)
Eutropiichthys vacha	Breeding season March-July (in lower stretch). Winter breeding observed in Patna and Allahabad stretch of Ganga(December onwards)	June to September, (Ref: Qasim and Qayyum, 1961)
Johnius coitor	Perennial breeder.	NA
Mystus tengara	Reduction in post-monsoon phase of breeding. Breeding restricted till August.	July to September May to September (Ref: Guraya *et al*., 1976; Gupta and Banerjee, 2013)
Mystus cavasius	Extension in post-monsoon phase of breeding. Breeding extending till October.	June to September August to September February to July (Ref: Qasim and Qayyum, 1961; Bhatt, 1971' Ashashree *et al*. 2013)
Puntius sophore	Breeding season extending from February to September.	February to August June to August June to September (Ref: Mitra *et al*., 2006; Phukon and Biswas, 2012; Choudhury *et al*., 2015)
Schizothorax richardsonii	Peak spawning observed during September end to mid-October, while spawning in some of the samples was also noticed during the August to November. The prolonged spawning activities may be attributed to erratic monsoon and lesser rains.	September-October (Ref: Joshi, 2004)
Tor putitora	Spawning was observed during May to September and peak during August. The breeding season unusually extended which may be attributed to lesser pre-monsoon and erratic monsoon rains	May- June August -September (Ref: Joshi, C.B., 2011; Pathani , 1972; Hora and Mukherjee, 1936; Hora 1940)

Beneficial effect of climate change on reproductive traits of fish

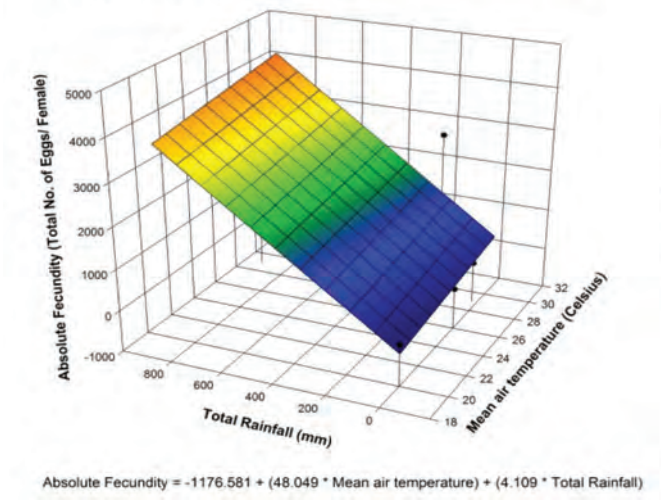
Characterization of reproductive biology in relation to climate change have been carried out for 7 target fish species (*Channa punctatus, Eutropiichthys vacha, Johnius coitor, Mystus tengara, Mystus cavasius, Odontoamblyopus rubicundus*, and *Puntius sophore*) occupying different ecological niches in lower and middle stretches of River Ganga. A number of reproductive traits were studied (breeding periodicity, G_nSI, fecundity, egg weight, egg diameter, maturity stages and length at first maturity) alongside the trends in temperature and rainfall pattern prevailing in the sites. Preliminary studies revealed the probable beneficial impact of the increased temperature and rainfall regime on fish spawning in Ganga river basin. To ascertain the most important habitat parameters among all that significantly influence female G_nSI (gonado somatic index), a stepwise forward multiple regressions was conducted. The preliminary results revealed 6 habitat

parameters *i.e*. water temperature, dissolved oxygen, total dissolved solids, conductivity, nitrate and phosphate had significant bearing on female G_nSI.

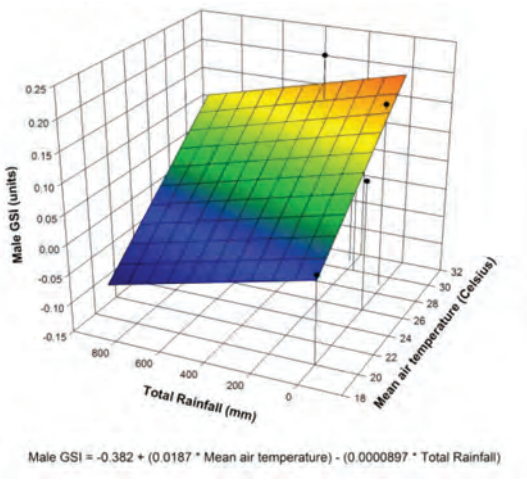
Development of region-specific climate dependence models

An attempt was made to develop region specific climate dependence models for predicting certain reproductive biology parameters of 9 target fishes (*Channa punctatus*, *Eutropiichthys vacha*, *Johnius coitor*, *Mystus tengara*, *Mystus cavasius*, *Odontoamblyopus rubicundus*, *Puntius sophore*, *Amblypharyngodon mola*, and *Colisa fasciata*) from Ganga river basin under various temperature and precipitation regime. 3D Scatter and Mesh Multiple Regression Plot was created using spatial data with existing climatic conditions. These models are capable of predicting expected changes in particular parameter like GSI, fecundity, egg weight, egg diameter and maturity stages under various temperature and precipitation scenarios. However validation of these models needs to be done along with impact of climatic variables on fish habitat and its likely impact on spawning biology.

Dependence of Absolute Fecundity of *Channa punctatus* on Climatic Factors in flood plain wetlands of West Bengal



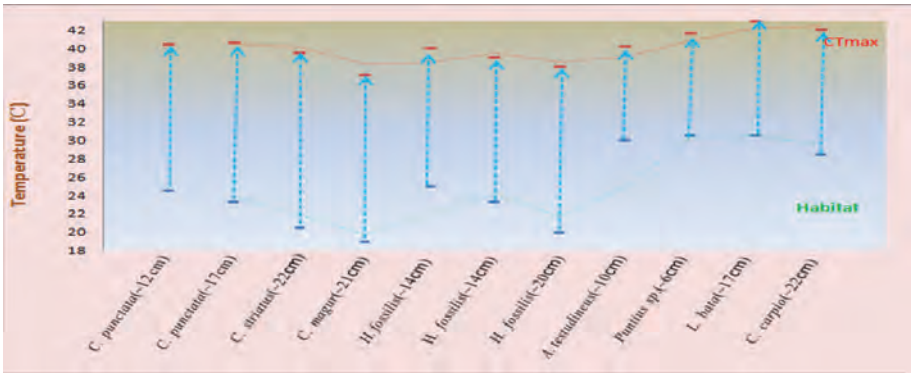
Dependence of Female GSI of *Channa punctatus* on Climatic Factors in flood plain wetlands of West Bengal



Predictive climate dependence model for absolute fecundity of Channa punctatus under different temperature and precipitation regimes

Thermal tolerance of fishes

Increase in water temperature due to global warming and climate change may affect the habitat potential and biological aspects of fishes. Generation of data on upper thermal tolerances limit (CTmax) will help to predict thermal survival of fishes from different aquatic ecosystems and to select potent thermal tolerant species under future global warming scenario. *Ex situ* thermal tolerance of eight inland fishes were assessed during different seasons. The CTmax value ranged from 37.07±0.0.55 to 42.92±0.46°C with highest value for *Labeo bata* and lowest for *Clarias magur*. Data also revealed more CTmax value for fishes collected from habitat of higher temperature. Observed thermal tolerance (CTmax) of the eight studied species indicate their potential to thrive the habitat temperature of pond, wetlands etc. (20.0 to 37±1°C) in future increased temperature scenario (+2°C) due to global warming and associated water stress. Observed thermal tolerance (CTmax) of the studied species indicate their capacity to thrive in higher temperature (20.0 to 37±1°C) in future increased temperature scenario (+2°C) due to global warming and associated water stress.

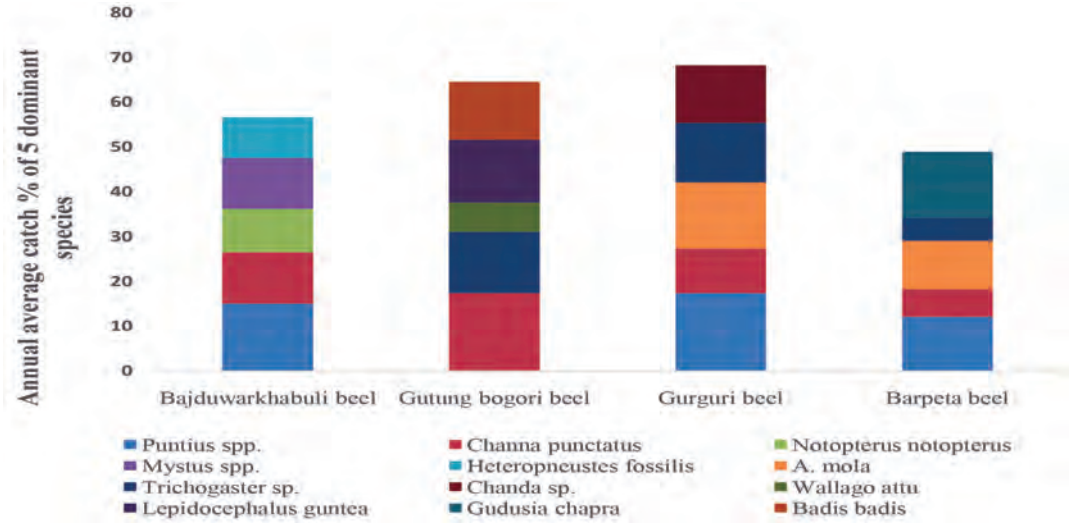


Thermal tolerance of the selected fish species

FISHERIES OF WETLANDS IN RELATION TO CLIMATE VARIABILITY

The information on ecology, catch composition and reproductive potential of fish species from four wetlands of Nagaon (Barpeta and Gurguri) and Lakhimpur (Bajduarkhabuli and Gutung-Bogori) of Assam coming under low and high rainfall climatic zones respectively were collected in relation to climatic variables (temperature and rainfall). Physico-chemical parameters were estimated seasonally and no significant variation was observed among the four wetlands except for water temperature and depth. Water level of the wetlands was directly related to difference in annual rainfall received in the Nagaon (low rainfall) and Lakhimpur (high rainfall) districts. Total catch and species composition of the *beels* showed considerable variation that may be attributed to climatic variability with respect to precipitation received in the two districts (and the beels therein) with influence on reproductive success of their fish species. Fish yield from Barpeta, Gurguri and Bajduarkhabuli over a decade showed positive correlation with the rainfall however the correlation was not significant.

The preliminary data in comparison with earlier records indicated that catch of Indian major carps from these beels apparently diminished because of loss of riverine connectivity. *Beels* with more depth and rich growth of submerged aquatic macrophytes faced wide seasonal variations in water level and area might have supported breeding and survival of higher number of indigenous fish species including *Channa* spp., *Heteropneustes*

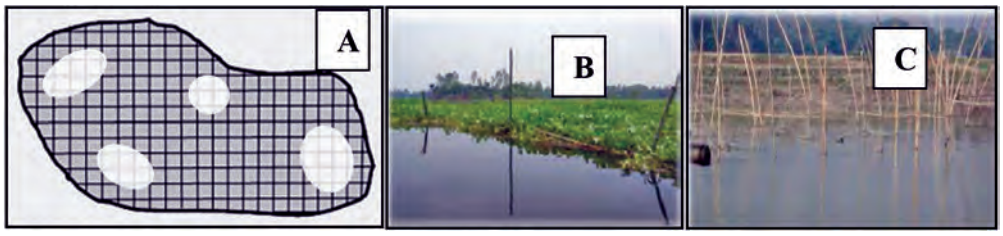


Annual average catch % of five most dominant species in the selected wetlands

fossilis and *Mystus* spp. The beels experiencing lower rainfall and less macrophyte infestation witnessed moderate seasonal variations in water levels and seemed to have supported breeding and survival of lesser number of indigenous fish species especially *Puntius* spp., *Pseudambassis* spp., *Macrognathus* spp. and *Amblypharyngodon mola* etc.

CLIMATE RESILIENT ADAPTATION STRATEGIES

ITKs from four wetlands of West Bengal were studied and climate change adaptation strategies were documented. The pictorial documentation of some of the ITKs practiced in the wetlands as a strategy to overcome impacts of water stress and macrophyte proliferation is depicted below.

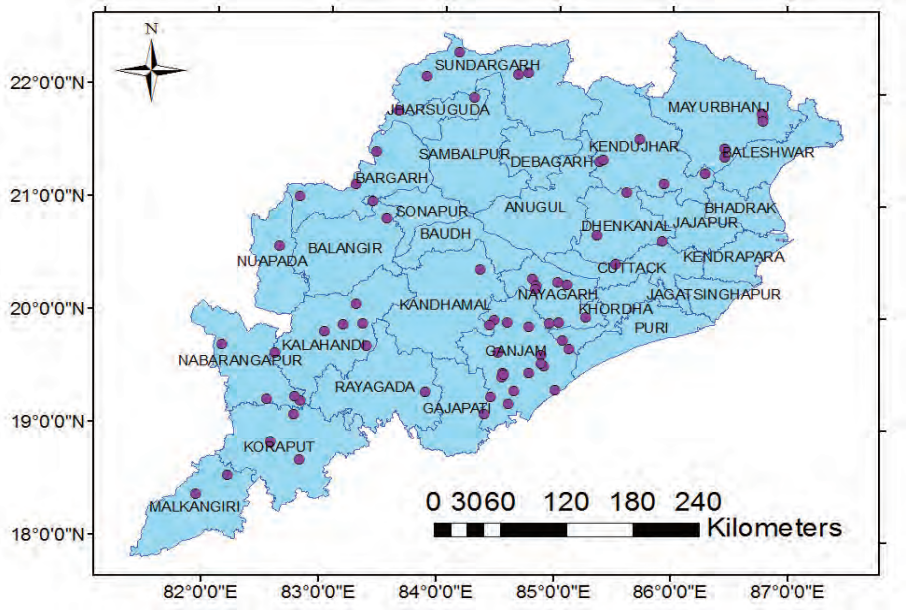


Climate change related adaptation strategies for wetland fisheries [A. Deep pool refuge based fishery, B. Weed refuge based fishery, C. submerged branch pile based fishery

RESOURCE ASSESSMENT AND MODELLING

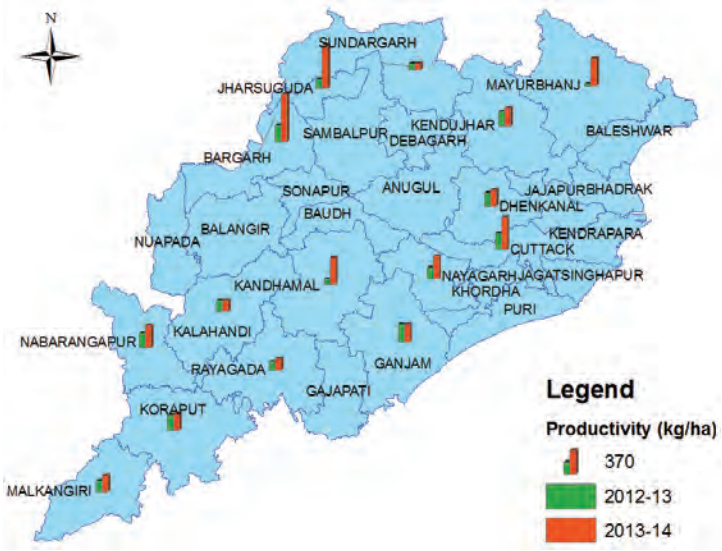
RESOURCE MAPPING IN GIS PLATFORM

A total of 70 small reservoirs were covered under SC & ST Development Program by Govt. of Odisha for the productivity enhancement in those reservoir and livelihoods development of SC and ST fishers. The list of reservoirs, their location, area and production information were provided by Fisheries Department, Govt of Odisha. Based on the location (village name and district) the position of the reservoir was mapped in Google earth manually. After mapping of these reservoirs, their district wise locations were presented in GIS platform. The dots in the district represent the location of the reservoirs.



District wise reservoirs considered for resource mapping

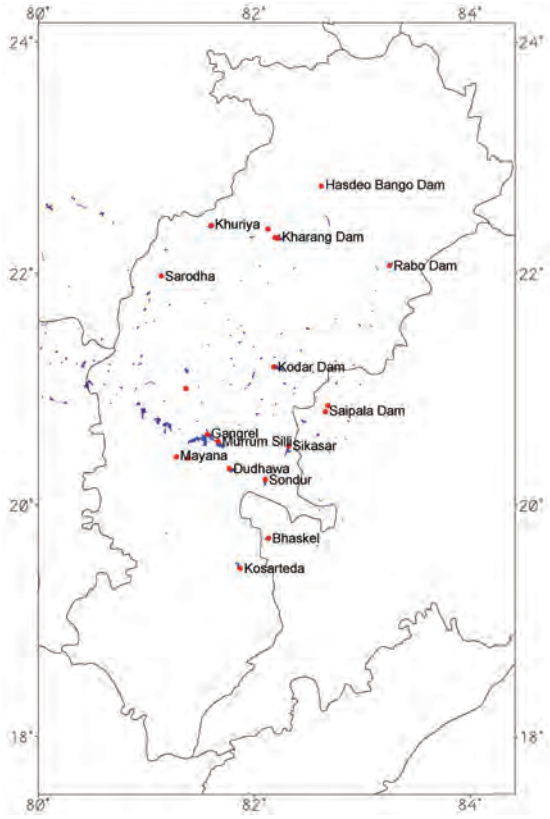
District wise productivity for the year 2012-13 and 2013-14 were calculated using the information provided by the Fisheries Department, Odisha. The productivity map was presented in the GIS platform. From the productivity map it is quite clear that in the district of Mayurbhanj the change in productivity from the year 2012-13 to 2013-14 is quite high. Similarly the GIS maps were also prepared for district wise reservoir fish production per fisher per year and a district wise gradient map as per the reservoirs undertaken for fisheries development. The thematic maps will help the decision makers to take right decision, find out the opportunity for fisheries development.



District wise reservoir productivity of Odisha

WATER LEVEL FLUCTUATIONS IN RESERVOIRS

Reservoirs are major water resources identified for fish production enhancement. However, due to seasonal monsoon and long day period in a year, water levels in reservoirs may vary grossly making decision on fish stocking and fisheries in reservoir difficult. The present study has measured round the year water fluctuations in selected reservoirs that would facilitate decision making on reservoirs fisheries development.



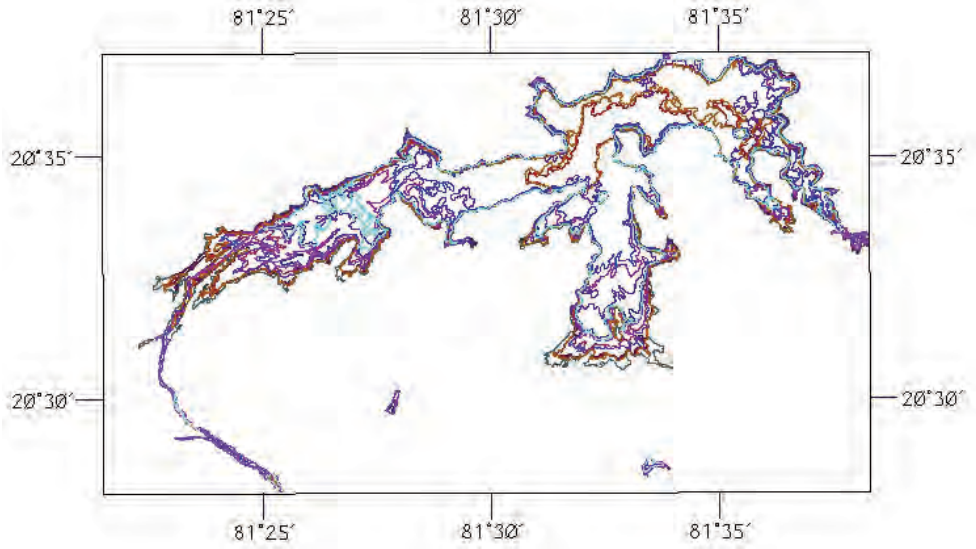
Location of reservoir in Chattishgarh and Odisha

Monthly Variation of surface water area in different Reservoirs of Chattishgarh and Odisha

A total of 54 Remote sensing imageries (Landsat-8) of different date of pass were procured starting from January 2015 to December 2015 for Chattishgarh and Odisha. Each image is having 11 numbers of bands. Selected water bodies were delineated for different months using band no 3,4,5 and 6. Initially Normalized Difference Water Index (NDWI), Normalized Difference Built Index(NDBI) and Normalized Difference Vegetation Index (NDVI) were derived using band 3,4,5,6 and then it was transformed to HIS (Hue Intensity and Saturation). Surface water area was delineated on the basis of Hue, Intensity and Saturation.

Gangrel reservoir

Gangrel Dam, also known as the Ravi Shankar Sagar Dam, was constructed in 1979 across the Mahanadi River. It is located in Dhamatari District. It is the longest dam in Chhattisgarh. This dam supplies water for the purpose of irrigation throughout the year. The dam also supplies 10 MW of hydro-electric power. The water area of the reservoir is 94.50 km^2 at Full reservoir level but in year 2015 the maximum water area for the reservoir was 8453 ha (in the month of October 2015). Water area of Gangrel reservoir started reducing from the month of January 2015 and reduced to 4157 ha in the month of May 2015. The present analysis shows that there is 46.4% variation in water area around mean water area. The water area has reduces to 43% percent of its full reservoir level (FRL) area in lean seasons.

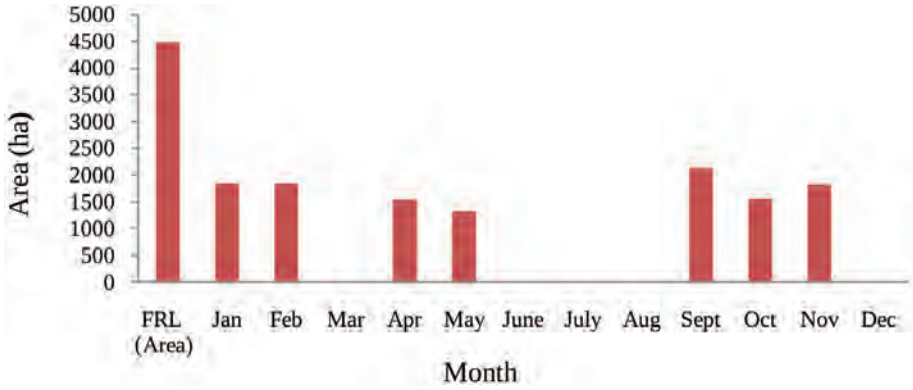


Change in water area in different months of reservoir Gangrel

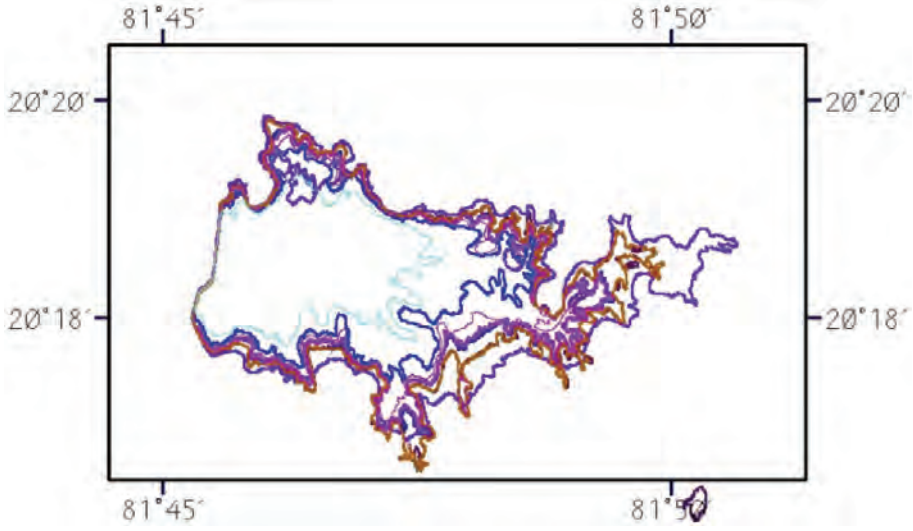
Water area of Gangrel reservoir in different months

Dudhawa reservoir

Dudhawa Dam is located in Dhamtari district of Chattisgarh. It is built across the Mahanadi river in the village of Dudhawa, 21 km from Sihawa (the origin of River Mahanadi) and 29 km from Kanker. The height of the dam is 24.53 m and the length 2,906.43 m. At the Full Reservoir Level (FRL) the submerged area of reservoir is 44.84 km^2. In the year 2015, Dudhawa reservoir was having maximum water area (2134 ha) in the month of Sept and started shrinking from the month of November. However, the minimum water area (1328.5 ha) encountered in month of May. From the present analysis, it was found that there is 18% variation in water area around the mean water area of the reservoir, while water area reduces to 30% percent of its FRL (Full Reservoir Level) Area in lean season.



Water area of Dudhawa reservoir in different months

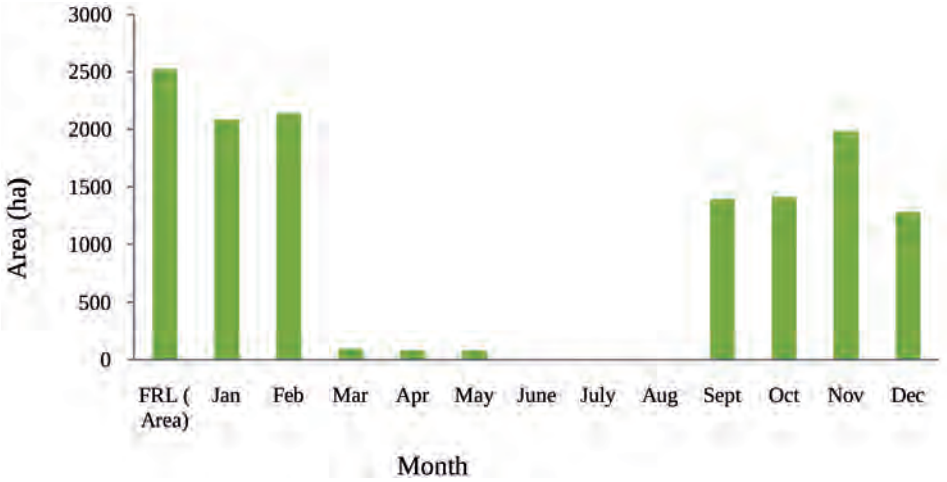


Water area of Dudhawa reservoir in different months

Murrum Silli reservoir

Murrum Silli Dam, is an earth-fill embankment dam on the Sillari River, a tributary of the Mahanadi River, which is located in Dhamtari District of Chhattisgarh. FRL Area of Murum Silli dam is 25.25 km^2. In year 2015, the reservoir the maximum area of the

reservoir was recorded in the month of February (2139 ha) and minimum 79 ha in the month of May 2015. The month wise trend in fluctuation is given in fig. Again after monsoon it reaches to 1984 ha in the month of November. Analysis showed that there is 81% variation in water area around mean water area of reservoir.

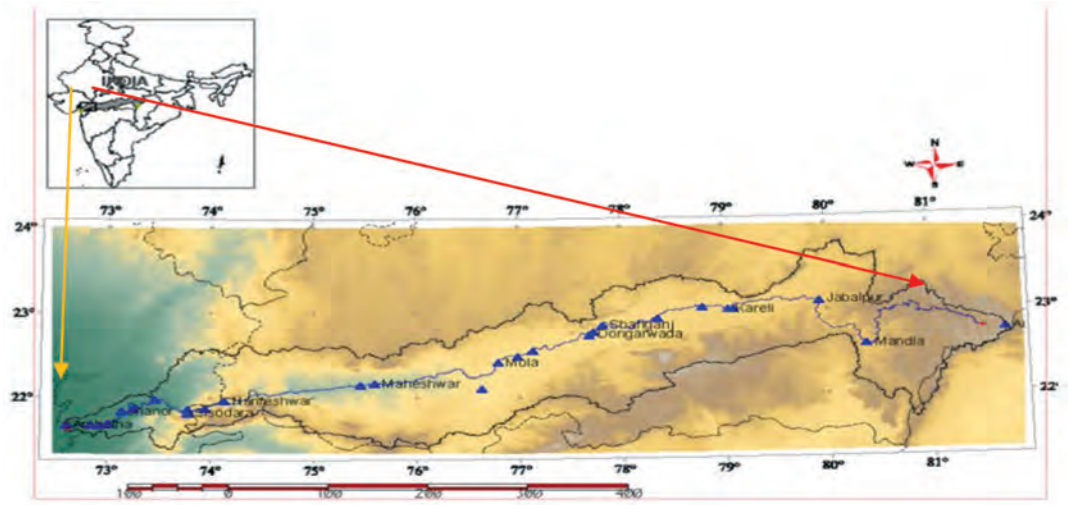


Water area of Murrum Silli reservoir in different months

Summarily for other reservoirs the variation of water area were delineated. The delineation of water area in different months will help the decision makers to take decision on how much seed to be stocked in the reservoirs and fisheries management options for fisheries development. Also the selection of site for cage aquaculture can be judged if delineated water area is known.

MODELLING ECOLOGY OF RIVER NARMADA

The study area is located on the Narmada River spanning between latitude 21°.20´N and 23°.45´N and longitude 72°.32´E and 82°.45´E. The whole study area was segmented into four stretches viz. (a) Amarkantak to Gadarwada (b) Below Gadarwada to Harsud (c) Below Harsud to Surpan and (d) Below Surpan to Gulf of Cambay. Six to nine sites were identified on each stretch and samples from 28 sites have been collected.

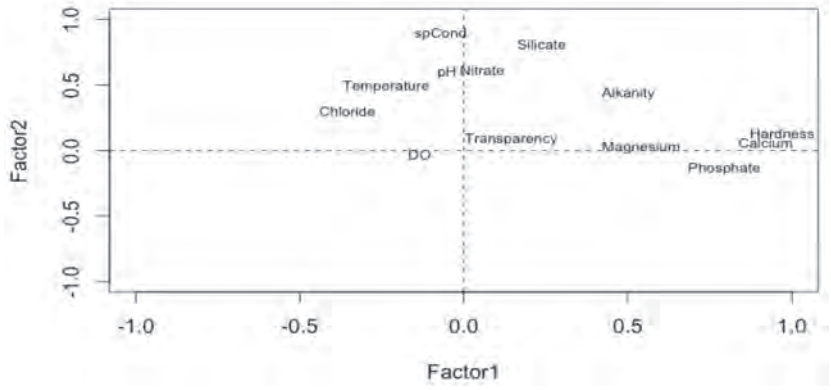


The study area

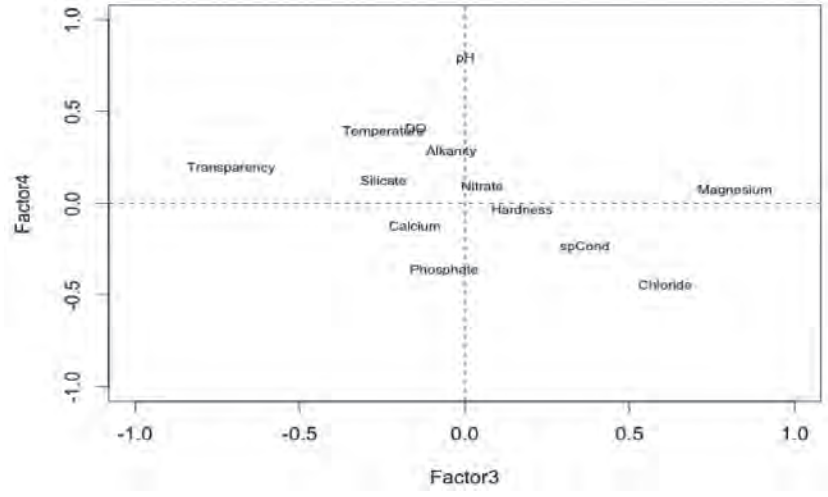
The data was prepared on the basis of an exploratory survey on the river Narmada. The data on 13 physic-chemical parameters of water quality, *viz*. water Temperature (°C), Transparency (cm), D.O. (mgl^{-1}), pH, Total Alkalinity (mgl^{-1}), Sp. Cond (µmhos cm^{-1}) , Ca (mg l^{1}) , Mg (mg l^{1}), Total Hardness (mg l^{1}), Chloride (mg l^{1}), Phosphate (mg l^{1}), Nitrate (mg l^{1}) and Silicate (mg l^{1}) for each of the 28 sites were extracted from secondary source of CIFRI bulletin (Singh, S.N., 2009). The abundance data on phytoplankton and zooplankton was also compiled and processed to quantify the effect of water quality on plankton abundance.

Water quality

To characterize the water quality in fewer dimensions after eliminating correlation, multivariate factor analysis was performed to extract hidden factors. It was observed that four factors cumulatively explained 85% variation and 5 factors cumulatively explain 92% variation of water quality of the river. However, characterization was restricted to only four factors, considering the tradeoff between ease to interpretation and accuracy. The first factor comprising of calcium, phosphate and total hardness of water explains 32.5% variability. The phosphate, a component of nutrient of aquatic system, dominates it. Second factor, a synthesis of silicate, nitrate, pH, sp. conductivity, is dominated by silicate. Since silicate is required for growth of diatoms, we may call this factor as productivity potential of the river aquatic system. Third factor is a differential effect between transparency and magnesium. It can be renamed a water clarity. The fourth factor represents the pH.



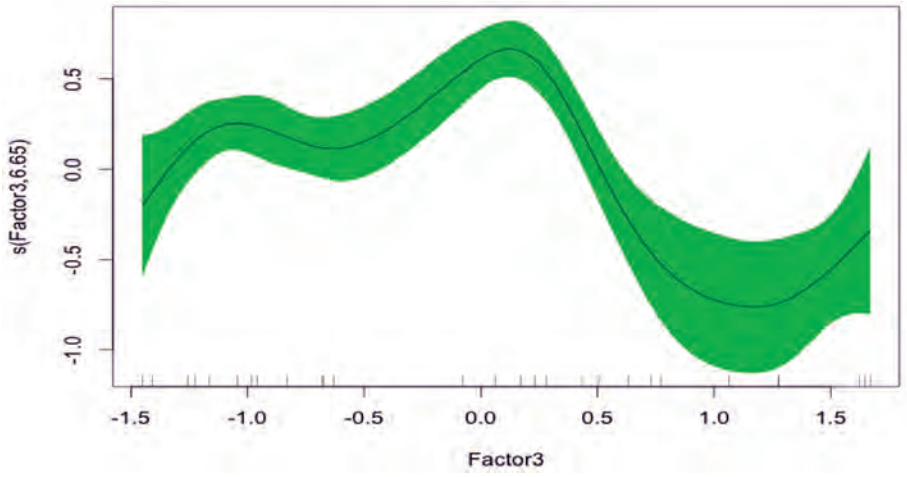
Loadings of water quality parameters on factor 1 and factor 2



Loadings of water quality parameters on factor 3 and factor 4

Model-based inference on plankton abundance in relation to water quality

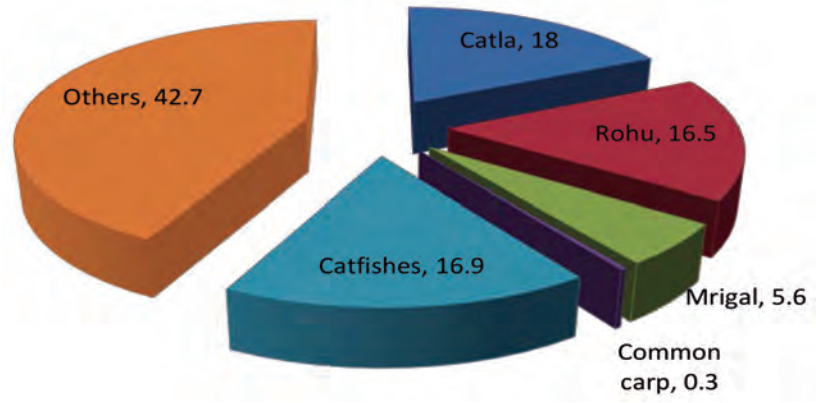
Two types of models viz., Generalized Linear Model (GLM) and non-linear Generalized Additive Models (GAM) were applied to make model-based inferences on plankton abundance in relation to water quality characterized by extracted four factors. For phytoplankton abundance, R^2 values were 0.36 and 0.38f or GLM and GAM respectively. It implies non-linear model could not improve the R^2 value. Considering simplicity the interpretation was done on the basis of the results of GLM. It was found that all the four factors were significant for explaining phytoplankton abundance. The relative importance of factor 3 (i.e. water clarity) with negative effect is highest among all the four factors. For the zooplankton abundance, GAM performed better (R^2 = 0.86) than the GLM (R^2 = 0.76) in terms of R^2 value. The factor1 (productivity potential) has highest positive linear significant effect on zooplankton abundance. However, factor3 (water clarity) has non-linear effect on zooplankton abundance.



Plankton abundance pattern against factor 3 (water clarity)

Development of Electronic Data Acquisition System (e-DAS)

The trial implementation of electronic data acquisition system (e-DAS) was done at Tunga and Manchanbele reservoirs in Karnataka and species-wise fish catch data were collected from these reservoirs on daily basis. There was an estimated total fish catch of 54.1 t from Tunga reservoir and the fishery was dominated by catla (18.0%) followed by catfishes (16.9%), rohu (16.5%) and mrigal (5.6%). Miscellaneous fishes contributed 43.0% to the total fish catch.



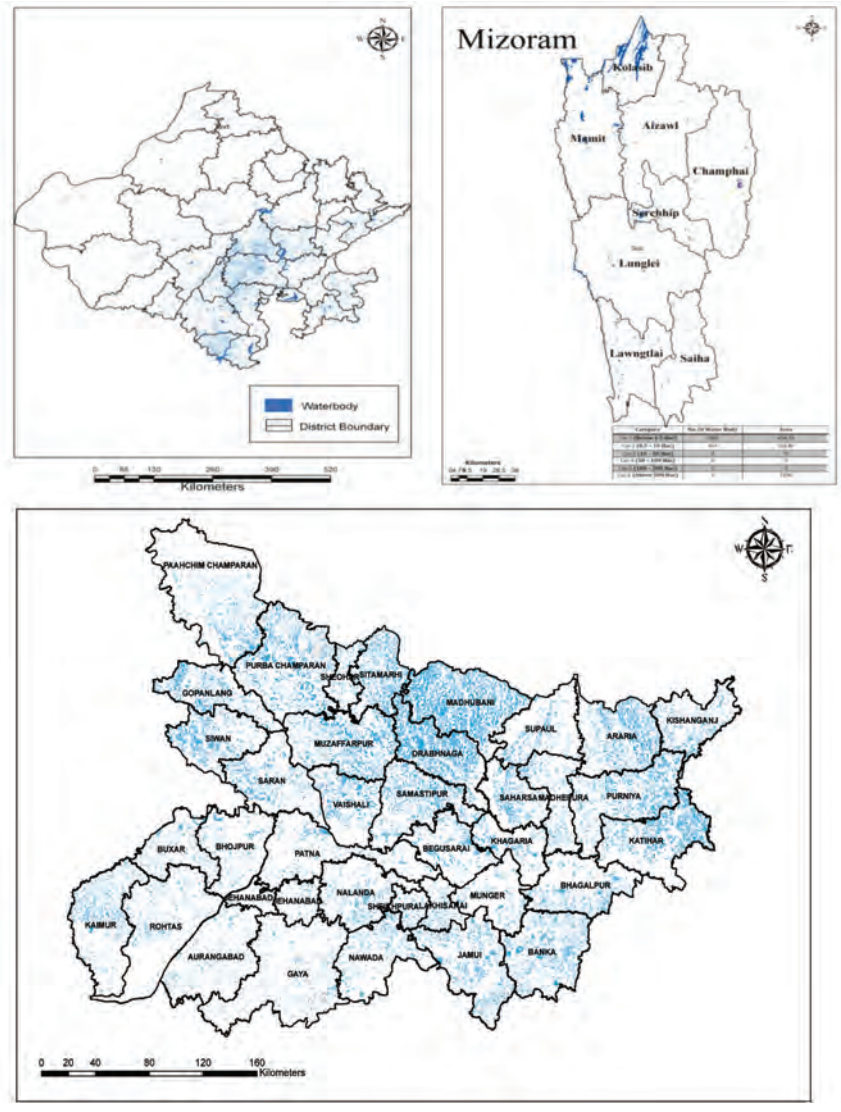
Fish species composition in Tunga reservoir during 2015-16

DATABASE AND GEOGRAPHICAL INFORMATION SYSTEM

This year catch assessment and GIS and remote sensing training has been given to officials from Odisha and Andhra Pradesh. Training has also been provided for e-Atlas navigation, open source GIS software and GPS navigation. A new version of the catch assessment survey manual has been prepared. The schedule for catch assessment has been reduced to two pages instead of three to simplify it for field investigators. An optional schedule was prepared for database enhancement.

In continuation with the generation of e-atlas user manuals, additions have been made for Chhattisgarh, Uttar Pradesh, Odisha, Maharashtra, Kerala and Punjab. They provide users with details of steps required to navigate through the software provided. Training with respect to the software has been provided to two state fishery officials from Odisha.

Water bodies from the state of Rajasthan, Mizoram and Nagaland can now be visualized in compatible tools like TNT-MIPS, ARC GIS and other open source GIS and RS soft-wares. Water bodies from Bihar have been modified for updating information. For greater efficiency of route planning during field verification, e-Atlas of Gujarat was revised by including the road layer and important places at taluka scale.

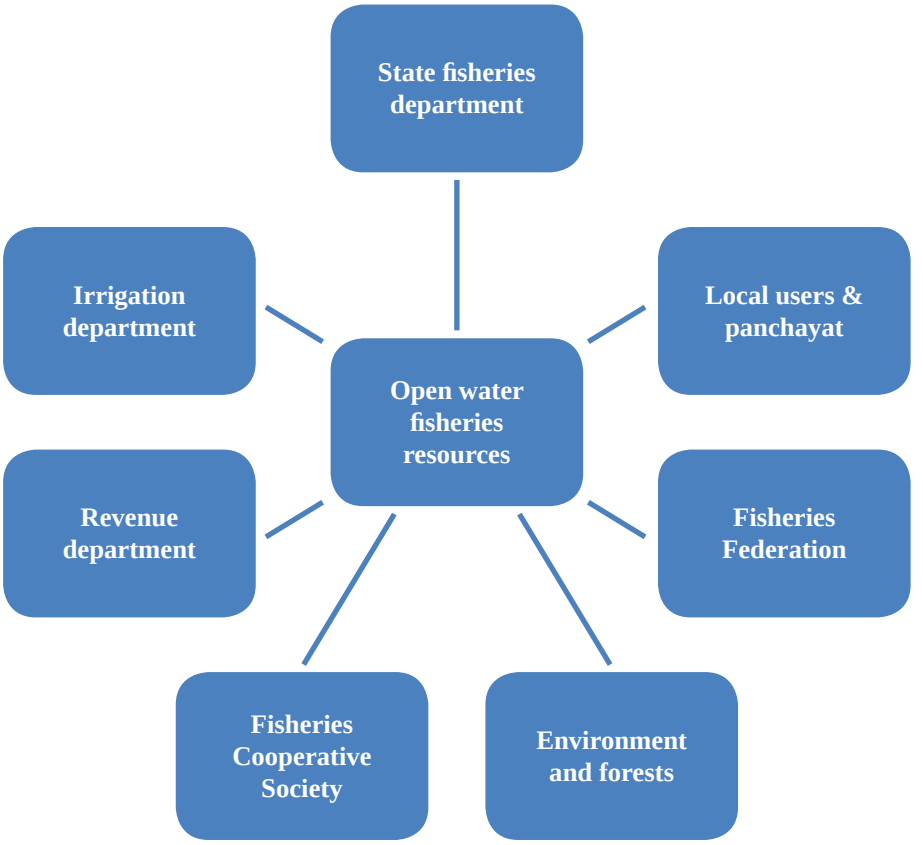


Delineated water bodies of Rajasthan Mizoram and Bihar

FISHERIES SOCIO-ECONOMICS

INSTITUTIONAL ARRANGEMENTS AND FISHERIES GOVERNANCE

Chhattisgarh state was selected for studying institutional arrangement and governance in the inland open water-bodies. There are three categories of available water resources in the state, viz., village ponds, irrigation tanks and reservoirs. The total area under Reservoirs in the state is 88700 ha. Survey revealed that a large number of stakeholders are involved in open water fisheries management in Chhattisgarh. Besides the Revenue, Fisheries, Panchayat, Cooperative, irrigation and Environment and Forest departments, others like Chhattisgarh Cooperative Fisheries federation, Fisheries Cooperative societies, and Local bodies, Fishers, end users and water users of the reservoirs are other stakeholders.



Stakeholders in inland open water fisheries in Chhattisgarh

Leasing system: Based on primary and secondary information available the leasing system of open water fisheries resources in the state was studied. The leasing right of water bodies upto 10 ha lies with Gram Panchayat. The water resources from 11-100 ha is with Janpad Panchayat. The leasing authority of water bodies of around 200-1000 ha is given to Fisherman cooperative society by Department of fisheries.

Leasing rights of water resources of Chhattisgarh

Area	Authority
10 ha	Gram Panchayat
100 ha	Janpad Panchayat
100-200 ha	Jila Panchayat
200-1000	Fisherman cooperative societies
1000-5000 ha and above	CG Matsya Mahasangh

Water Resources above 1000 ha to 5000 ha is allotted by the Chhattisgarh Matsya Mahasangh on royalty basis. Lease period on each case has been extended for 7 years, from earlier 5 years, and the lease rent is ₹ 2000/- per ha with an annual increment of 10%. The priority to get lease of water resources is as follows:

1. Registered Fishermen Cooperative
2. Fishermen group
3. Individual fisherman
4. Persons displaced on account of submergence
5. Self Help Group in absence of above four

Governance of reservoirs

Two reservoirs, namely, Ravi Shankar Sagar (Gangrel) and Dudhwa reservoir were studied for fisheries institutional arrangement and details are given in Table below. Both the reservoirs are located on River Mahanadi having geographical coordinatesof 20°34´ latitude and 81°34´ longitudes.

Institutional governance mechanisms of reservoirs in Chhattisgarh

Institutional mechanism	Ravishankar reservoir	Dudhawa reservoir
Total catchment area	3670 sq. km	621 sq. km
Gross storage capacity	909.3 mcm	288.68 mcm
Water spread area	9540 ha at FRL	4486 ha at FRL
Water level fluctuation	348.70 - 336.21 m	425.12 - 409.96 m
Area of reservoir	6935 ha	2500 ha.
Water distribution	Yes	No
Ownership	Department of Irrigation, CG Govt.	Department of Irrigation, CG Govt.
Management rights	Department of Fisheries, CG Govt	CG apex fisheries cooperative federation
Fishing Rights	Joint Board of 10 cooperative societies	Individual Fishers (private)
Lease amount	12.5 lakh per year (10% increase every 2 year	50 lakhs (10% increase every 2 year
Closed season for fisheries	16th June to 15 August	16th June to 15 August
Production per ha	Data not available	200 kg/ha

LIVELIHOOD ASSET MAPPING OF FISHERS

The livelihood assets mappings of fisher of Ganga basin is a sincere attempt to assess five assets of livelihood, *viz*., natural, physical, human, financial and social assets. For the year 2015-16 the Pakurdistrict of Jharkhand, namely, Saran, Siwan and Gopalganj districts of Bihar and Varanasi and Allahabad districts of Uttar Pradesh were surveyed with a structured interview schedule. The preliminary analysis shows that the livelihood issues and assets of fishers of Ganga basin in these states are distinctive.

Jharkhand: In Pakur district 91% of the sampled population belong to fishermen caste (SC) with poor literacy rate. As per the Census 2001, the literacy rate in the district is only 30.65%, where-as among the fishermen community the literacy rate is 49%, which is lower than the average national literacy rate. The main source of income of that community is fishing and annual income from fishery is ₹ 47390/-. Other than fishery, they are also work as labour in stone chip mines etc.which contribute 44% to the total family income.About, 40% of the members of the fishermen community are indebted due to social obligations like daughter's marriage etc. and their average indebtedness is ₹ 11000/-.

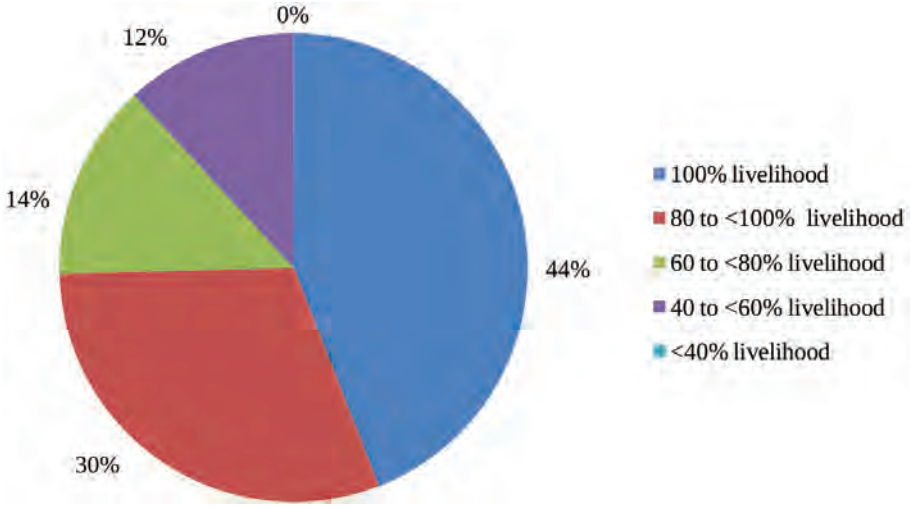
Uttar Pradesh: The average annual income of fishers of the Varanasi district is Rs. 42000/- where the average family size is 7. Almost all the fishermen are illiterate and due to financial constraint they are unable to send their children to schools. In Allahabad district, the average annual income from fishery is ₹ 46000/-. Only 17% fishermen have membership in fishery cooperatives society. The fish marketing system is organized, though fish markets are not specified in Allahbad city area, which also causes lower income of the fishermen. The literacy rate of the fishermen is 56%. Due to low income, fishers are now switching over to other jobs, like labourer etc.

Bihar: The literacy rate among fishers household of Siwan is 65%, with low literacy among female members. The annual average income of fishers' household from fisheries activities were ₹ 60000/-. Around 50% of the fishers household have Kisan credit card. Many aquaculture farms have come up in last three four years in this district. Average literacy rate of Saran was 65.96, with male and female literacy were 77.03 and 54.42 respectively. The literacy rate among fishers household was 60%, with low literacy among women. The average annual income of fishers from fisheries activities were ₹ 48000/-. Riverine fishers of Pahlejaghat stretch of Ganga River do fishing in Ganga for 4 months and for rest 8 months in a year many of them migrate to Rihand reservoir in Sonbhadra district of Uttar Pradesh on wage basis. The literacy rate among fishers of Gopalganjwas 48%, with very low literacy among female. The average annual household income from fisheries was ₹ 53000/-. Fishers involved in aquaculture has high income compared to the riverine fishers. Fisheries sector occupies an important place in socio-economic development of thecountry and it is the source of livelihood fora large section of economically backward population of the country. It has also beenrecognized as a powerful income and employment generator as itstimulates growth of a number of subsidiary industries, and is a source of cheap and nutritiousfood besides being a foreign exchange earner. So, in these three states, the sustainable inland fisheries should be promoted to secure livelihood of the fishermen community.

VALUATION OF GOODS AND SERVICES

The Deepor *Beel* in Assam is a Ramsar site and was selected for the study. Deepor *Beel* is considered as one of the large and important riverine wetlands in the Brahmaputra valley of lower Assam, India.The contribution of the *beel* in livelihood and employment generation of fishermen was studied. Also, the tourism potential of Deepor *beel* was estimated using travel cost method. The study revealed that nine villages in the vicinity of the *beel* and around 850 households were involved in fishing. Moreover, during Feb-March fishers from neighboring villages also fish in the wetland. The *beel* provided at

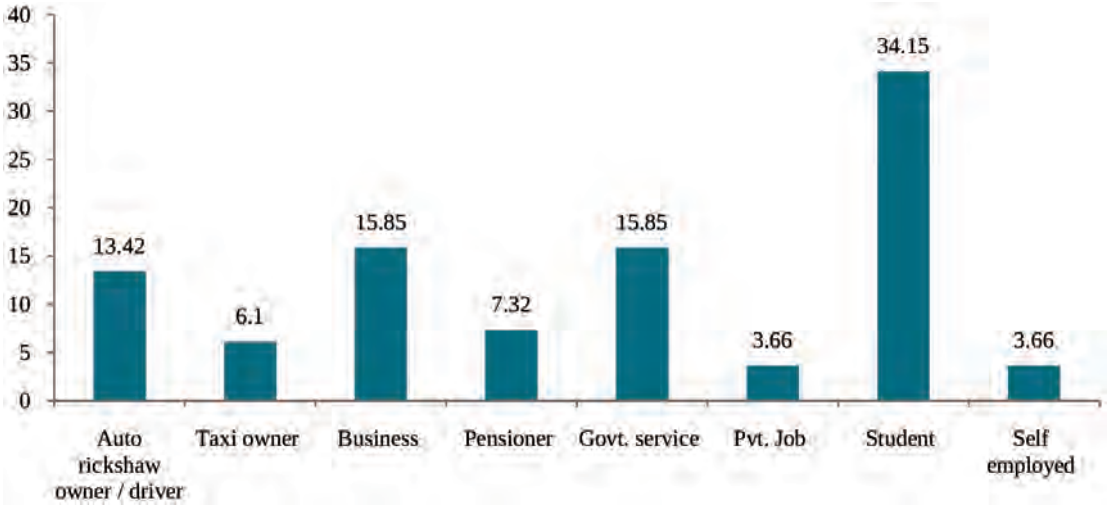
least 40% livelihood to all the fishermen household and about 45% households derived full livelihood from the *beel*.



Contribution of Deepor *beel* in livelihood of fishers households

It was estimated that employment generated through fishing was 65.3 thousand man-days per year and the *beel* provided full time employment to 45% of the households. It was also observed that the *beel* fishes were the only source of animal protein to 71% fishermen households and it was one of the major protein sources to 29% households.

Economic value of tourism provided by the Deepor *beel* was studied by interviewing 100 visitors from across different backgrounds like students, Govt. servants, businessmen, pensioners, auto rickshaw driver/owners.



Occupation pattern of the visitors to the Deepor *beel* (% of respondents)

'Travel Cost Method' was used to estimate the economic use values associated with Deepor *beel* ecosystems that are used for recreation. The relationship between number of visits and other variable was regressed using primary data.

By applying the concept of utility function, the functional equation was expressed as:

VISITS_NUM = f (FS, INC, EDU, GEND, EXP)

ANOVA models are used to assess the statistical significance of the relationship between quantitative and qualitative variables and can be accomplished within the framework of regression analysis. For present analysis, the following model was applied:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 D_1 + \beta_5 D_2 + U_i$$

Where, Y = Dependent variable
β_0 = Intercept
$X_1 \ldots X_3$ = Quantitative independent variable
D_1 and D_2 = Dummy or qualitative variable
U_i = Error term

The number of visits in a year was the dependent variable. The explanatory (independent) variables were of 2 categories *viz*, quantitative variables and qualitative variable. The quantitative variables included Family size, Monthly income and Money spent on visiting Deepor *beel*. The qualitative variables were Gender and Education for those dummy variables were used.

Estimates of the variables indicated that family size, expenditure are highly significant factors in explaining the variances of travel expenditure.

Estimation of consumer surplus

Peoples' willingness to pay to visit the site can be estimated based on the number of visits that they make at different travel costs. By finding consumer surplus of the individual visitors we can estimate the tourism potential of the tourism site. Our study showed that the estimated consumer surplus was ₹ 160/visitor and the Tourism value of the beelwas estimated to be ₹ 16 lakh. However, this value seems to be in lower side keeping in view the location and size of the beel. Presently, except a watch tower and bill board showing list of the birds visiting the beel, no infrastructure is visible. Therefore an attempt was made to elicit the visitors' suggestion to increase the potential of tourism.

Visitors' suggestions for improving facilities at Deepor *beel*

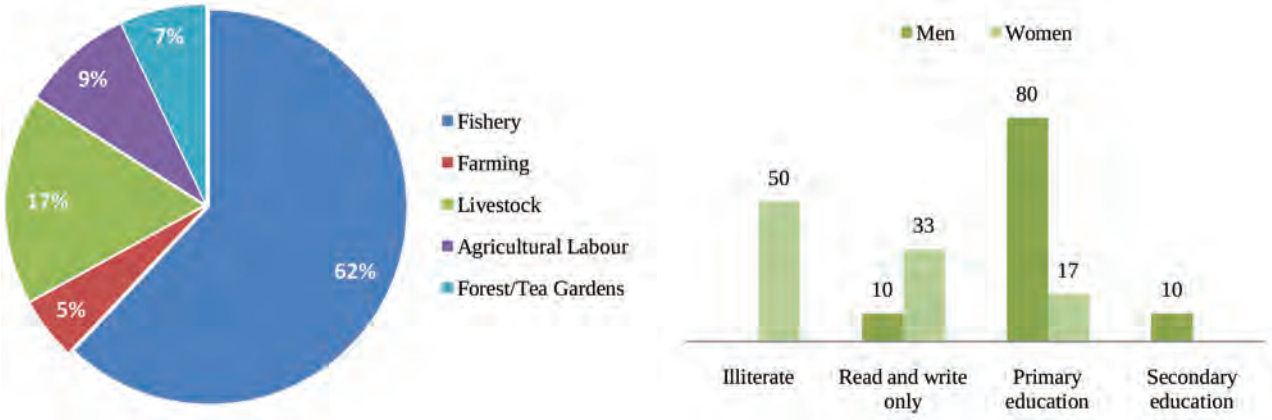
Facility	% of visitors
Improved Road Condition	19.51
Toilet/Lavatory	93.90
Transportation facilities	50.00
Precautionary Signs	42.68
Parking facility	74.39
Food Stalls/ drinking water	76.83
Boating facility	74.39
Toy train	30.49
Accommodation	24.39
Waste Disposal/ Cleanliness	91.46
Parasailing	1.22
Bird watching place	4.88
Angling facility	1.22

Majority of the visitors demanded facilities like toilet, parking facility, food stalls/ drinking water, boating facility and waste disposal/cleanliness and 76% of visitors suggested that money for infrastructure would come from imposing entrance fees and funding by the Government. The study found that the on an average each visitor were willing To Pay (WTP) ₹ 33.75 for bird sanctuary and ₹ 13.17 for picnic spot of the *beel* as entrance fees.

SOCIO-ECONOMIC EVALUATION OF FISHERS OF TORSA RIVER

Among the important rivers of sub-Himalayan Terai region of West Bengal, Torsa is one of the major river and lifeline of a major number of native populations. These rivers swell up enormously in the rains and almost dried up in winter.

Survey revealed that the fisher folk of Torsa river area have annual average family income of ₹ 46574/- and average hand holdings of 1.25 *Katha*. Most of them have *kachha* houses.



Family income and education of the fishers along the Torsa river

Along the upper stretch from Totopara to Jaldapara of river Torsa, involvement of women in fishing activities was higher. It was found that about 52% of the women of fishermen community are grossly involved in fishing and 48% are involved in fish marketing. Moreover, women are involved in other livelihood activities like livestock rearing and marketing and tea garden labourer, etc. Among women, 50% illiteracy was found. The average annual income of the woman-headed family is ₹ 37250/-, which is lower than the average income of man-headed family, i.e., ₹ 53100/-. Fishing/fish harvesting from Torsa River contributes 62% to average family income of a fishermen family, followed by livestock rearing (17%), agricultural laborer (9%), and Tea garden/ Forest laborer (7%) and from farming (5%). The fisher family spends their maximum expenditure on food items (59%) and it is a ray of hope that they utilize almost 16% percent of family expenses for children education. The Rabhas tribe belong to the Indo-Mongoloid group of people and bears similarities with other members of Bodo group such as *Garos, Kachari, Mech, Koch, Hajong* and others. Rabhas are found in 13 States in Indian, but in significant numbers are found in Assam (352,000), followed by Meghalaya (37,000), West Bengal (23,000), Arunachal Pradesh (3,300), Nagaland (2,700) and Mizoram (200).

Traditional fishing gear of *Rabha* tribe

Dry prawns and SIFs for Nishuchepa preparation

Rabhas are unique matri-lineal society with rich socio-cultural inheritance. Agriculture is the main livelihood adopted by them. In earlier days they used to follow *Jhumor* shifting cultivation, butcultivate rice, pulses, mustard, vegetables etc. now-a-days. In addition to agriculture, considerable sections of the *Rabhas* are engaged in fishing. Rabhasfish from rivers, streams, rivulets, wetlands for their livelihood. Female are involved in community fishing with hand-made traps, called *Jhakoi* and other traps like *Tapai*, *Thusi*, *Burung*, etc. The *Rabhas* are fond of small indigenous fishes and prawns. They prepare dry fish powder, called *Nishuchepa*, from dry prawn or small fishes for future use. Fishing is an important activity in the life of the *Rabha* people, and it is assimilated in their culture in the form of dance, which is performed by the women-folk of the Rabha community for depicting their daily lives. *Rabha* tribes perform dance with melodious music wearing colorful costumes. Fishing dance is one of the important dances performed by the Rabha women among the other dances like welcome dance, celebration dance and war dance.

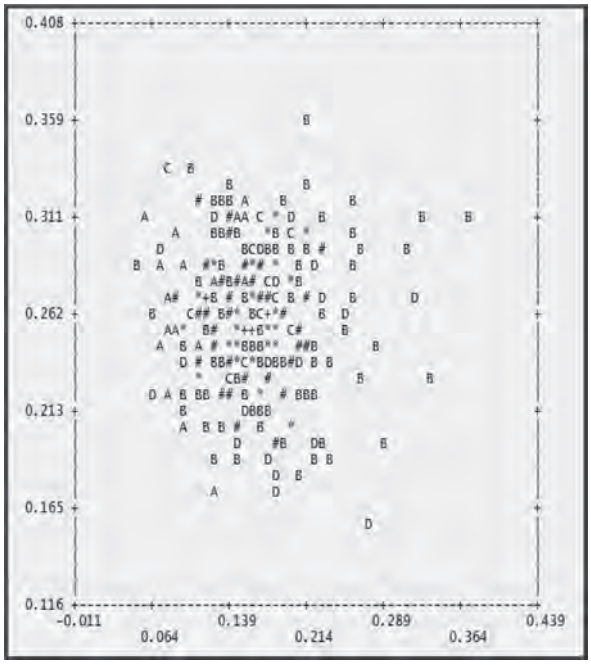
OUTREACH ACTIVITIES

GENETIC DIVERISTY OF *LABEO GONIUS*

The samples of *Labeo gonius* were collected from the representative stations of different rivers *viz*. Mahanadi, Ganga, Teesta, Narmada and Brahmaputra have been collected. The morphometric measurements were recorded. The spawning season of *L. gonius* was recorded during July-September and it has annual spawning frequency. The fecundity was observed to be 1, 87,757nos/kg body weight. The Maturity ($L_{50\%}$) was attained at 27.0 cm of size. The truss analysis revealed the degree of morphological homogeneity among the stocks of Brahmaputra, Ganga, Narmada and Teesta rivers. The mitochondrial Cytochrome b gene (n=213), ATPase 6/8 gene (n=204) and D-Loop (n=66) of *L. gonius* have been PCR amplified and sequenced. The sequences have been submitted to NCBI GenBank and Accession numbers received (Cytochrome b gene: KJ801820-KJ801824, KP201607-KP201634, KT005332-KT005343, KU577402, KJ864914-KJ864922, KT005322-KT005331, KP211959-KP211991, KP205273-KP205284, KU577379-KU577401, KU577403-KU577405, KP201576-KP201606, KU577354-KU577365, KU577366-KU577378, KU577406-KU577426 ; ATPase 6/8 gene: KT001131-KT001151, KU686232-KU686246, KU686294-KU686295, KT005344-KT005384, KU686222-KU686231, KU686303-KU686333, KU686247-KU686276, KU686297-KU686302, KU686360-KU686363, KU686277-KU686293, KU686296, KU686334-KU686359 ; D Loop gene: KP676861-KP676883, KP676818-KP676860).

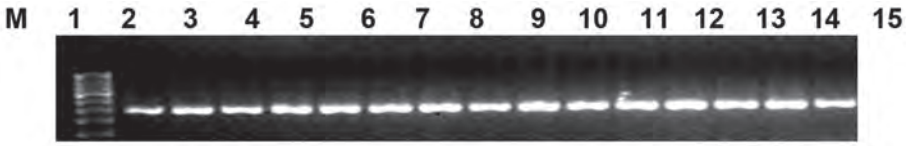
Morphometric measurements of *L. gonius*

Traits	*Labeo gonius* (n=94, unit: cm)			
	Minimum	Maximum	Mean ± SE	CV (%)
Total length	17.27	36.65	28.06±2.97	10.58
Fork length	14.73	32.18	24.68±2.72	11.00
Standard length	13.35	29.46	22.63±2.51	11.11
Head length	2.95	6.82	4.68±0.73	15.51
Pre-orbital length	0.62	1.64	1.10±0.20	18.40
Eye diameter	0.77	1.57	1.02±0.20	19.51
Pre-dorsal length	6.09	13.98	10.39±1.29	12.37
Pre-pectoral length	3.00	6.92	4.92±0.75	15.21
Pre-pelvic length	7.00	16.47	12.39±1.54	12.39
Pre-anal fin length	10.29	24.41	18.39±2.22	12.07
Caudal fin length	4.08	7.39	5.73±0.71	12.43
Body depth	3.82	9.08	6.75±0.93	13.74



Bivariate plot: PC2vsPC3

Sheared PCA of morphometric measurement of *L. gonius*



Amplification of Cytochrome b gene (307bp) from *L. gonius* M- 100bp DNA Marker, Lane 1-15

NUTIENT PROFILING OF FISHES

Nutritive value of several Indian food fishes are unknown. In continuation with last year activity, nutrient composition of few more fish species have been determined.

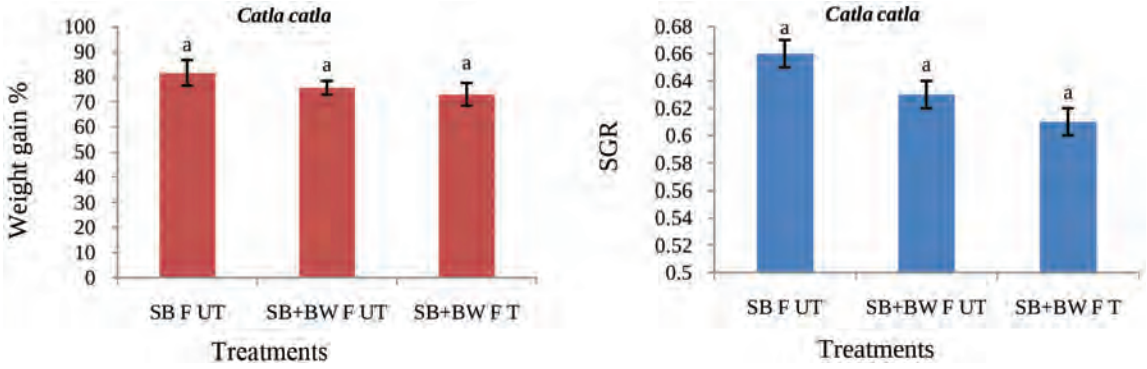
- Proximate composition of *Notopterus notopterus*, *Chitala chitala*, *Liza parsia*, *Pampus argenteus*, *Johnius coitor* showed that *Notopterus notopterus*, *Chitala chitala*, *Pampus argenteus* are medium fat containing fishes (4-8% fat) where as *Liza parsia* and *Johnius coitor* are lean fishes (fat <2%) and contain high amount of protein.
- Volatile composition of Hilsa was studied by static headspace GC-MS analysis. A total of 42 volatiles have been identified among which some of the compounds contributing to its unique flavor was identified. 2, 4-hexadienal and 2,4-Pentadiene-1-ol, 3-ethyl-(2Z) have been identified as possible freshness indicators; similarly, 2-methyl-1, 5 hexadiene and 7-Heptadecyne-17- chloro could be possible spoilage indicators.
- Proximate composition of 12 species of fishes from the Chilika lagoon in Odisha has been completed and the Database “Nutritional composition of food fishes from India” has been updated with this information.
- Clinico-epidemiological surveys on fishermen community regular fish eating and the cohorts from non-fishermen community showed that fish consumption has a positive effect on the health status of regular fish consuming population.

FEED FOR CAGE CULTURE OF CARPS

Effect of brewery waste based diet on growth, feed utilization and nutrient retention

Catla catla

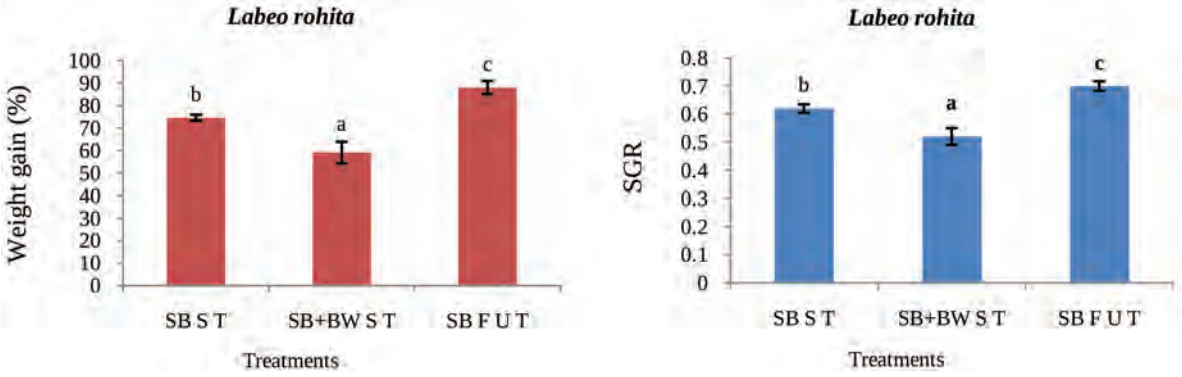
Total dependency on artificial feed in cage fish culture system necessitated incessant search for nutritionally sound economic ingredients for profit optimization. A balanced suitable feed is key to successful cage fish farming. In this direction a feeding trial was conducted in Maithon reservoir to test the efficacy of different forms of feed and replacement of soybean meal by brewery waste on growth performance, feed utilization, nutrient retention and biochemical composition of *Catla catla*. Overwintered seeds of Catla with average size of 70-85g were stocked in HDPE net cages of 5×5×3.5m dimension fitted in GI frame. The fishes were fed with experimental diets @ 5% of the body weight twice a day at two equal instalments at 10.00 hr and 16.00 hr during the feeding trial. Growth monitoring was carried out at monthly interval. In case of Catla, no significant difference ($p>0.05$) was observed in weight gain %, SGR and feed conversion efficiency between fish groups fed with floating feed containing treated and untreated brewery waste as ingredient. Similarly, feed containing soybean meal and 50% replacement of soybean with untreated brewery waste yielded insignificant differences in weight gain %, SGR and feed conversion efficiency after 90 days feeding trial. However, 50% replacement of soybean meal by brewery waste gives economic benefit of ₹ 4.45 per kg of feed (16.4 % cost reduction) in comparison to soybean based feed.



Weight gain (%) and SGR of *Catla catla* fed with experimental diets

Labeo rohita

Another experiment was conducted to test the efficacy of floating and sinking feed and replacement of soybean meal by brewery waste involving Rohu, *Labeo rohita* in Maithon reservoir. Overwintered seeds of Rohu with average size 35-50g were stocked in HDPE made cages having dimensions of 5×5×3.5 m fitted to a GI frames. The fishes were fed with experimental diets @ 5% of the body weight twice a day at two equal installments at 10.00 hr and 16.00 hr during the experimental trial. Growth monitoring of fishes after 90 days of feeding trail revealed significant difference in weight gain %, SGR and feed conversion efficiency ($p<0.05$) between fish groups fed with floating and sinking pellets, and soybean based and 50% replacement ofsoybean with untreated brewery waste after 90 day of feeding trail. Highest growth rate was observed in *Labeo rohita* fed with soybean based floating feed. Significantly lower ($p<0.05$) weight gain and specific growth rate was noted in treatment group where 50% of the soybean meal was replaced by brewery waste. However the flesh quality analysis revealed fat accretion (10 times) in all the treatment groups after the feeding trial. However, 50% replacement of soybean meal by brewery waste gives economic benefit of ₹ 4.45 per kg of feed (16.4 % cost reduction) in comparison to soybean based feed.



Weight gain (%) and SGR of *Labeo rohita* fed with experimental diets

SPECIES DESCRIPTION/ NEW RECORDS

Barilius torsie, a new species of cyprinid fish (Cyprinidae: Rasborinae) recorded from river Torsa, Brahmaputra drainage, India

***Barilius torsie*: lateral aspect of holotype, 71.41 mm SL (ZSI-FF5542)**

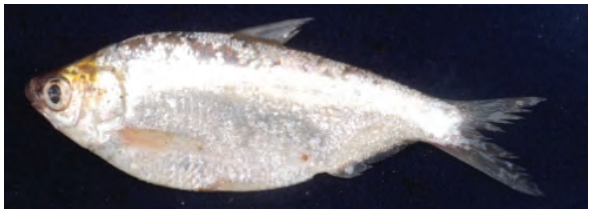
***Barilius torsie*: lateral aspect of paratype, 74.56 mm SL (ZSI-FF5543)**

New record of Indian hill trout *Barilius bendelisis* (Cypriniformes: Cyprinidae) and *Chagunius chagunio* (Cypriniformes: Cyprinidae) from Kangsabati river, West Bengal.

Barilius bendelisis

Chagunius chagunio

***Garra lamta* from river Ganga**



***Gonialosa modesta* from river Mahanadi**

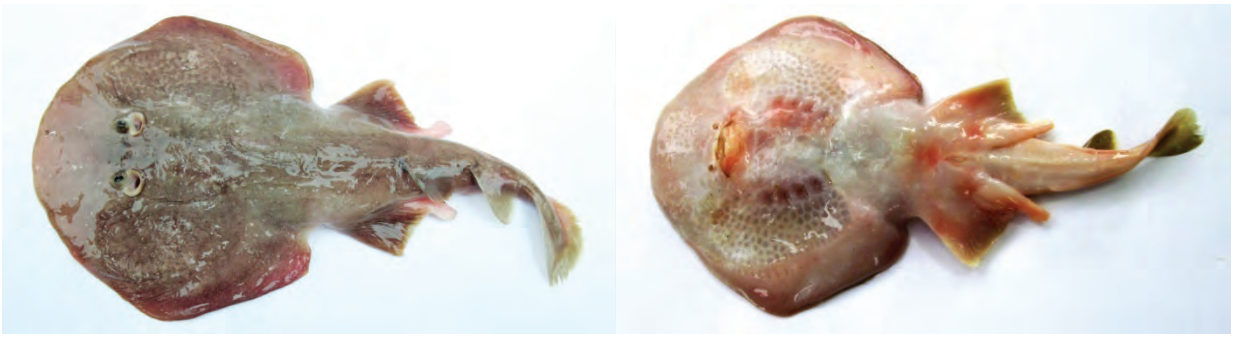
***Armina babai* from Northern Bay of Bengal**

***Zebrias synapturoides* from Chilka Lagoon**

***Favonigo biusreichei* from Chilka Lagoon**

***Neotropius atherinoides* from Chilka Lagoon**

***Taenioides anguillaris* from Chilka Lagoon**



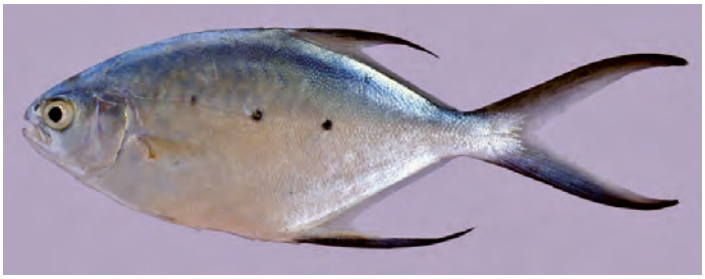
***Narcine timlei* from Chilka Lagoon**

***Johnius borneensis* from Chilka Lagoon**

***Taeniamia macroptera* from Chilka Lagoon**

***Carangoides oblongus* from Chilka Lagoon**

***Trachinotus botla* from Chilka Lagoon**



***Trachinotus baillonii* from Chilka Lagoon**

***Caranx papuensis* from Chilka Lagoon**

***Carangoides ferdau* from Chilka Lagoon**

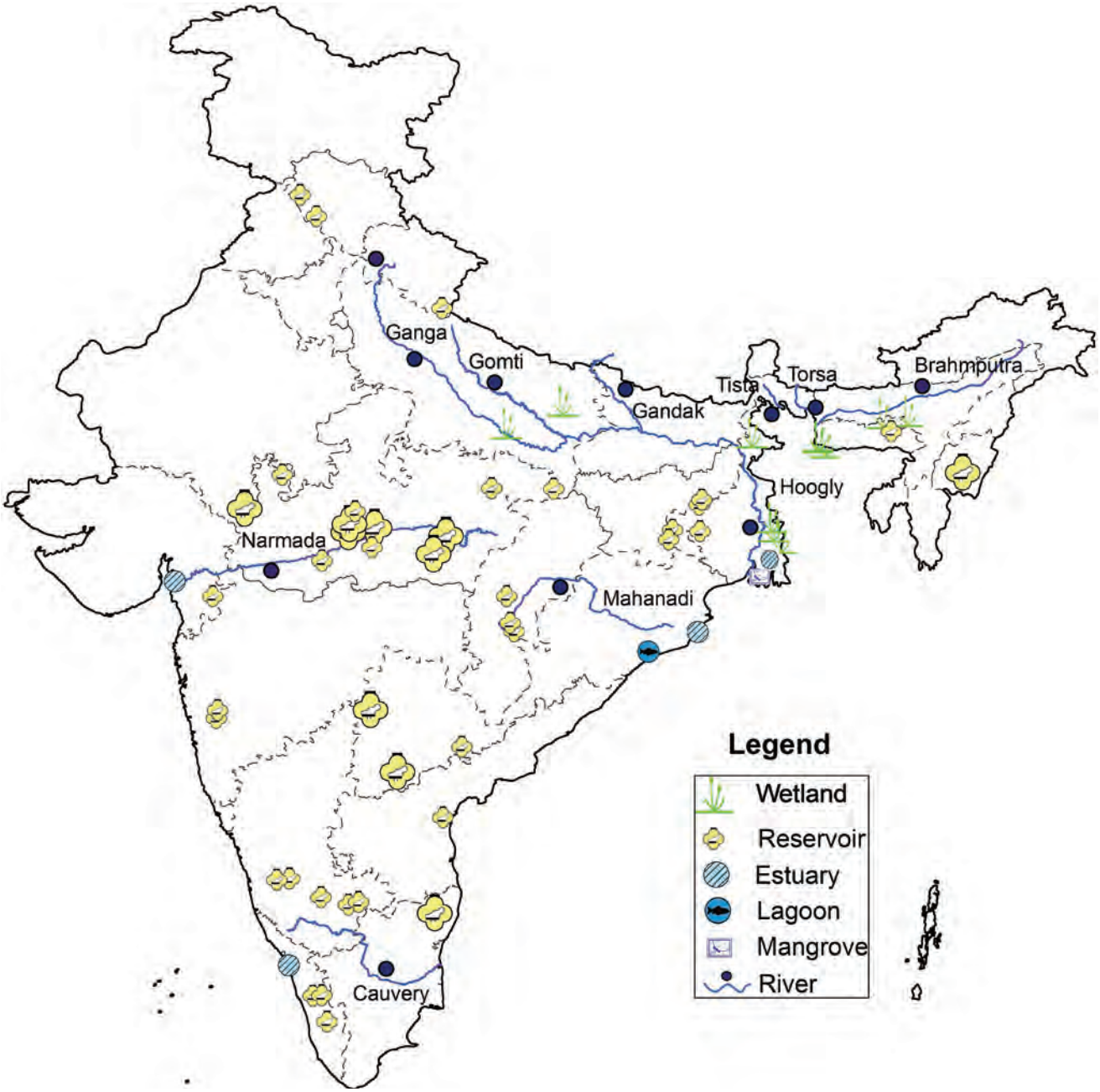
***Trachicephalus uranoscopus* from Chilka Lagoon**

STATE WISE OUTREACH OF CIFRI

During 2015-16, ICAR-CIFRI conducted research on following resources

States	Rivers	Estuaries	Reservoirs	Wetlands	Lagoons
Himachal Pradesh			Gobind Sagar, Pong		
Uttarakhand	Ganga		Nanak Sagar		
Uttar Pradesh	Ganga, Gomti		Rihand	Gujwar, baghar	
Jharkhand			Chandil, Panchet, Maithon, Hatia		
Madhya Pradesh			Indirasagar, Bansagar, Gandhi Sagar, Tawa, Halali, Barna, Kolar, Kerwa, Bargi, Bheemgarh		
Odisha	Mahanadi	Mahanadi	83 nos reservoirs		Chilika
Bihar	Gandak				
Assam	Brahmaputra			Deepor, Mer, Damal, Sorbhog, Sukdol-Sarubori	
West Bengal	Torsa, Teesta, Hooghly	Sundarban	Kansabati, Maithon	Akaipur, Khalsi, Bhomra, Garapota	
Gujarat	Narmada	Narmada	Ukai		
Kerala		Korapuzha	Peechi, Pothundi, Malankara		
Maharashtra			Dhom, Bhatghar		
Chhattisgarh			Dudhwa, Ravishankar Sagar, Murrum Silli		
Andhra Pradesh			Paleru		
Telangana			Wyra, Nizam Sagar, Dindi		
Karnataka	Cauvery		Tunga, Jambadahalla, Mallaghatta, T G Halli, Nagavara		
Tamil Nadu			Kelavarapalli		
Meghalaya			Umiyam	Boro, Katuli, Kumligaon	
Manipur			Loktak		
Rajasthan			Mahi		

STATE-WISE OUTREACH OF ICAR-CIFRI



DEMONSTRATION AND TRANSFER OF TECHNOLOGY

NEH ACTIVITIES

ICAR-CIFRI initiated and executed the following programs for demonstration, popularization and up-scaling of fisheries technologies in NEH region:

Demonstration of pen culture in Mer *beel*, Assam

Raising fish fingerlings in pen enclosures has emerged as a viable option to enhance fish production from floodplain wetlands (*beels*) of Assam. Pen aquaculture demonstration was undertaken in Mer *beel*, Nagaon district, Assam by ICAR-CIFRI Regional Centre, Guwahati in collaboration with AFDC Ltd., Guwahati, Assam. Four pens (each of 0.25 ha) were constructed using net-lined bamboo screens in the *beel* and stocked with six fish species namely, *Labeo rohita, Catla catla, Cirrhinus mrigala, Ctenopharyngodon idella, Hypophthalmichthys molitrix* and *Labeo gonius*. Average weight of fish after 5 months of culture was 150.9 g with a weight gain of 311%.

Pen culture demonstration at Mer *beel*, Assam

Representatives of ICAR-CIFRI and AFDC Ltd. at Mer *beel*

Fish stock enhancement in Sorbhog *beel*, Assam

To enhance fish production from *beels*, ICAR-CIFRI Regional Centre, Guwahati in collaboration with AFDC Ltd., Guwahati, initiated fish stock enhancement programme in Sorbhog *beel*, Barpeta district of Assam. The Institute demonstrated scientific fish seed stocking methods in the *beel* by stocking fingerlings of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* (@ 3,000 nos. ha^{-1}). After 3 months of stocking, it was observed that rohu was performing well with SGR of 1.28, followed by catla (SGR 0.85) and mrigal (SGR 0.41).

Representatives of ICAR-CIFRI &AFDC Ltd during fish seed stocking in Sorbhog *beel*

Stocking of fish seed at Sorbhog *beel*, Assam

Collaborative pig-cum-fish farming

The first pig-cum-fish farming demonstration was initiated by ICAR-CIFRI in collaboration with ICAR-NRC on Pig, Rani, Kamrup, Assam during 2014-15. A pond of 1.1 ha was stocked with fingerling of *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Cyprinus carpio, Ctenopharyngodon idella* and *Barbonymus gonionotus*. CIFRI recommended stocking of fish @ 8000 nos ha^{-1} and 18 nos. of piglets (2-3 months old) were housed in shed constructed on the bank of the pond. Integrated fish farming with piggery provided a viable option for employment generation and increasing household income.

Pig-cum-fish farming at ICAR-NRC on Pig, Assam

Cage culture in reservoirs of Himachal Pradesh

Cage culture in Govindsagar and Pong reservoirs of Himachal Pradesh is being implemented by the Institute in collaboration with Directorate of Fisheries, Government. of Himachal Pradesh and ICAR-Central Institute of Fisheries Technology (CIFT), Kochi. A total of forty eight (48) HDPE floating cages (6m × 4m × 4m) have been installed at Bhakra in Govindsagar and Khatiyar in Pong reservoir. Fish seed of *Pangasianodon hypophthalmus* were stocked. The fish seeds are being reared in cages and supplemented with artificial feed to grow to marketable sizes in close association with the fishers' cooperative societies of the two reservoirs.

Cages installed at Govindsagar Reservoir, Himachal Pradesh

Cage culture of fish in model village Sitaabari, Maithon

The cage culture of fish model village Sidhabari, West Bengal was organized by ICAR-CIFRI on 25th April 2015 in collaboration with Damodar Valley Corporation at Maithon dam, Sidhabari village, Asansol. The programme was organized to create awareness amongst the stakeholders and villagers on utilization of existing open water resources to augment fish production and generate livelihood through cage culture. The programme was attended by more than 300 participants including villagers, officials from Damoder Valley Corporation and scientists from ICAR-CIFRI, West Bengal University of Animal and Fisheries Sciences and other ICAR institutions. The programme began with inauguration of cage culture by the honourable Chief guest Shri Babul Supriyo, honourable Minister of State for Urban Development Housing and Urban Poverty Alleviation, Government of India by releasing 16,000 *Pangasioanodon hypophthalmus* fingerlings in presence of guests of honors Dr. (Mrs) B. Meenakumari, DDG (Fy), ICAR, New Delhi, Shri B. D. Sahu, Coal Coordinator & Project Head, DVC, Maithon, Shri G. P. Singh former Coal Coordinator & Project Head, DVC, Maithon, Jharkhand and Prof A. P. Sharma, Director ICAR-CIFRI, Barrackpore.

Release of fish seed in cages by Shri Babul Supriyo, honourable Minister of State for Urban Development Housing and Urban Poverty Alleviation, Government of India

TRIBAL SUB PLAN PROGRAMME

The Institute planned and executed TSP programme to uplift socio-economic conditions of tribal fishers in different parts of the country through training, input supply, society formation, etc. towards enhanced aquatic productivity, employment generation, food and financial security, and resource conservation.

Uttar Pradesh

Fisheries development activities were conducted in tribal area of Chandan Chouki, Paliya in Lakhimpur Kheri district of Uttar Pradesh under TSP. Awareness cum training programme were organized and fish seeds (440 kg) were distributed to tribal fish farmers and stocked in their water bodies during August 2015 and November 2015. Also about 12 t of fish feed and 5 t of lime were distributed among tribal fish farmers. Growth of the stocked fishes in selected tribal ponds in the area was also monitored.

The average fish production from the region has considerably increased from <1.5 t ha^{-1} before CIFRI's initiative to 3.0-4.3 t ha^{-1}. Further, the tribal farmers expanded fish farming activities in all the available patches of ponds and derelict water spread areas in the region, owing to intensive awareness campaigns, trainings and empowerment efforts initiated by the Institute. There is good demand of fish in the region and fish marketing is not a constraint.

Monitoring of fish growth in the tribal ponds

West Bengal

With the objective to enhance fish yield from available aquatic resources and increase income of the tribals, the Institute initiated activities in the tribal area of Sagar Island of Sundarban, West Bengal. 6400 Indian major carp (*C. mrigala, C. catla* and *L. rohita*), *L. bata* and *Puntius sarana* fingerlings were released in three fresh water bodies of total 0.29 hectare and 3100 fingerlings of *Rhinomugil corsula, Liza parsia, Mugil cephalus* and *Mystus gulio* in two brackish water bodies of total 0.12 ha in village Khansahebabad of Sagar Island. The tribal fisherwomen along with male fishers took active part in fish seed stocking in the respective ponds. Water and soil quality of these water bodies were also analyzed and based on water and soil parameters, 100 kg lime and 100 kg fish feed were supplied. The tribal fisher folk were educated on various fish farming practices in general and pond management in particular.

Pre-stocking field survey, water quality and fish food organisms monitoring were done in three canals (total area: 7.0 ha.) under Kalitala Gram Panchyat, Hingalganj district in Sundarbans, West Bengal. A total of 35000 advanced fingerlings of Indian major carps were stocked in three canals to benefit 41 tribal fisher families. Five days field training on "Post stocking management practices for carp production in

Operation of cast net by fisherwomen

Release of fish seed in freshwater bodies

canals of Sundarbans" were organized at Kalitala during 29-30 September 2015 and 4-6 February 2016. Drag net (*Ber jal*) were distributed to tribal fishers of three canals under Kalitala Gram Panchyat.

Karnataka

The Bangalore Research Centre of the Institute organized a mass awareness program on safe fishing by using fiber glass coracles on 7 February 2016 in Wayanad District of Kerala. The programme was aimed at empowerment of unemployed tribal youth of the tribal belt in the Wayanad District of Kerala. Each fisherman was given coracle for fishing.

Seventy two tribal youths were empanelled as members of the fisherman cooperative society, mainly by the joint efforts of scientists of ICAR-CIFRI and the Kerala State Fisheries Department. The society was supplied with mercantile marine department approved life jackets. With adoption of the Institute technology in Karapuzha reservoir fish catch has increased from 18 kgha^{-1} to 150 kgha^{-1}. The Institute provided Bamboo coracles to the active fishermen of this Tribal Fisheries Co-operative society on a previous occasion.

Smt. P. K. Jayalekshmi, Minister for Tribal Development and youth welfare, Kerala handing over the Fiberglass coracle to the Tribal fisherman of Nellarachal Scheduled Tribe Fishermen's society, Wayanad, Kerala

Mass awareness programmes to showcase the technologies developed by CIFRI on Reservoir Fisheries as well as Cage and Pen culture was also arranged.

Two brochures in vernacular Kannada were distributed on the following themes:

1) Scientific management of reservoirs for sustained fish production
2) Cage culture of fish in reservoirs.

AWARDS AND RECOGNITIONS

Personnel	Recognition
Dr. U. K. Sarkar	Felicitated at the National Level Young Scientists Meet - 2016; Prof. H.L. Chaudhuri Commemorative Conference organized by Zoological Society, Kolkata in collaboration with Department of Zoology, University of Calcutta, for outstanding contribution in the field of fish diversity and conservation during 4-6 February, 2016.
Dr. B. P. Mohanty	Felicitated by the Society for Veterinary Biochemists and Biotechnologists of India at its Annual Convention-2016, for 'Outstanding Contribution in the field of Biochemistry, Bitotechnology and Allied subjects during 11-12 March, 2016.
Dr. D. N. Jha	Young Scientist Associate - 2016 award during "18th Indian Agricultural Scientists & Farmers Congress" organized by Bioved Research Institute of Agriculture, Technology & Sciences, Allahabad, during 20-21 February, 2016.
Dr. A. K. Sahoo	Young Scientist Recognition by Zoological Society of India, Kolkata, on 4 February, 2016.
Shri Ganesh Chandra	Awarded 'SURE Distinguished Scientist' for outstanding contribution in the field of 'Fisheries Extension' from Society for up-liftment of Rural Economy, Varanasi at National Conference on Rural Livelihood security through innovative Agri-entrepreneurship at ICAR-CPRI Station, Patna, during 12-13 March 2016.
Dr. R. K. Manna	Best oral presentation award in International conference on Aquatic Resources & Sustainable Management, Science City, Kolkata during 17-18 February, 2016 on 'Major factors influencing fish species spectrum in floodplain wetlands of Assam' authored by Manna, R. K., Aftabuddin, Md., Suresh, V. R. and Sharma, A. P.
Mr. Jayanta Mukherjee	Best poster presentation award as co-author in National Seminar on Hilsa fisheries and Conservation organized by IFSI and SoFTI at CIFRI, Barrackpore 18th November, 2015 on 'Size distribution, recruitment and exploitation of juveniles of Hilsa in Hooghly Bhagirathi river system' authored by Mukherjee Jayanta, Sandhya, K. M., Sajina, A. M., Suresh, V. R., Manna, R. K., Behera, B. K., Banik, S. K. and Kar, S.
Dr. Rohan Kumar Raman	Best Paper oral presentation for technical session IV inNational Seminar on Recent Advances in Statistical Tools for Agriculture and Allied Sciences, BCKV, Kalyani, Nadia, West Bengal, during 3-5th March 2016 on "Clinico epidemiological study to correlate the health benefits of fish consumptions on maternal and child health-A cross sectional study at Farakka, West Bengal" authored by "Rohan Kumar Raman, SatabdiGanguli, ArabindaMahanty, TandrimaMitra, Debajit Das, PrasenjitParia, Tanuja Abdulla, P. K. Parida, B. K. Behera, Md. Aftabuddin and B. P. Mohanty.
Shri Vikash Kumar Ms. Suvra Roy	Awarded with Netaji Subhas - ICAR International fellowship for the year 2015-16 for PhD studies in overseas university
Ms. Suvra Roy	Best poster presentation award in National Level 'Young Scientists' Meet-2016; Prof H.L. Chaudhuri Commemorative Conference organized by Zoological Society, Kolkata in collaboration with Department of Zoology, University of Calcutta, during4-6 February, 2016 on 'In silico structural and sequence based characterization of fatty acyl Δ6 desaturase from *Pangasianodon hypophthalmus*' authored by Suvra Roy, Vikash Kumar, H J Chakraborty, B K Behara, R.S. Rana, Subodh Gupta, Gopal Krishna and Gireesh Babu P.
Ms. Niti Sharma	Awarded Best M.F.Sc student 2014-2015 by ICAR-CIFE, Mumbai on 6th June, 2015. During her master degree programme, she studied on "Toxicity studies of silver nanoparticle at genomic and cellular level in *Labeo rohita* (Hamilton, 1822)" from Fish Genetic and Breeding Division.

Shri Ganesh Chandra receiving the 'SURE Distinguished Scientist' award

DOCTORATE DEGREE

Shri Manas H. M. received Ph.D degree in Fisheries Science with specialization in Fisheries Resource Management for thesis entitled "Seasonal Distribution, Abundance and Nutritional Profile of Caulerpa Species along Northwest Coast of India" on 7th April, 2016 from ICAR-Central Institute of Fisheries Education, Mumbai.	
Shri Lianthuamluaia received Ph.D degree in Fisheries Resource Management for thesis entitled "Pattern of aquatic biodiversity and trophic status of Savitri (Ranbajire) Reservoir in Raigad district, Maharashtra" on 7th March, 2016 from ICAR-Central Institute of Fisheries Education, Mumbai.	
Ms. Kavita Kumari received Ph.D degree in Fish Biotechnology for thesis entitled 'Characterization of CYP1A gene in *Catla catla* and Evaluation of its Expression as Biomarker for Xenobiotic Pollution' on 8th December, 2015 from ICAR-Central Institute of Fisheries Education, Mumbai.	

NOMINATIONS

Dr. V. R. Suresh	Member, National level Committee for cage culture development in inland water bodies, NFDB.
Dr. K.D. Joshi	Nominated as member of the High Power Committee constituted by National Green Tribunal (NGT), Principal Bench, New Delhi for Kanhar irrigation project in Sonbhadra district of U.P.
Dr. B. P. Mohanty	Delivered invited talk in CAFT training program at ICAR-CIFE, International Symposium on Genomics in Aquaculture at ICAR-CIFA, National Seminar on Advances in Marine Natural Products and Nutraceutical Research" at ICAR-CIFT and Key Note Lecture in Society of Veterinary Biochemists and Biotechnologists of India (SVBBI) Convention. Expert Member- Institutional Biosafety Committee (IBSC) for ICAR- CRIJAF, Nilganj, Kolkata. Supervised a probationer ARS Scientist from ICAR-CIFE, Mumbai for Professional Attachment Training and one M.Sc. (Biotechnology) student from Vidya Sagar University for dissertation research.
Dr. M. A. Hassan	Member, Agriculture and Allied Sectors Standing Working Groups, State Planning Commission, Govt. of Chhattisgarh, Naya Raipur. Member, Core Group, for formulation of protocols for identification & Assessment of Wetlands, Bihar State Wetland Development Authority, Govt. of Bihar.
Dr. U. K. Sarkar	Expert member, Selection Committee for the Teachers/Scientists promotion under Career Advancement Scheme by Uttar Banga Krishi Viswa Vidyalaya, Lake Hall, West Bengal, on 30 October, 2015.
Dr. B. K. Bhattacharjya	Expert Member in the Assam State Biodiversity Board, Guwahati and college Extension Advisory Committee of College of Fisheries, Lembucherra, Tripura Expert in Aquaculture, Krishi Darshan Programme of DDK, Guwahati and expert for selection of Junior Consultants (Fisheries) of NFDB Regional Centre, Khanapara, Guwahati.
Dr. D. S. Krishna Rao	Expert member in the Selection Committee for Teachers/Scientists for promotion under Career Advancement Scheme - 2006 in the Subject of Fisheries Science, on 23 February, 2016.
Dr. S. Samanata	Panel Expert of the workshop on Mitigating environment and social impact of the Jal MargVikas Project organized by Inland Waterway Authority of India, Ministry of Shipping, Govt. of India at Patna on 22 February, 2016. Centre Supervisor for conducting the following ASRB Examinations -ARS Preliminary and NET Examinations 2015 held during 4-10 December, 2015 at ICAR-CIFRI, Barrackpore.
Dr. Malay Naskar	Invited as content writer for UGC sponsored e-PG Pathsala project of Ministry Human Resource Development in Statistics and contributed for five video lectures on Bayesian Analysis
Shri S. K. Sahu	Invited talk on "Potential of CARTOSAT data for enhancement of fishery resource study" in seminar on "CARTOSAT 1; 10 year completion" at NRSC Hyderabad 5 May 2015
Dr. Preetha Panikkar	Invited talk on "Impact of invasive fishes on the ecological processes in Peninsular reservoirs of India" at the International Conference on Aquatic Exotics: Trends, Challenges and Policies, organised by Department of Aquatic Biology & Fisheries University of Kerala during 28-30 March 2016.
Dr. Pronob Das	Expert in Aquaculture, KrishiDarshan Programme of DDK, Guwahati.
Dr. P. K. Parida	Invited as resource person to the one day state level consultation on FAO Voluntary Guidelines for securing sustainable small scale fisheries in the context of food security and Poverty eradication organized by ECGG, University of Waterloo, Canada and NIRMAN, Odisha, on 19 December 2015.

TRAINING AND CAPACITY BUILDING

Training and capacity building attended by staff members

Sl No	Name of the program	Date	Participants	Organizer and venue
1.	Hands on training on Aspects of plankton biology	30th March - 30th April, 2015	Suman Kumari Suvra Roy	IISER, Kolkata
2.	Workshop on Development of computer vision based technology for automating fish abundance data generation for characterizing fisheries stock	22- 23rd May, 2015	V. R. Suresh S. K. Sahu Manas H. M. Gunjan Karnatak	ICAR-CIFRI, Barrackpore
3.	Climate change and its impact on Fisheries (special emphasis on greenhouse gas emission in mangrove wetlands)	15th June - 14th September, 2015	Thangjam Nirupda Chanu	CIBA, Chennai
4.	Environmental Flows	15th June - 14th September, 2015	Simanku Borah	National Institute of Hydrology, Roorkee
5.	Phytoplankton diversity in selected floodplain wetlands of Assam	16th June - 15th September, 2015	Jeetendra Kumar	ICAR-CIFRI Regional Centre, Guwahati
6.	Freshwater Fish taxonomy of Northeast India	25th May -24th August, 2015	Niti Sharma	Faculty of Life Sciences, Manipur University, Imphal
7.	Application of remote sensing and GIS to study trophic status of Chilika lagoon and its impact on fish production	22nd June-21st September, 2015	P. K. Parida	Space Applications Centre, Ahmedabad
8.	Ecological modeling	25th May -24th August, 2015	Sibina Mol S.	CIFRI Regional Centre, Bangalore
9.	Ecological modeling	25th May -24th August, 2015	Vaisakh G.	CIFRI Regional Centre, Bangalore
10.	Benthic taxonomy and ecology	9th July-8th October 2015	Wakambam Anand Meetei	Garhwal University, Srinagar
11.	Training workshop on Innovative/best practices in NeGP-agriculture & allied sectors	30th July-1st August, 2015	Sibina Mol S.	CIPS, Hyderabad UAS, Dharward
12.	Training programme on Consultancy project management	3-7th August, 2015	K. D. Joshi	ICAR-NAARM, Hyderabad
13.	HRD programme on Fish disease	17th August, 2015	B. K. Bhattacharjya	College of Fisheries, Raha
14.	Hindi Stenography training programme	19th August-16th December, 2015	Jolly Saha	Hindi Training Sub Centre, Kolkata
15.	Training cum workshop on “Reducing and managing risk of acute hepatopancreatic necrosis disease of cultured shrimp – Re echo seminar”	14th-15th September 2015	A. K. Sahoo	NBFGR, Lucknow

Sl No	Name of the program	Date	Participants	Organizer and venue
16.	Training on Climate change governance	14-25th September, 2015	Deepa Sudheesan	Wageningen University, Netherlands
17.	International training course on Fishery stock assessment and ecosystem modelling	16-22th September, 2015	D. Panda	ITCOOCean, INCOIS, Hyderabad
18.	International training programme on Ecosystem approach to fisheries	21st September -9th October, 2015	Sandhya K. M.	Centre for Development Innovation, Wageningen, Netherlands
19.	ICAR-sponsored short training on Advanced techniques for bioremediation and management of salt affected soils	15-24th October, 2015	S. K. Das	ICAR-CSSRI Lucknow Centre
20.	Training on "Molecular biology and Biotechnology for fisheries potential".	1st November, 2015-31st January, 2016	Pronob Das	DBT, New Delhi, ICAR-CIFA CIFA Bhubaneswar
21.	National workshop on Coldwater endemic fishes of North Eastern Himalaya: Avenues and challenges	5-6th November, 2015	D. Debnath A. K. Yadav	ICAR-DCFR, Bhimtal Gangtok, Sikkim
22.	Workshop on Feed and feed technologies for responsible aquaculture	18-19th November, 2015	Pronob Das	ICAR-CIFA, Bhubaneswar
23.	Winter school on " Bioinformatics and High Dimensional Genome data analysis"	25th November- 15th December 2015	A. K. Sahoo	ICAR-IASRI, New Delhi
24.	MDP on Leadership development (a pre-RMP programme)	29th November-12th December, 2015	U. K. Sarkar	NAARM, Hyderabad
25.	Freshwater fish taxonomy of North East India	2nd December 2015-1st March 2016	S. K. Koushlesh	School of Life Sciences, Manipur University, Imphal
26.	Monitoring and assessment of surface water quality in Nadia, West Bengal	3rd December 2015 -2nd March 2016	N. Samarendra Singh	BCKV, Mohanpur, Nadia
27.	National training programme on Entrepreneurship development and management for scientists and technologists	7-11th December, 2015	M. Karthikeyan	EDI, Ahmedabad
28.	Working towards Marine Stewardship Certification(MSC) process	11th December, 2015	Preetha Panikkar	WWF, India and Marine Stewardship Council UK Kochi
29.	Workshop on TDS (Tax deduction at Source/Income Tax)	14th December, 2015	All scientists at HQ	ICAR-CIFRI, Barrackpore
30.	Workshop on Unified messaging and web hoisting solutions	18th December, 2015	V. R. Suresh U. K. Sarkar S. Samanta A. Pandit B. K. Behera P. Maurya D. Karunakaran Aparna Roy Mishal P Gunjan Karnatak Manas H M Kavita Kumari Raju Baitha Suvra Roy	ICAR-IASRI, New Delhi ICAR-CIFRI, Barrackpore
31.	CAFT on Application of computer algorithms and statistical software packages in agriculture	18th December-7th January 2016	R. K. Raman	ICAR-IASRI, New Delhi

Sl No	Name of the program	Date	Participants	Organizer and venue
32.	Bulk sediment properties of Gautami – Godavari mangrove, Andhra Pradesh	1st January 2016-31st March 2016	Gulshan K. Sharma	School of Environmental Sciences, JNU, New Delhi
33.	Hands on Advance instruments of water quality testing	11-15th January, 2016	B. K. Naskar	NIH, Roorkee
34.	CAFT on Statistical Advances for Technological Enhancement in Agriculture Research	19th January-8th February 2016	Manas H. M.	ICAR-IASRI, New Delhi
35.	Training workshop of HRD nodal officers of ICAR institutes	10-12th February, 2016	S. K. Nag	NAARM, Hyderabad
36.	National workshop on Antibiotic residue analysis in aquaculture environments	11-12th February, 2016	S. K. Manna	ICAR-CIFT, Kochi
37.	Training on An Introduction to fish taxonomy	15-20th February, 2016	Sajina A. M. Deepa Sudheesan	PMFGR Centre, NBFGR, Kochi
38.	Competency enhancement programme for Technical Officers of ICAR institutes	01-10th March, 2016	Subrata Das	ICAR-NAARM, Hyderabad
39.	Workshop on Ecolabelling and MSC certification process	07- 11th March, 2016	Preetha Panikkar	WWF, India and Marine Stewardship Council UK
40.	Workshop on Fisheries and aquaculture response in emergencies	10-12th March, 2016	Niti Sharma, S. Borah	ICAR-CIFE, Mumbai Jorhat, Assam
41.	Hindi training and workshop	21 -23rd March, 2016	Sibina Mol S.	ICAR- NIANP, Bangalore

Training attended

S. No.	Category	No. of Staff	No. of trainings planned for 2015-16 as per ATP	No. of employees undergone training			% realization of trainings planned during 2015-16
				April-September 2015	October 2015-March 2016	April 2015-March 2016	
1	**2**	**3**	**4**	**5**	**6**	**5+6=7**	**7/4×100=8**
1	Scientist	70	19	16	19	35	184.21
2	Technical staff	51	10	0	7	7	70
3	Administrative & Finance staff	39	9	4	11	15	166.66
4	SSS	61	59	0	57	57	96.61
Total		**221**	**97**	**20**	**94**	**114**	**117.52**

Training organized for various categories of employees

S. No.	Category	No. of trainings organised
		April 2015 -March 2016
1	Scientist	1*
2	Technical	1*
3	Administrative & Finance	1*
4	SSS	4
Total		**5**

* Same training (on ISO Internal Auditing) was organised for Scientific, Technical and Administrative Staff

HRD fund allocation and utilization (₹ in lakh)

S. No.	RE 2015-16 for HRD			Actual Expenditure 2015-16 for HRD	% Utilization
	Plan	Non plan	Total		
1	12	0	12	11.75	97.92

Students training organized

S. No.	Training course	Date	Participants
1	Inland Fisheries Management	17-24 August, 2015	9 M. F. Sc. Students of FRM Division, CIFE,
2	Inland Fisheries Management	25 August- 03 September, 2015	17 P.G. Students of P. K. Roy Memorial College, Dhanbad
3	Inland Fisheries Management	25 August- 03 September, 2015	5 P.G. Students of Vinoba Bhave University, Hazaribag
4	Inland Fisheries Management	14-18 December, 2015	24 Students of B.Sc. (I.Fish) from Begusarai, Bihar.
5	Inland Fisheries management	6-8 January, 2016	11 B.F.Sc students from College of Fisheries, Ludhiana

Training for fish farmers

Sl. No	Name of the training	Date	Participants
1	Inland open water fisheries management & development	03-09 April, 2015	29 farmers, Motihari, Bihar (DoF)
2	Inland open water fisheries management & development	10-16 April, 2015	29 farmers, Jahanabad, Bihar (DoF)
3	Inland open water fisheries management & development	03-09 June, 2015	25 farmers, Aurangabad, Bihar (DoF)
4	Inland open water fisheries management & development	15-21 June, 2015	30 farmers, Purnea, Bihar (DoF)
5	Inland open water fisheries management & development	24-30 June, 2015	31 farmers, Katihar, Bihar (DoF)
6	Inland open water fisheries management & development	14-20 July, 2015	31 farmers, Jamui, Bihar (DoF)
7	Inland open water fisheries management & development	23-29 July, 2015	31 farmers, West Champaran, Bihar (DoF)
8	Inland open water fisheries management & development	31 July- 6 August, 2015	27 farmers, Nalanda (Bihar Sarif) (DoF)
9	Inland open water fisheries management & development	18-24 August, 2015	32 farmers from Darbhanga, Bihar (DoF)
10	Inland open water fisheries management & development	26 September- 01 November, 2015	30 farmers, Patna, Bihar (DoF)
11	Inland open water fisheries management & development	04-10 September, 2015	30 farmers, Arwal, Bihar (DoF)
12	Inland open water fisheries management & development	23- 29 September, 2015	31 farmers, Araria, Bihar (DoF)
13	Inland open water fisheries management & development	5-11 December, 2015	31 farmers, Sitamarhi, Bihar (DoF)
14	Inland open water fisheries management & development	26 December- 01 January, 2016	32 farmers Siwan, Bihar (DoF)
15	Inland open water fisheries management & development	5-11 January, 2016	31 farmers Madhubani, Bihar (DoF)
16	Inland open water fisheries management & development	25-31 January, 2016	28 farmers Kishangunj, Bihar (DoF)
17	Inland open water fisheries management & development	5-11 February, 2016	30 farmers, Madhepura, Bihar (DoF)
18	Inland open water fisheries management & development	17-23 February, 2016	30 fishers, Gaya, Bihar (DoF)

Training/workshops coordinated

Sl. No	Name of the training	Date	Venue	Participants
1.	Orientation training on Reservoir fisheries management and cage culture including Extension & Training activities at CIFRI	26 October, 2015	CIFRI, H.Q. Barrackpore	3 ARS (Probation) Scientists of CIFRI, Barrackpore
2	Orientation training on Inland Fisheries management	15 January, 2016	CIFRI, H.Q., Barrackpore	16 Fishery Extension Officer, Assam

Exposure visit of students/farmers/officers

S. No.	Particulars of visitors	Nos.	Date of visit	Purpose
1	B. Sc. (Industrial Fish & Fisheries) Students from APC College, New Barrackpore	37	01 April, 2015	Education visit
2	SMS of KVK, from MP, Chattishgarh, Odisha and PC, KVK	18	24 April, 2015	Educational visit
3	Orientation training on i) Cage aquaculture & ii) Reservoir fisheries management to DoF Officials of NE states & Chattishgarh under training at CIFE, Kolkata Centre	20	23 August, 2015	Exposure visit to Maithon reservoir, Jharkhand
4	Students from College of Fisheries, Ratnagiri, Maharashtra	40	02 November, 2015	Educational visit
5	Students from College of Fisheries, Raha, Assam Agricultural University	16	06 November, 2015	Study tour
6	B. Sc (Hons.) 3rd year Geography students from Dumdum Motijheel Rabindra Mahavidyala, Kolkata	17	30 November, 2015	Educational visit
7	Kids from 'UDAYAN' NGO welfare & Rehab Program for the Children of Leprosy patents	58	21 December, 2015	Exposure visit
8	B.F.Sc. students from College of Fisheries, Kamdhenu Viswavidayalaya, Chattisgarh	17	31 December, 2015	Study tour
9	Farmers from Fishers Cooperative Society, Pokhara, Nepal	17	02 January, 2016	Exposure visit
10	B.Sc. Zoo (Hons) 2nd & final year students from Karimgunj College, Assam	31	02 January, 2016	Educational tour
11	Fishery Officials under DDF Training Institute, Nowgong, Chhatarpur, M.P.	17	28 January, 2016	Exposure visit
12	Farmers from Tripura	20	18 March, 2016	Study tour
13	Final year M.Sc Zoology students of Guwahati University, Assam	9	26 March, 2016	Study Tour
14	Fishers from ATMA, Nawada, Bihar	10	28 March, 2016	Exposure visit

Exhibitions (participated/coordinated)

Sl. No	Name of Programme	Venue	Date
1	Horti Fair 'Horti-Sangam 2015', at Motihari, organized by National Horticulture Board	Motihari, Bihar.	9-11 April, 2015
2	New Digha Utsav-2015	Medinipur.	6-11 April, 2015
3	Foundation stone laying ceremony of ICAR-IARI, Hazaribagh by Hon'ble Prime Minister of India.	Hazaribagh	27-18 June, 2015
4	NRC Integrated Farming Inauguration at Piprakothi, Motihari	Motihari	20-21 August, 2015
5	Confederation of Indian Industries II	Burdwan	8-10 October, 2015
6	5th Agro Protech-Towards sustainable food security through "Green, Blue & White revolution" organized by ICC.	Milan Mela, Kolkata	19-21 November, 2015
7	CAA5, Cochin, Kerala	Kerala	25-28 November, 2015
8	Sunderban Kristi Mela-O-loko Sanskriti Utsav	Kultali, Sundarban	20-29 December, 2015
9	Sunderban Yuba Mela	Taldi, South 24 PGS	22-31 December, 2015
10	5th Nahati Utsav	Naihati	24-31 December, 2015
11	Sijani Sangha, Manmohan Mela	Chhotojagulia, Barasat	3-10 January, 2016
12	Mati Utsav-2016, Burdwan	Burdwan	19-25 January, 2016
13	NESFA, CAU	Lembuchera Tripura	21-22 January, 2016
14	Sunderban Lokopriya Utsav- 2016	Basanti, South 24 PGS	23-30 January, 2016
15	2nd International Symposium on Genomics in Aquaculture	CIFA, Bhubaneswar	28-30 January, 2016
16	Sunderban Gramin Kuthir Shilpo -O- Loko Sanskriti Utsav-16	Jaigopalpur Gram Vikash Kendra, Basanti, South 24 PGS	11-14 Febuary, 2016
17	International conference on Aquatic Resources and Sustainable Management	Science City, Kolkata	17-19 Febuary, 2016
18	Jhanjharpur Vigyan Saksharata Utsav-16	Jhanjharpur, Madhubani, Bihar	21-23 Febuary, 2016
19	Krishi Unnati Mela- 2016	IARI Main Campus, New Delhi	19-21 March, 2016

Mass awareness organized

Sl. No	Awareness Programme	Participants	Date	Venue
1	Electronic Data Acquisition System (eDAS) for Fish Catch in Reservoirs	Fish farmers	27 April, 2015	Manchanbele Reservoir, Ramnagara District (Karnataka)
2	Reservoir Fisheries Management and Cage Culture of Fish in Reservoirs	Fish farmers	20 August, 2015	Paleru Reservoir Wyra Reservoir
3	'Fisheries resource management and aquaculture production enhancement in Assam'	Fish farmers	21-22 August, 2015	ICAR-CIFRI RC, Guwahati
4	'Fish disease surveillance	Fish farmers	26 August, 2015	Silchar, Assam
5	Reservoir Fisheries Management and Cage Culture of Fish in Reservoirs	Fish farmers	4 September, 2015	Vanivilasasagara reservoir, Chitradurga District, Karnataka
6	Aquatic animal diseases in Assam	Fisheries extension officers, DFDO and researchers (55 nos.)	17 October, 2015	ICAR-CIFRI, Guwahati Centre
7	Safe Fishing	Fish farmers	07 February, 2016	Pookote Lake, wayanad
8	Climate Change Impact and Adaptation Strategies for Wetland Fisheries	60 fishers from four wetlands of West Bengal (Bhomra, Garapota, Akaipur and Khalsi),	09, February, 2016	ICAR-CIFRI, Barrackpore
9	Conservation of small indigenous fish for livelihood and nutritional security'	500 fish farmers	10 February, 2016	Mataiya, Anshan Patepur, Vaishali, Bihar

ONGOING PROJECTS

In-house projects

Project code	Project title	Associated scientists
Programme: Restoration of rivers and estuaries for ecosystem integrity and conservation of fish stocks		
REF/ER/12/01/02	Population characteristic of small indigenous fishes in rivers and associated ecosystems in relation to rural livelihood and nutritional security	**Archana Sinha**, S. K. Das, Aparna Roy, Suvra Roy, Kavita Kumari, Raju Baitha
REF/ER/12/01/03	Assessment of environmental variability, nutrient dynamics, biodiversity, fish stock assessment of selected estuarine and mangrove ecosystems	**Sanjoy K. Das**, R. K. Manna, Rosith C. M., D. Sudheesan, Manas H. M., Suvra Roy, D. Bhakta, Ramya V. L., W. A. Meetei, T. Nirupada Chanu
REF/ER/12/01/05	Quantification of environmental flow requirements for ecosystem functions in rivers with special focus on fisheries	**A. K. Sahoo**, Roshith C.M., Soma Das Sarkar, Rohan K. Raman, Manas H. M. Lianthuamluaia, Kavita Kumari, Simanku Borah
REF/NR/12/01/06	Impact assessment of multiple habitat alterations on ecosystem functions and fisheries in rivers	**K. D. Joshi**, R.S. Srivastava, D. N. Jha, AbsarAlam, S. C. S. Das, Vaishakh G., Jeetendra Kumar
Programme: Ecosystem based fisheries management of reservoirs and wetlands		
RWF/NE/12/02/01	Sustainable management of floodplain wetlands for enhanced fishery and livelihood.	**B. K. Bhattacharjya**, M. A. Hassan, Md. Aftabuddin, K. M. Sandhya, Suman Kumari, Lianthuamluaia, Vikash Kumar, Mishal P., D. K. Meena, Arun Pandit, Sona Yengkokpam, Dipesh Debnath, A. K. Yadav, Pronob Das, Md. AbsarAlam, S. C. S. Das, D. N. Jha, Vaishakh G., Jeetendra Kumar, Niti Sharma
RWF/SR/12/02/02	Habitat characteristics, fish assemblage and stock dynamics and impact of stocking in selected reservoirs	**D. S. Krishna Rao**, U. K. Sarkar, R. Palaniswamy, M. Karthikeyan, P. Panikkar, T. T. Paul, V. L. Ramya, D. Panda, K. M. Sandhya, DibakarBhakta, Suman Kumari, Lianthuamluaia, Gunjan Karnatak, Vikash Kumar, Mishal P., Sibina S. Mol
RWF/SR/12/02/03	Application of acoustics and trophic models for ecosystem –based fisheries management in reservoirs	**M. Feroz Khan**, Preetha Panikkar, V. L. Ramya, Sibina S. Mol
RWF/ER/12/02/04	Refinement of enclosure fish culture (pens and cages) in reservoirs and wetlands for production of stocking materials and table fish	**A. K. Das**, U. K. Sarkar, D. Panda, Suman Kumari, Gunjan Karnatak, Vikash Kumar, A. Alam, D. N. Jha

Project code	Project title	Associated scientists
Programme: Environment and health monitoring of inland open-waters for ecosystem amelioration		
FREM/ ER/12/03/02	Monitoring and benchmarking of ecosystem health of major river systems in India	**Srikanta Samanta**, Subir K. Nag, Malay Naskar, Sajina A. M. Deepa Sudheesan, Raju Baitha
FREM/ ER/12/03/03	Developing microbiological protocols for bioremediation of polluted aquatic environment	**S. K. Manna**, S. K. Nag, Md. Aftabuddin, P. Maurye, S. Das Sarkar
FREM/ ER/12/03/05	Development of biotechnological tools for inland aquatic ecosystem health assessment	**B. P. Mohanty**, D. Karunakaran, Tanuja Abdullah, P. K. Parida
FREM/ ER/12/03/06	Development of eco-restoration protocols for eutrophic inland aquatic systems	**M. K. Bandyopadhyay**, Debabrata Das
FREM/ ER/12/03/07	Acquisition of fish catch data and resource mapping of inland open –waters on GIS platform, using modern tools	**S. K. Sahu**, D. Karunakaran, P. Maurye, T. T. Paul, P.K. Parida
FREM/ ER/12/03/08	Inference on fisheries of some selected open water through data mining and generalized linear models.	**M. Naskar**, D. Das, S. K. Sahu, G. Chandra, Rohan Kumar, T. Abdulla
FREM/ ER/12/03/10	Bioprospecting of genes and allele mining for abiotic stress tolerance	**B. K. Behera**, D. K. Meena
Programme: Valuation, institutional mechanisms and livelihoods in inland open waters		
AES/ER/12/04/01	Preparation of inventory of inland open waters according to their institutional arrangement and governance and mapping of fishers' livelihood assets	**Ganesh Chandra**, M. Naskar, S. K. Sahu, Aparna Roy, A. Ekka
AES/ER/12/04/02	Valuation of goods and services of inland open waters	**Arun Pandit**, Anjana Ekka, Archana Sinha, Roshith CM
Outreach program		
OR/ER/08/09/01	Carp culture in cages and pens using feed	**M. A. Hassan**, Md. Aftabuddin, D.K. Meena, Mishal P
OR/ER/08/09/02	Fish genetic stocks	**B. K. Behera**, D. K. Meena, D. Panda, P. Das, D. Bhakta, Kavita Kumari
OR/ER/08/09/03	Nutrient profiling and evaluation of fish as a dietary component	**B. P. Mohanty**, Archana Sinha, D. Karunakaran, D. Debnath, Rohan Kumar Raman, Tanuja Abdulla, P. K. Parida

Consultancy projects

Title of the project	Funding agency
Post-restoration assessment of the ecology and fisheries diversity of Chilika Lake	Chilika Development Authority
Study of minimum environmental flow requirement for aquatic life in River Tangon for Attunli Hydroelectric Power project	Attunli Hydroelectric Power Company Limited
Studies on environmental flow for monsoon period in river Dri and Tangon	Etalin Hydroelectric power company limited
Implementation of cage culture scheme in State Reservoirs	Directorate of Fisheries, Govt. of Himachal Pradesh
Impact analysis on ecology, flora, and fauna including fish and fisheries, due to movement of barges carrying coal through National Waterways No. 1 (Sagar to Farakka)	Jindal ITF Ltd.
Impact assessment of coal transportation through barges along the National Waterways No. 1 (Sagar to Farakka) along river Ganga	Inland Waterways Authority of India

Sponsored projects

Project title	Associated scientists	Funding source
Assessment of spawning behavior of major fish species in inland environments with a view to harness the beneficial effects of temperature	**U. K. Sarkar**, D. S. K. Rao, K. D. Joshi, B. K. Bhattacharjya, S. K. Nag, M. Naskar, M. Aftabuddin, Arun Pandit, P. Panikkar, A. K. Sahoo, D. Sudheesan, S. Das, A. K. Yadav, D. Debnath, G. Karnatak, Vaishakh G., Sibina S. Mol	**NICRA**
Strengthening of database and geographical information system of the fisheries sector	**Director**, Malay Naskar, K. D. Joshi, B. K Bhattacharya, M. Karthikeyan, S. K. Sahu, D.N. Jha, Mishal. P.	**DAHD&F**
Stock characterisation, captive breeding, seed production and culture of Hilsa (*Tenualosa ilisha*)	**V. R. Suresh**, B. K. Behera, R. K. Manna, Sajina A. M, K. M. Sandhya	**NASF**
National surveillance programme for aquatic animal diseases	**B. K. Behera**, S. K. Manna, A. K. Sahoo, P. Das	**NFDB**
Metagenomic Applications and transcriptome profiling for inland aquatic environmental health surveillance	**B. K. Behera**, S. K. Manna	**ICAR-IASRI**
Identification and characterization of aquaporin gene from freshwater catfish Clarias batrachus and their expression during reproduction	**B. K. Behera**, A. K. Sahoo	**DBT, Govt. of India**
All India Network Project on Fish Health	**S. K. Manna**, S. K. Nag, Dr. P. Panikkar, Ms. Anjana Ekka, Dr. D. Debnath, Sh. Raju Baitha, Sh. Vikash Kumar	**ICAR-CIBA**
Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan	**K. D. Joshi**, V. R. Suresh, R. K. Manna, D. N. Jha, A. Alam, R. Baitha, Manas, H. M.	**NMCG, Govt. of India**
Small indigenous fishes to boost nutritional security: a road map for nutria-smart village in delta Sunderbans	**Aparna Roy**, Archana Sinha, Md. Aftabuddin, Suvra Roy	**ICAR Extramural**
Remote sensing of inland fisheries	**S. K**. Sahu, W. A. Meetei	**SAC**

MEETINGS

Research Advisory Committee meeting

The Institute Research Advisory Committee Meeting was held at Barrackpore during 20-21st April, 2015. Prof. Brij Gopal, Chairman, RAC, presided over the meeting. Other members of RAC Dr. N. Sarangi, Dr. C. Vasudevappa, Dr. V. V. Sugunan, Dr. M. R. Bhupendernath and scientists of CIFRI were present. The Heads of division, Regional centre and Research stations presented the progress of institute research projects started during XII plan during the year. The PIs of externally funded projects and out-reach projects also detailed the progress. Application of ecosystem based models developed by the institute for reservoirs fisheries management, e-flow required in rivers during different periods of the year etc. were recommended.

Research Advisory Committee Meeting

The Research Advisory Committee Meeting of the Institute was held at Barrackpore during March 21-22nd, 2016. Newly appointed RAC committee members, Prof (Dr.) B. Madhusoodana Kurup, Chairman, presided over the meeting. Heads of Divisions, Heads of Regional Centers, Scientist-In-Charges of CIFRI Research Stations and scientists of CIFRI HQ attended and actively participated in the meeting. The program coordinators presented the salient achievements and future initiatives of the research program of CIFRI. RAC committee emphasized to formulate knowledge based strategic plans to enhance fish production, management of resources,and conservation of fish biodiversity and to ameliorate deleterious effects of pollution in inland open waters.

Institute Research Council Meeting

The annual meeting of IRC was held during 9-11th May, 2015 at Barrackpore. Prof A. P. Sharma, Director presided over the meeting. All the Head of Divisions and scientists of all cadres participated in this important meeting. Scientists presented their achievements made during previous year and also the future work plans in this meeting. The Chairman expressed that scientists should strictly follow suggestions of Quinquennial Review Team and Research Advisory Committee recommendations. He explained that institute has identified some flagship programmes, which are to be given proper focus during the XII Plan. On the last day scientist-administration interface meeting was held to forage better coordination between researchers and administration.

NASF-Hilsa project 5th Advisory Committee Meeting

The 5th Advisory committee meeting of NASF project on 'Stock Characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)' was held in CIFRI, Barrackpore during 6-7th August,2015. Dr. K. K.Vass, Chairperson and other members of the coordination committee Dr. P. K. Agarwal, ADG, NASF; Dr. K. G. Padmakumar, Director, IBSFRI, Kerala, Mr. R. F Lepcha, Addl. Director, Department of Fisheries, Government of West Bengal were present. In addition all the investigators involved in the project were also present. Dr. V. R. Suresh, PI of the project presented the overall progress of the project, which was followed by detailed presentations on progress made by individual partners. Action taken on the recommendation of the previous meeting was presented by the PI, which was accepted with minor modifications.

Midterm Review Meeting of RCM

The midterm review meeting of Regional Committee II was conducted in 19th September, 2015 at the institute head quarters to review the action taken on the recommendations of 22nd meeting of the committee held during 21-22nd June, 2014. Dr. A. K. Singh, DDG (Fisheries, Additional Charge) and Nodal Officer of the region chaired the meeting. Representatives from ICAR Institutes, State Departments, ICAR Headquarters and scientists of CIFRI attended this meeting. The meeting started with the welcome address by Dr. V. R. Suresh, Director (Acting), ICAR-CIFRI and Member Secretary of Regional Committee II. The action taken report was presented and discussed at the meeting. Special emphasis was given on development of agenda items for the 23rd meeting of Regional Committee II to be held during 2016.

Parliamentary Standing Committee on Agriculture

Study visit of the Parliamentary Standing Committee on Agriculture was jointly organized by ICAR-Central Inland Fisheries Research Institute and ICAR-Central Research Institute for Jute and Allied Fibres on June 14th, 2016 at Hotel Novotel, Newtown, Kolkata. Other than ICAR institutes State agriculture department of West Bengal and Indian Farmers Fertiliser Cooperative Limited also participated in the meeting.

WORKSHOPS ORGANIZED

Developing Road Map for Agriculture Growth in Lower Gangetic Plains Region

Indian Council of Agricultural Research organized a workshop on 31st October, 2015 for preparing development road map for agriculture and allied sectors in Lower Gangetic Plains Region (Agro-climatic Region-III) covering West Bengal (Except hilly areas), eastern part of Bihar and Bramhaputra valley of Assam at ICAR- Central Inland Fisheries Research Institute (CIFRI), Barrackpore. The workshop was organized under the Chairmanship of Dr. A. K. Singh, Deputy Director General (Agricultural Extension and Fisheries Science), ICAR. On the basis of interactions with farmers and further deliberations with scientists, recommendations were made for overall agricultural development of the region with primary focus on sustainable income to farmers. Dr. S. D. Singh, Assistant Director General (Inland Fisheries), ICAR, Prof. G. Trivedi, former Vice-Chancellor, RAU, Pusa, Prof. S. K. Sanyal, former Vice-Chancellor, BCKV, Mohanpur, Prof. C. S. Chakraborty, former Vice Chancellor, WBUAFS were present in the meeting. Dr. V. R. Suresh, Director (Acting), ICAR-CIFRI and Dr. A. K. Singh (Director), ICAR-ATARI were the Nodal Officer, for the workshop. Several progressive famers and entrepreneurs put forth their problems related to production systems, field technologies, marketing issues and extension mechanisms. Representatives from SAUs viz. BCKV, Mohanpur; UBKV, Pundibari; BAU, Sabour; and AAU, Jorhat and ICAR institutes/Centers from this region responded to farmers' need and presented the technologies, packages of practices developed by them. They also elaborated on various initiatives to extend supports to farmers for addressing their specific problems.

Annual Zonal Workshop of ICAR-ZPD, Zone-II

The Annual Zonal Workshop of ICAR-ZPD, Zone-II was organized by Zonal Project Directorate, Kolkata at ICAR-CIFRI, Barrackpore during May 26-27th, 2015. The inaugural session was graced by Directors of CIFRI, Barrackpore and NIRJAFT, Kolkata, Zonal Project Director, Director, SAMETI, West Bengal, Directors of Extension Education of six SAUs of Zone-II, Heads of division of CIFRI, officials from Zonal Project Directorate, Programme Coordinators of 83 KVKs spread across Bihar, Jharkhand, West Bengal and A&N Islands and other dignitaries. During the inaugural session, Dr. A.K. Singh, Zonal Project Director, Zone II briefed the house about various initiatives taken for the KVKs and performance of the KVKs in mandated and other activities. A special lecture on ushering in green revolution in rainfed rice areas in eastern India; stress tolerant rice varieties were delivered by Dr. U.S. Singh, Sr. Scientist and South Asia Regional Coordinator, IRRI. Few KVKs involved in seed production and other activities related to those varieties shared their experiences. It was decided that a structure mechanism will be developed at the ICAR headquarter level for involving KVKs in extrapolation of those varieties under specific land situation.

Farmer-Scientist Interface Meet at CIFRI, Barrackpore

A "Farmer-Scientist Interface Meet" was organized on 10th July, 2015, aiming to provide solution to the problems faced by the farmers in Inland Fisheries Management. More than 100 farmers from different States viz. West Bengal, Bihar, Jharkhand, Madhya Pradesh and Maharashtra were present in the meet. Issues like destruction of hilsa juveniles in Hooghly river, decline of various finfish and shellfish in Wetlands, adverse effect of Clarias gariepinus culture, non-availability of quality monosex Tilapia seed in adequate quantity in West Bengal, lack of quality feed and medicine for aquarium fishes etc. were also discussed by the fishers and fish farmers in the interface meet. The interface meet came to an end with viable solution given the Scientists of CIFRI and Dean, COF, SVVU, Tirupati. On the occasion of National Fish Farmers Day, the 'Farmer-Scientist Interface Meet' organized by ICAR-CIFRI was a rational step towards successful inland fisheries development .

Sensitization Workshop on "Aquatic Animal Diseases in Assam" at ICAR-CIFRI, Regional Centre, Guwahati

ICAR-Central Inland Fisheries Research Institute, Regional Centre, Guwahati, organized a Sensitization Workshop on "Aquatic Animal Diseases in Assam" on 17th October, 2015 under the National surveillance programme on aquatic animal diseases (NSPAAD). Dr. Pronob Das, Scientist; Dr. B. K. Behera, Senior Scientist & PI, NSPAAD; Dr. B. Kalita, Professor, College of Fisheries (AAU), Raha; Dr. D. Debnath and Shri A. K. Yadav, Scientists deliberated on various activities of NSPAAD. Fisheries officials working in different districts of Assam attended the Workshop. An interactive session was conducted between the resource persons and fisheries officials and the session was moderated by Dr. B. K. Bhattacharjya. The participants discussed about the ways for jointly contributing for successful completion of the surveillance programme in Assam by involving the fish farmers. The valedictory session was graced by Shri Hemanta Narzary, IAS, Principal Secretary, Fisheries department, Govt. of Assam; Shri Ratul Mahanta, ACS, Director of Fisheries, Govt. of Assam; Dr. K. K. Tamuli, Dean (i/c), College of Fisheries (AAU), Raha and Dr. R. C. Barman, Officer-in-Charge, NFDB Regional Centre, Guwahati. The Director of Fisheries assured all support from the department for successful implementation of the programme.

Workshop-cum-Training and Demonstration organized under NSPAAD Project

One day workshop was organized by ICAR-CIFRI, Barrackpore on "Fish Disease and Health Management" on 10th December, 2015. More than 70 farmers (3-4 farmers from each district) of West Bengal were attended the workshop. This workshop was organized under the project NSPAAD in collaboration with FFRTC, Kulia, State Fisheries Department, Govt. of West Bengal. Dr. V. R. Suresh, Director (acting), inaugurated the workshop and welcomed the farmers. Dr. B. P. Mohanty, HOD, FREM and the convener of the workshop emphasized upon nutritional value of different fish and the importance of growing disease free fish. He also emphasized on the importance on fish disease surveillance. The farmers were also taken to different labs (Microbiology lab, Biotechnology lab, Nutrition lab and Biochemistry lab) of the institute for an exposure.

SEMINAR ORGANIZED

National Seminar on Hilsa Fisheries and Conservation

A national seminar was organized on Hilsa Fisheries and Conservation jointly by Inland Fisheries Society of India, Kolkata and Society of Fisheries Technologists (India), Cochin on 18th November, 2015. Dr. Swapan Kumar Dutta, former Deputy Director General (Crop Science), Indian Council of Agricultural Research, New Delhi inaugurated the Seminar and presented the SOFTI Biennial Award to Dr. B. Meenakumari, former DDG (Fy.). Invited lectures were arranged on Hilsa Fisheries of India, National Plan of Action for Hilsa, Hilsa fishery of Hooghly estuarine system, Hilsa fishery on the West Coast of India, Hilsa Conservation: Initiatives of HCRC, West Bengal, Conventional Fishing Techniques for Hilsa Capture, Responsible Fishing for Hilsa Conservation, Conservation of Hilsa: Fisheries Perspective and Socioeconomics of Hilsa Fishery along Hooghly Estuary. In the technical session 19 posters were presented and three posters were adjudged for the best posters. In the Plenary session recommendations that emanated from the seminar were prepared. After discussion in the house necessary suggestions were incorporated.

NATIONAL CONSULTATIONS

National consultation on following themes were organized during the year

1. National consultation on hilsa fisheries
2. Ganga River Basin Management Plan
3. Climate variability and resilience in inland fisheries
4. Expert consultation on “Perspective plan for fisheries development in West Bengal”
5. Aquatic environment management with special emphasis on river Ganga
6. Environment flow requirement for rivers and associated ecosystems

OTHER EVENTS

National Fish Farmers' Day

ICAR-CIFRI celebrated National Fish Farmers Day at Head Quarter, Barrackpore on 10th July, 2015. The celebration began with floral tribute to Late Prof. Hiralal Chowdhury, the architect of "Blue revolution" in India and the "Father of induced breeding" technique who achieved the feat of induced breeding of carp fish in India. This laid the foundation of modern aquaculture in the country. Sri Sumanta Choudhury, IAS, Principal Secretary, Department of Fisheries, WB graced the occasion as Chief Guest. Dr. T. V. Ramana, Dean, College of Fisheries, SVVU, Tirupati, Dr. B. C Jha, Consultant NFDB and Dr. M. K Das, Former HOD, CIFRI also graced the occasion. More than 100 farmers, State Government Officials, past and present CIFRI scientists, scholars and staff members, attended the function. Four fish farmers, one entrepreneur and two fish production groups representing West Bengal, Bihar, Jharkhand, Maharashtra and Madhya Pradesh were awarded "Prof Hiralal Choudhury Best Fish Farmer Award 2015" by the Institute.

87th ICAR foundation day

CIFRI celebrated ICAR foundation day on 16th July 2015. Dr. Utpal Bhaumik former Head of Division, CIFRI was the chief Guest of this function. All the staff of CIFRI including Head of Divisions,scientists' technical officers and CIFRI retired scientists attended the programme. Quiz and Antakshari competitions were organized. Prof. A. P. Sharma, Director, in his address remembered the achievements of the ICAR and Institute. He appealed all the staff members for doing excellence in their work.

Independence Day

CIFRI celebrated the Independence Day with great zeal and enthusiasm on 15th August, 2015. Dr. V. R. Suresh, Acting Director of the institute hoisted the tri-colour and paid rich tribute to the nation. He remembered the achievements of CIFRI. He urged the staff to work hard with total honesty to keep the CIFRI flag high. He emphasized for teamwork and cohesiveness. All the CIFRI staff and members of the family were present on the occasion.

Vigilance awareness week

The ICAR- CIFRI observed Vigilance Awareness Week during 26-31st October, 2015. The programme commenced on 26th October, 2015 with a pledge taking ceremony by all the employee of the institute. During the week long programme several awareness activities such as cartoons and slogans were written and displayed to sensitize CIFRI staff about the menace of corruption and how the society cripples due to corrupt environment. An essay writing competition on the topic 'Building of Corruption Free Society: Role of Students and Youths' was organized. On 30th October a guest lecture and concluding programme was arranged. The guest speaker Shri B. R. Prabhakar, Deputy Superintendent of Police, CBI, Kolkata delivered a talk on 'Corruption in Government Offices and the role of proactive vigilance'.

World Fisheries Day

ICAR-CIFRI, Barrackpore celebrated 'The World Fisheries Day-2015. On the occasion, an interaction meeting of fishers with scientists was organized. The objective of the programme was to sensitize the fish farmers, fishers and fish traders of West Bengal, about the need for conservation of natural water resources as well as fish biodiversity. More than 40 fishers, CIFRI retired scientists and CIFRI personnel participated in the programme.

Republic Day

ICAR-CIFRI celebrated the Republic Day with great enthusiasm on 26th January, 2016. Dr. V. R. Suresh, Director(Acting)of the institute hoisted the tri-colour and paid tribute to the nation. Dr. Suresh delivered a motivational speech on this particular occasion. All the CIFRI staff and members of the family were present on the occasion.

70th Foundation Day

ICAR-CIFRI celebrated its 70th Foundation Day on 17th March, 2016 at head quarter, Barrackpore, Kolkata.

DISTINGUISHED VISITORS

Head quarter

- Sri Sumanta Choudhury, IAS, Principal Secretary, Department of Fisheries, West Bengal
- Prof. Brij Gopal, former Prof. of Environmental Science at the Jawaharlal Nehru University, New Delhi and Chairman, Centre for Inland Waters in South Asia National Institute of Ecology
- Prof. Sam Martin, Professor (Fish Physiology), Institute of Biological and Environmental Sciences, University of Aberdeen, UK
- Dr. K. K.Vass, Former Director Central Inland Fisheries Research Institute, Barrackpore
- Dr. V. V. Sugunan, Former Assistant Director General (I.Fy.), ICAR
- Dr. Swapan Kumar Dutta, Deputy Director General (Crop Science), Indian Council of Agricultural Research, New Delhi
- Dr. N. Sarangi, Former Director ICAR-CIFA, Bhubaneswar
- Dr. C. Vasudevappa, Vice Chancellor, University of Agricultural and Horticultural Sciences, Shimoga, Karnataka, India

- Prof (Dr.) B. Madhusoodana Kurup, Vice Chancellor of Kerala University of Fisheries and Ocean studies (KUFOS)
- Dr. U. S. Singh, Sr. Scientist and South Asia Regional Coordinator, IRRI
- Prof. G. Trivedi, former Vice-Chancellor, RAU, Pusa
- Prof. S. K. Sanyal, former Vice-Chancellor, BCKV, Mohanpur
- Prof. C. S. Chakraborty, former Vice Chancellor, WBUAFS, Kolkata
- Dr. T. V. Ramana, Dean, College of Fisheries, SVVU, Tirupati

Allahabad Regional Centre

- Dr. Mohd. Arif, former Additional Director, Defence Research and Development Organization, Haldwani
- Prof. U. C. Srivastava, Department of Zoology, Allahabad University
- Prof. Anita Gopesh, Department of Zoology, Allahabad University
- Prof. Deepa Punetha, Department of Psychology, Allahabad University
- Dr. Sandeep Behera, Consultant, NMCG, New Delhi

Guwahati Regional Centre

- Shri Hemanta Narzary, IAS, Principal Secretary, Fisheries, Govt. of Assam
- Shri RatulMahanta, ACS, Director of Fisheries, Govt. of Assam
- Dr. C. K. Murty, Former Executive Director (Technical), NFDBI, Hyderabad
- Dr. D. Seenappa, Chief Scientific Officer, UAS, Bangalore
- Prof. Dr. Shivkumar Magada, College of Fisheries, Mangalore
- Dr. K. K. Tamuli, Dean, College of Fisheries (AAU), Raha
- Dr. J. K. Jena, Director, ICAR-NBFGR (presently DDG, Fisheries)
- Prof. G. Dash, Department of Fish Health Management, WBUAFS, Kolkata
- Dr. Shamik Das, Joint Director, Directorate of Fisheries, Government of West Bengal

Bangalore Research Centre

- Shri. H. Veerappa Gowda, Director of Karnataka State Fisheries
- Dr. K. K. Vass, Former director, visited ICAR- CIFRI Research Centre, Bangalore

LINKAGES

The institute maintains close linkages with several organizations involved in fisheries research and development. The institute collaborated with them in research, development, extension, outreach activities, seminars, workshops and publications. The key partners of the institute in 2015-16 were

INTERNATIONAL

- Bay of Bengal Large Marine Ecosystem, FAO
- International Union for Conservation of Nature (IUCN)
- Wageningen University and Research Centre, Wageningen NETHERLANDS
- Wetland International, New Delhi
- WWF-India, New Delhi

NATIONAL

Universities

- State Institute of Rural Development (SIRD), Govt. of Assam
- Uttarbanga Krishi Viswavidyalaya, Poondibari, 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
- Assam Fisheries Development Corporation Ltd., Guwahati, Assam
- Department of Zoology, University of Calcutta, West Bengal
- Department of Environmental Science, Manonmaniam Sundar University, Alwarkurichi, Tamilnadu
- University of Kalyani, West Bengal
- Vidyasagar University, West Bengal
- West Bengal Biodiversity Board
- Visva-Bharati University, West- Bengal
- Bidhan Chandra Krishi Viswavidyalaya, Mohanpur
- Garhwal University, Srinagar
- Centre for Innovation in Public Sector, Hyderabad
- University of Agriculture Science, Dharward

CENTRAL

- National Fisheries Development Board, Hyderabad
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Central University of Bihar, Patna
- College of Fisheries, Central Agricultural University, Lembucherra, Agartala
- Indian Statistical Institute, Kolkata, West Bengal
- Indian Institute of Science Education and Research, Kolkata
- Manipur University, Imphal, Manipur
- National Institute of Oceanography (NIO), Dona Paula, Goa
- Indian Institute of Technology, Kharagpur
- Chilika Development Authority, Bhubaneswar
- National Institute of Ecology, Jaipur
- IISER, Kolkata
- Faculty of Life Sciences, Manipur University, Imphal
- Space Applications Centre, Ahmedabad
- ITCOOCean, INCOIS, Hyderabad
- School of Environmental Sciences, JNU, New Delhi

ICAR

- Indian Agricultural Research Institute, New Delhi
- Central Institute of Fisheries Education, Mumbai
- National Academy of Agricultural Research Management, Hyderabad
- ICAR Research Complex for NEH , Umiyam, Meghalaya
- Zonal Project Directorate (ZPD), ICAR Zone III, Umiam, Meghalaya
- Central Marine Fisheries Research Institute, Kochi
- Central Institute of Fisheries Technology, Kochi
- Central Institute of Freshwater Aquaculture, Bhubaneswar
- Central Institute of Brackishwater Aquaculture, Chennai
- Directorate of Coldwater Fisheries, Bhimtal
- National Bureau of Fish Genetic Resources, Lucknow
- NRC on Pig , Rani, Assam
- Zonal Project Directorate-II, Kolkata
- National Institute of Research on Jute & Allied Fibre Technology, Barrackpore
- ICAR- NIANP, Bangalore

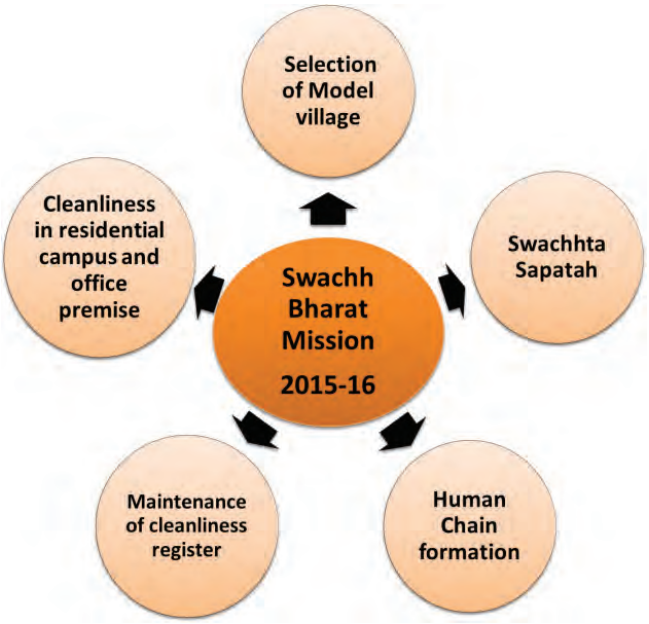
State departments

- 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 , Telengana
- Directorate of Fisheries , Karnataka
- Directorate of Fisheries , Madhya Pradesh
- Directorate of Fisheries , Kerala
- Directorate of Fisheries , Uttar Pradesh

SWACHH BHARAT MISSION

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Activities under Swachh bharat mission



Human chain formation

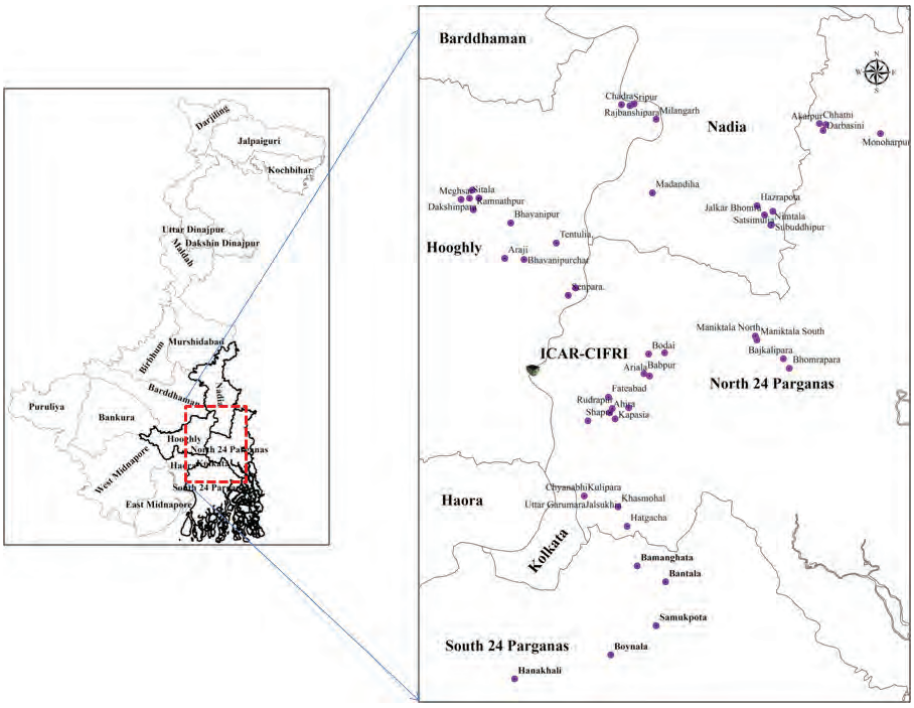
Cleaning the neighbourhood

Cleaning the campus

Sensitization of school students on the occasion of Swachhta Pakhwara

MERA GAON MERA GAURAV

Total 50 villages were selected for implementation of Mera Gaon Mera Gaurav programme after baseline survey in 4 districts of West Bengal.



Major problems reported by the farmers of the villages

- Agriculture: Pest and disease outbreaks, non availability of certified seeds in time, over use of fertilizers, Marketing problem & market price, Agricultural input problem
- Livestock: Disease outbreak, Low milk yield, Lack of improved breed
- Aquaculture: Insufficient seed/feed, lack of knowledge on modern fish culture practices
- Sewage fed fish farming: Less availability of sewage water for fish farming
- Capture fishery: intensity high due to high no. of fishermen & same water area & lack of knowledge on culture based fisheries
- Beel Fishery: Flooding, Loss of River connectivity, Macrophyte infestation, Siltation etc.

Activities envisaged

- Preparing database of mobile user farmers
- Village meetings/ Interface with the farmers
- Advisory services whenever needed
- Awareness programmes
- Demonstration of suitable technologies with the help of KVKs or State Govt.
- Development of village specific brief technical literature
- Imbibe the thought of Swachh Bharat

HINDI CELL

Hindi *Pakwada* organized

Hindi fortnight (Hindi *pakhwada*) was observed from 07th to 14th September 2015 at CIFRI, Headquarter and all regional centres. At CIFRI, HQ various quiz completion like essay writing, dictation, official were organized.

At Bangalore research centre, a workshop on " Prashasan me Hindi Ka Upayog" was conducted by Mr. A. K. Jagadeesan, Asst. Director (OL), ICAR-IIHR.All the staff at the centre enthusiastically participated in the workshop as well as the events conducted in association with the programme.

LIBRARY AND INFORMATICS

Library and Informatics Section facilitates knowledge sharing through its resources of approximately 10000 books, 5000 journals, and 5000 other valuable documents. CIFRI Central library located at CIFRI HQ, Barrackpore; during 2015-16, CIFRI library added a total number of 29 books, subscribed 15 foreign journals and 40 Indian journals to strengthen its resources. Besides Central Library at HQ, Barrackpore; few selected books, journals and Institute publications have also been procured for other centers of CIFRI to enrich libraries of regional centers.

Library & Informatics Section have 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 institutions for online search.About 234 old documents have been scanned and already uploaded in CIFRI website and 'Krishikosh' for easy download. CIFRI library has become an active member of 'CeRA' Consortium by sending 210 documents to different NARS institute through Document Delivery Requests (DDR) during the year.

STAFF

Staff Position (as on 31.03.2016)

Category	Sanctioned Strength	Filled up	Vacant
R.M.P	1	-	1
Scientist	95	72	23
Technical	85	53	32
Administrative	66	39	27
Skilled Support Staff (SSS)	130	60	70
TOTAL	**377**	**224**	**153**

Centre – wise staff in position (as on 31.03.2016)

Name of the Centre	RMP	Scientist	Technical	Administrative	SSS	Total
Barrackpore	–	45	36	32	30	143
Kolkata	–	3	1	1	–	5
Vadodara	–	2	3	1	6	12
Allahabad	–	7	6	3	10	26
Bangalore	–	6	1	2	3	12
Guwahati	–	7	4	–	5	16
Kochi	–	2	2	–	6	10
TOTAL	**–**	**72**	**53**	**39**	**60**	**224**

PERSONNEL

Headquarter, Barrackpore
Director (Actng.)
Dr. V. R. Suresh

Head of Divisions
Dr. B. P. Mohanty
Dr. V. R. Suresh
Dr. U. K. Sarkar

Principal Scientists
Dr. M. A. Hassan
Dr. A. K. Das (In-Charge E & T Cell)
Dr. S. Samanta (In-Charge Hindi Cell)
Dr. Malay Naskar
Dr. M. K. Bandopadhyay
Dr. S. K. Nag
Dr. B. K. Behera
Dr. S. K. Manna (In-Charge PME Cell)
Dr. Md. Aftabuddin
Dr. Arun Pandit (In-Charge AE Section)

Senior Scientists
Dr. R. K. Manna (In-Charge L & I SECTION)
Dr. A. K. Bera

Scientists
Shri P. Maurye
Shri Ganesh Chandra
Dr. D. Das
Shri D. Karunakaran (In-Charge IT&AC)
Shri S. K. Sahu
Dr. A. K. Sahoo (In-Charge A &H Unit)
Shri Roshith C.M
Dr. D. Panda
Shri Dharmendra Kumar Meena
Dr. Sandhya K.M
Dr. Deepa Sudheesan
Dr. (Ms) Aparna Roy
Ms. Anjana Ekka
Dr. Sajina A.M
Dr. Soma Das
Dr. Rohan Kumar Raman
Ms. Tanuja Abdulla
Dr. P. K. Parida
Shri Raju Baitha
Ms. Suvra Roy
Shri Manas H. M
Ms. Kavita Kumari
Ms. Suman Kumari
Shri Vikas Kumar
Shri Lianthuamluaia
Ms. Gunjan Karnatak
Shri Mishal P
Shri S. K. Koushlesh
Shri Gulshan Kumar Sharma
Shri N. S. Singh

Technical Staff
Dr. S. Bhowmick
Smt. Sucheta Majumder
Shri D. K. Biswas
Ms. Sunita Prasad
Smt. Keya Saha
Shri S. K. S. S. Hameed
Shri S. K. Paul
Shri S. Bandopadhyay
Shri Arijit Ghosh
Sk. Rabiul
Shri A. K. Jana
Shri Biswanath Bose
Shri R. C. Mandi
Shri C. N. Mukherjee
Smt. A. Sengupta
Shri D. Saha
Shri A. Roy Chowdhury
Shri S. Mondal
Shri L. R. Mahaver
Smt. Subhra Saha
Shri Subrata Das
Md. Y. Ali
Shri B. K. Naskar
Mr. J. Balmiki
Shri Sujit Chowdhury
Shri Atanu Das
Shri M. Roy
Shri Lokenath Chakraborty

Shri T. K. Halder
Shri Soumitra Roy
Shri S. K. Biswas
Shri Md. Qasim
Shri A. Chakraborty
Shri A. K. Mondal
Shri Giridhari Paramanick
Shri Sanjay Kumar Das

Senior Finance Accounts Officer
Shri S. K. C. Bose

Administrative Officer
Mr. N. K. Jha

Administrative Staff
Shri Sudipta Gupta (AAO)
Shri Shyam Sundar Ghosh (AAO/ DDO)
Shri Sujit Kumar Ghosh (AAO)
Smt. Anita Majumder (AAO)
Shri Biswajit Barua (AAO)
Shri Bijoy Kumar Roy (UDC)
Mrs. Mousumi Banerjee
Ms. Pausali Mukherjee
Mrs. Ruma Ghosh
Shri Pratyay Sarkar
Ms. Sefali Biswas
Shri Suranjan Kr. Singh
Shri Subir Das
Shri Satyabrata Biswas
Smt. S. Mitra
Shri Sukumar Sarkar
Shri Santosh Sarkar
Shri Kishore Shaw
Shri Ganesh Chandra Burman
Shri Pradipta Sen
Shri Swapan Kumar Das
Shri S. Karmakar
Mr. M. Joarder

Shri Chandan Chakraborty
Shri Fazal Khan
Mrs. Swapna Chattopadhyay
Shri R. K. Roy
Mrs. Jolly Saha
Shri B. L. Dhanuk

Supporting Staff
Smt. S. Chakraborty
Shri S. Banerjee
Smt. K. Biswas
Shri B. K. Halder
Shri D. K. Das
Shri A. N. Prasad
Shri Gopal Chandra Roy
Shri U.S. Ram
Shri G. S. Gawate
Shri S. K. Gain
Shri A. K. Bhanja
Shri M. P. Das
Shri D. Singha
Shri P. C. Paramanick
Shri Ratan Das
Shri Anil Chandra Das
Shri Manabendra Dutta
Shri Rabi Kumar Sonkar
Mr. Sukhen Das
Shri Shabbir Ahmed
Shri Probodh Mahata
Shri Asoke Kumar Dey
Shri M. L. Sarkar
Smt. Shibani Bhattacharjee
Shri K. C. Malakar
Shri T. K. Gayen
Smt. Bindu Singh
Shri Mahendra Balmiki
Shri U. Naik
Mr. B. K. Sahani
Shri S. C. Sadhukhan

Regional Centre, Bangalore
Shri M. Feroz Khan (Scientist & Officer-in-Charge)

Principal Scientist
Dr. D. S. Krishna Rao
Dr. (Mrs.) Preetha Panikkar

Scientist
Shri M. Karthikeyan
Shri Ramya V. L.
Ms. Sibna Mol S

Technical Staff
Shri Vijay Kumar M. E.

Administrative Staff
Smt. G. Vinodalaxmi
Smt. S. Sumitra Devi

Supporting Staff
Shri S. Mahendran
Shri M. Pennappa
Shri K. Mohannan
Shri M. Mari

Regional Centre, Guwahati
Dr. B. K. Bhattachariya (Principal Scientist & Head)

Scientist
Dr. Dipesh Debnath
Shri Anil Kumar Yadav
Ms. Sona Yengkokpam
Shri Pranob Das
Ms. Niti Sharma
Shri Simanku Borah

Technical Staff
Shri K. K. Sharma
Shri Bipul Ch. Ray
Shri A. K. Goswami
Shri Amulya Kakati

Supporting Staff
Shri K. C. Das
Shri N. Deka
Shri S. Kalita
Shri Hemanta Das
Shri Sudama Basfore

Regional Centre, Allahabad
Dr. K. D. Joshi (Principal Scientist & Head)

Senior Scientist
Dr. R. S. Shrivastava

Scientist
Dr. Dharm Nath Jha
Mr. Md. Absar Alam
Shri S.C. Sukla Das
Shri Jeetendra Kumar

Technical Staff
Shri S. K. Srivastava
Dr. (Mrs.) KalpanaSrivastava
Shri SitaramMeena
Shri Vijay Kumar
Shri Jitendran Kr. Singh
Shri Ram Sajiwan

Administrative Staff
Shri A. C. Biswas
Mrs. Divya Jain
Shri Manish Kumar Singh

Supporting Staff
Shri Sitala Prasad
Shri G. Lal
Shri Gopal Chand
Shri Jairam Prasad
Shri Kamlesh Kumar
Smt. Laxmi Devi
Shri M. Panika
Shri Anil Kumar
Shri Roop Narayan Singh
Shri Munshi Ram Rana

Regional Centre, Vadodara
Scientist
Dr. Dibakar Bhakta (on Study leave)
Wakambam Anand Meetei (Scientist-in-Charge)
Mr. Vaisakh G

Technical Staff
Shri R. K. Sah
Shri Solanki Jayesh K.
Shri Ram Prasad

Administrative Staff
Shri C. D. Parmer

Supporting Staff
Shri G. J. Roundale
Shri R. N. Kantibhai
Shri H. J. Chetanbhai
Shri Machi Suresh Bhai Chimanbhai
Shri Tadvi Santibhai Chandubhai
Shri Dangar Arjan Valabhai

Kolkata Station
Dr. A. Sinha (Principal Scientist &Officer-in-Charge)

Principal Scientist
Dr. S. K. Das

Scientist
Ms. Nirupada Chanu

Technical Staff
Shri Arunava Mitra

Administrative Staff
Smt. Subhra Bhattacherjee

Kochi Station
Dr. Rani Palaniswamy (Principal Scientist & Officer-in-Charge)

Scientist
Dr. Thankam Theresa Paul

Technical Staff
Shri S. Monoharan
Smt. Usha Unnithan

Supporting Staff
Shri S. Govindarajan
Shri R. Nagraj
Shri P. V. Shajil
Shri T. V. Velayudhan
Smt. M. G. Soudamini
Shri R. Rajendran

Superannuation during FY 2015-16

Sl. No.	Name of the Official	Designation	Date of Superannuation
1.	Smt. Amita Chakraborty	Assistant	30.04.2015 (F. N.)
2.	Smt. HemlataHalder	Skilled Support Staff	30.04.2015 (F. N.)
3.	Shri S. L. Bairagi	Technical Assistant	31.05.2015 (F. N.)
4.	Shri B. P. Samanta	Skilled Support Staff	31.05.2015 (F. N.)
5.	Smt. Dhanmaya	Skilled Support Staff	31.05.2015 (F. N.)
6.	Shri B. P. Mishra	Skilled Support Staff	30.06.2015 (F. N.)
7.	Smt. M. Biswas	Skilled Support Staff	30.06.2015 (F. N.)
8.	Shri B. K. Biswas	Asstt. Chief Tech. Officer	31.07.2015 (F. N.)
9.	Shri T. P. Ghosh	Lower Division Clerk	31.07.2015 (F. N.)
10.	Shri R. K. Sardar	Skilled Support Staff	31.07.2015 (F. N.)
11.	Shri Paras Ram	Assistant	31.08.2015 (F. N.)
12.	Shri B. Balmiki	Skilled Support Staff	31.08.2015 (F. N.)
13.	Shri S. Mahendran	Skilled Support Staff	31.10.2015 (F. N.)
14.	Shri A. K. Barui	Sr. Tech. Assistant	30.11.2015 (F. N.)
15.	Shri U. B. Bhattacharyya	Assistant	31.12.2015 (F. N.)
16.	Shri K. K. Dhir	Upper Division Clerk	31.12.2015 (F. N.)
17.	Shri Fatik Manna	Asstt. Chief Tech. Officer	31.01.2016 (F. N.)
18.	Shri N. K. Chaki	Skilled Support Staff	31.01.2016 (F. N.)

Promotion of Scientific Staff during FY 2015-16

Sl. No.	Name	Date of DPC	Assessment Period	Result
1.	Shri Ganesh Chandra, Scientist	15.12.2015	24.11.2010 to 23.11.2013	Promoted to the post Scientist with RGP ₹ 9000 w.e.f. 24.11.13
2.	Shri Praveen Maurya, Scientist	03.11.2015	16.11.2010 to 15.11.2013	Promoted to the post of Scientist with RGP ₹ 9000 w.e.f. 16.11.13
3.	Shri D. Karunakaran, Scientist	03.11.2015	01.09.2011 to 31.08.2014	Promoted to the post of Scientist with RGP ₹ 9000 w.e.f. 01.09.14
4.	Shri D. N. Jha, Scientist	28.05.14	16.11.2009 to 05.11.2013	Promoted to the post of Scientist with RGP ₹ 8000 w.e.f. 16.11.10

Promotion of Administrative Staff during FY 2015-16

Sl. No.	Name of the Official	Promoted to the Post	Date of Promotion
1.	Shri C. D. Parmer	Assistant	22.07.2015
2.	Smt. Divya Jain	Assistant	22.07.2015
3.	Smt. Ruma Ghosh	Assistant	01.09.2015

Promotion of Technical Staff during FY 2015-16

Sl. No.	Name	Date of DPC	Assessment Period	Result
1.	Shri S. Manoharan	22.08.2015	04.06.2008 to 03.06.2015	Promoted to the post of Chief Technical Officer w.e.f. 04.06.2015
2.	Shri Giridhari Paramanick	22.08.2015	02.08.2004 to 16.09.2014	Promoted to the post of Technical Assistant w.e.f. 17.09.2014
3.	Shri Debasis Saha	10.02.2016	01.07.2009 to 30.06.2014	Promoted to the post of Technical Officer w.e.f. 01.07.2014
4.	Shri A. K. Barui	10.02.2016	01.01.2010 to 31.12.2014	Promoted to the post of Technical Officer w.e.f. 01.01.2015

New Entrants during FY 2015-16

Sl. No.	Name of the Official	Designation	Date of Joining
1.	Ms. Sibina Mol, S.	Fisheries Resource Management	08.04.2015 (afternoon)
2.	Sh. Simanku Borah	Fisheries Resource Management	08.04.2015 (forenoon)
3.	Sh. Vaisakh, G.	Fisheries Resource Management	08.04.2015 (afternoon)
4.	Ms. Thangjam Nirupada Chanu	Fisheries Resource Management	09.04.2015 (forenoon)
5.	Sh. Wakambam Anand Meetei	Fisheries Resource Management	10.04.2015 (forenoon)
6.	Sh. Pranaya Kumar Parida	Fisheries Resource Management	09.04.2015 (forenoon)
7.	Sh. Jeetendra Kumar	Fisheries Resource Management	10.04.2015 (forenoon)
8.	Ms. Niti Sharma	Fish Genetics & Breeding	09.04.2015 (forenoon)
9.	Sh. Ningthoujam S. Singh	Agricultural Chemicals	09.10.2015 (forenoon)
10.	Sh. S. K. Koushlesh	Fisheries Resource Management	08.10.2015 (forenoon)
11.	Sh. Gulshan Kumar Sharma	Environmental Science	09.10.2015 (forenoon)

- Shri James Murmu, Senior Technical Officer died in harness on 28.10.2015.
- Shri Pranab Gogoi, Senior Technical Assistant was relieved from ICAR-CIFRI, Barrackpore on 28.12.2015 (A. N.) to enable him join ICAR-NAARM, Hyderabad for attending 103rd FOCARS from 01.01.2016 as an ARS Scientist (On Probation).
- Shri Asoke Dey, SSS who had been convicted in criminal case, was removed from service w.e.f. 08.03.2016.

PUBLICATIONS

RESEARCH PAPERS

1. Agnihotri P, Sarkar UK, Nagpure NS, Mishra R, Kumar R, Pal A, Awasthi A, Pandey BK and Kumar N (2016). Comparative analysis of length - weight relationship (LWR) of *Ompok bimaculatus* (Bloch, 1794) from six tributaries in the River Ganges Basin, India. *Advances in Applied Research*, 7(2):101-104.
2. Alam A, Chadha NK, Joshi KD, Chakraborty SK, Sawant PB, Kumar T and Sharma AP (2015). Maturation profile and fecundity of the exotic *Oreochromis niloticus* in the River Yamuna, India. *Journal of Environmental Biology*, 36 (4): 927-931.
3. Bandyopadhyay MK, Saha K, Paul SK, Sharma AP, Mohanty BP (2016). Beta diversity of cyprinids as indicators of shifting fishery zonations in Damodar river. *Journal of Inland Fisheries Society of India*, 47(2):20-26.
4. Behera BK, Baisvar VS, Kumari K, Rout AK, Pakrashi S, Paria P, Rao AR and Rai A (2015). The complete mitochondrial genome of the *Anabas testudineus* (Perciformes, Anabantidae) and its comparison with other related fish species. *Mitochondrial DNA*, doi: 10.3109/19401736.2015.1115490.
5. Behera BK, Das P, Maharana J, Paria P, Mandal SN, Meena DK, Sharma AP, Jayarajan R, Dixit V, Verma A, Vellarikkal SK, Scaria V, Sivasubbu S, Rao AR, Mohapatra T (2015). Draft genome sequence of the extremely halophilic bacterium *Halomonas salina* strain CIFRI1, isolated from the eastcoast of India. *Genome Announcement*, 3(1):e01321-14.
6. Behera BK, Kumari K, Baisvar VS, Rout AK, Pakrashi S, Paria P, and Jena, J. K. (2015). Complete mitochondrial genome sequence of Indian medium carp, *Labeo gonius* (Hamilton, 1822) and its comparison with other related carp species. *Mitochondrial DNA*, doi: 10.3109/19401736.2015.1106517.
7. Behera BK, Meena DK, Das P, Singh NS and Pakrashi S (2015). Pengba, a prospective Species for diversification of carp polyculture. *World Aquaculture Society*, 46(4): 52-54.
8. Behera BK, Singh NS, Paria P, Sahoo AK, Panda D, Meena DK, Das P, Pakrashi S, Biswas DK and Sharma AP (2015). Population genetic structure of Indian Shad, *Tenualosa ilisha* inferred for variation in mitochondrial DNA sequences. *Journal of Environmental Biology*, 36(5):1193-1197.
9. Behera BK, Kunal SP, Paria P, Das P, Meena DK, Pakrashi S, Sahoo AK, Panda D, Jena J, Sharma AP (2015). Genetic differentiation in Indian major carp, *Cirrhinus mrigala* (Hamilton, 1822) from Indian rivers, as revealed by direct sequencing analysis of mitochondrial cytochrome b region. *Mitochondrial DNA*, 26(3): 334-336.

10. Bhakta D, Das SK, Manna RK, Roshith CM and Sudhesan D (2015). Fishery of *Otolithoides pama* (Hamilton, 1822) in Narmada estuary. *Journal of Inland Fisheries Society of India*, 47(2): 78-80.
11. Bhattacharjya BK, Yengkokpam S, Gogoi P, Sarma KK and Debnath D (2015). Rearing of carried over carp seed in pen enclosure in a closed floodplain wetland of Assam. *Journal of the Inland Fisheries Society of India*, 47(1): 43-48.
12. Chandra G and Bhattacharyya U (2016). Institutions and governance in fisheries of Indian Brahmaputra river basin. *Journal of AgriSearch*, 3 (1): 51-56.
13. Chandra S and Joshi KD (2015). Study on growth and survival of carps in salt affected ponds under different treatments. *Journal of Inland Fisheries Society of India*, 47 (1): 36-42.
14. Chaudhari A, Gireesh-Babu P, Tripathi G, Sabnis S, Dhamotharan K, Vardarajan R, Kumari K, Dasgupta S, Rajendran KV (2015). Expression studies on NA+/K+-ATPase in gills of *Penaeus monodon* (Fabricius) acclimated to different salinities. *Indian Journal of Experimental Biology*, 53(5): 273-280.
15. Chowdhury N, Samanta S, Manna SK, Mohanty BP, Sharma AP, Bandopadhyay C, Pramanik K and Sarkar S (2015). Arsenic in freshwater ecosystems of Bengal Delta: status, sources and seasonal variability. *Toxicological & Environmental Chemistry*, 97 (5): 538-551.
16. Das P, Behera BK, Meena DK, Azmi SA, Chatterjee S, Meena K and Sharma AP (2015). Salt stress tolerant genes in halophilic and halotolerant bacteria: Paradigm for salt stress adaptation and osmoprotection. *International Journal of Current Microbiology and Applied Science*, 4(1): 642-658.
17. Das UK, Rout SK, Kumar N, Misra RP, Bhattacharjya BK, and Gogoi P (2015). Limnochemistry of River Pagladia (a major tributary of Brahmaputra), Assam. *Environment & Ecology*, 33(2A):863-866.
18. Datta SN, Dhawan A, Kumar Kaur, VIA and Parida P (2015). Standardization of stocking density for maximum biomass production of spotted snakehead *Channa punctata* (Bloch, 1793) reared in cages. Ecology, *Environment and Conservation*, 21: 225-229.
19. Datta SN, Kumar S, Singh A and Parida P (2015). Study on ovarian development of *Channa punctata* (Bloch 1793) reared in pond cages and natural water Bodies of Punjab. *The Bio Scan*, 10(3): 1185-1189.
20. Ganguli B, Roy SS, Naskar M, Malloy EJ and Eisen EA (2015). Deletion diagnostics for the generalised linear mixed model with independent random effects. *Statistics in Medicine*, doi: 10.1002/sim.6810.
21. Hassan MA, Aftabuddin M, Meena DK, Mishal P and Dasgupta S (2016). Effective utilization of Distiller's grain soluble- an agro-industrial waste in the feed of cage reared minor carp *Labeo bata* in a tropical reservoir, India. *Environmental Science & Pollution Research*, doi: 10.1007/s11356-016-6732-z.
22. Jagadeesh TD, Murthy HS, Surendranath SV, Panikkar P, Manjappa N and Mahesh V (2015). Effect of supplementation of marigold (*Tagestes erecta*) oleoresin on growth, survival and pigmentation of rosy barb, *Puntius conchonius* (Hamilton). *The Bioscan* 10 (3): 1431-1435.
23. Jyoti S, Parashar A, Sarkar UK, Dayal R, Pandey AK and Bagare P (2015). Tor mahseer in Indian water with special reference to conservation strategies for *Tor tor* in Madhya Pradesh (India). *Journal of Applied Biosciences*, 41 (2): 110-123.
24. Khan MF, Panikkar P and Sharma AP (2015). Modeling the food web for assessment of the impact of stock supplementation in a reservoir ecosystem in India. *Fishery Management and Ecology*, 22(5):359–370.

25. Konan KJ, Joanny TGT, Sylla S, Lianthuamluaia and Kumar KL (2015). Stock assessment of the bigeye grunt *Brachydeuterus auritus* (Valenciennes, 1832) in the coastal water of Ivory Coast. *International Journal of Agricultural Policy and Research*, 3 (5): 222-230.
26. Kumar R, Jaiswar AK, Chakraborty SK, Sarkar UK and Lakra WS (2015). Morphological differentiation of catfishes. *Indian Journal of Fisheries*, 62(4): 109-115.
27. Kumar R, Pandey BK, Sarkar UK, Nagpure NS, Vishwamitra, Baisvar S, Agnihotri P, Awasthi A, Mishra A and Kumar N (2016). Population genetic structure and geographic differentiation in butter catfish, *Ompok bimaculatus*, from Indian waters inferred by cytochrome b mitochondrial gene. *Mitochondrial DNA*, doi:10.3109 /19401736.2015.1137898.
28. Kumar V and Hassan MA (2015). Methods and procedures of sampling, preservation and identification for fish taxonomy studies. *World Journal of Fish and Marine Sciences*, 7 (2): 105-108.
29. Kumar V, Roy S and Barman D (2015). Effect of *Mikania cordata* (Burm) B. L. Robins. On non-specific immune response of *Catla catla* (Hamilton, 1822) against Aphanomyces invadans. *Fishery Technology*, 52(1): 20-25.
30. Kumar V, Roy S, Sahoo AK, Behera BK and Sharma AP (2015). Horseshoe crab and its medicinal values. *International Journal of Current Microbiology and Applied Sciences*, 4(2): 956-964.
31. Lakra WS, Singh M, Goswami M, Gopalakrishnan A, Lal KK, Mohindra V, Sarkar UK, Punia P, Singh KV, Bhat JP and Ayyappan S (2015). DNA barcoding of Indian freshwater fishes. *Mitochondrial DNA*, doi:10.3109/19401736.2015.1101540.
32. Lianthuamluaia, Pandey PK, Purushothaman CS, Vennila A and Zohmingthanga (2015). Characterization of arsenic resistant bacteria from shallow tubewell and evaluation of their remediation capacity. *Nature Environment and Pollution Technology*, 14 (1): 119-124.
33. Mahanty A, Maji SR, Ganguly S, Mohanty BP (2015). GC-MS Fingerprinting of fatty acids of freshwater mollusc *Lamellidens Marginalis* using different columns, TR-WAX and TR-FAME. *Analytical and Bioanalytical Techniques*, doi: 10.4172/2155-9872.1000238.
34. Maharana J, Sahoo BR, Bej A, Jena I, Parida A, Sahoo JR, Dehury B, Patra MC, Martha SR, Balabantray S, Pradhan SK, Behera BK (2015). Structural models of zebrafish (*Danio rerio*) NOD1 and NOD2 NACHT domains suggest differential ATP binding orientations: Insights from computational modeling, docking and molecular dynamics simulations. *PLOS ONE*. doi:10.1371/journal.pone.0121415.
35. Maitra N, Bandopadhyay C, Samanta S, Sarkar K, Sharma AP and Manna SK (2015). Isolation, identification and efficacy of inorganic phosphate-solubilizing bacteria from oxbow lakes of West Bengal, India. *Geomicrobiology Journal*, 32: 751-758.
36. Maitra N, Manna SK, Samanta S, Sarkar K, Debnath D, Bandopadhyay C, Sahu SK and Sharma AP (2015). Ecological significance and phosphorus release potential of phosphate solubilizing bacteria in freshwater ecosystems. *Hydrobiologia*, 745 (1): 69–83.
37. Manas HM, Deshmukhe G, Venkateshwarlu G, Chakraborty SK and Jaiswar AK (2015). Morphological comparison of different Caulerpa JV Lamouroux species along Maharashtra and Gujarat coast, India. *Indian Journal of Geo-Marine Sciences*, 44: 5.
38. Mohanty BP, Banerjee S, Sadhukhan P, Chowdhury AN, Goldar D, Bhattacharjee

S, Bhowmick S, Manna SK, Samanta S (2015). Pathophysiological changes in Rohu (*Labeo rohita*, Hamilton) fingerlings following arsenic exposure. *National Academy Science Letters*, 38(4): 315-319.

39. Mohanty BP, Karunakaran D, Mahanty A *et al*. (2015). Database on nutritional composition of food fishes from India. *Current Science*, 109(11):1915-1917.
40. Mohanty BP, Mitra T, Banerjee S, Bhattacharjee S, Mahanty A, Ganguly S, Purohit GK, Karunakaran D and Mohanty S (2015). Proteomic profiling of white muscle from freshwater catfish *Rita rita*. *Fish Physiology and Biochemistry*, 41(3):789-802.
41. Nagpure NS, Rashid I, Pathak AK, Singh M, Pati R, Singh SP and Sarkar UK (2015). FMiR: A curated resource of mitochondrial DNA information for fish. *PLoS One*, 10(8): e0136711.
42. Naskar M, Sahu SK and Sharma AP (2015). Assessment of fish species assemblage on meso habitat scale: A case of middle stretch of Narmada River, India. *Aquatic Ecosystem Health and Management Society*, 18(2): 232-239.
43. Panda D, Jaiswar AK, Sarkar SD and Chakraborty SK (2015). Growth, mortality of bigeye scad, *Selar crumenophthalmus* off Mumbai, north-west coast of India. *Journal of Marine Biological Association of the UK*, doi: 10.1017/S0025315415001459.
44. Pandit A, Ekka A, Sharma AP, Bhattacharjya BK, Katiha PK and Biswas DK (2015). Economic valuation of natural ecosystems-an empirical study in a stretch of Brahmaputra River in Assam, North-East India. *Indian Journal of Fisheries*, 62(3): 107-112.
45. Prusty AK, Meena DK, Mohapatra S, Panikkar P, Das P, Gupta SK, Behera BK (2015). Synthetic pyrethroids (Type II) and freshwater fish culture: Perils and mitigations. *International Aquatic Research*, 7 (3):163-191.
46. Purohit GK, Mahanty A, Mohanty BP, Mohanty S (2015). Evaluation of housekeeping genes as references for quantitative real-time PCR analysis of gene expression in the murrel *Channa striatus* under high-temperature stress. *Fish Physiology and Biochemistry*, 42(1):125-135.
47. Raman RK, Paul AK, Das S and Wahi SD (2015). Empirical comparison of the performance of linear discriminant function under multivariate non-normal and normal data. *International Journal of Agricultural and Statistics Sciences*, 11 (2): 403-409.
48. Raman RK, Sud UC and Chandra H (2015). Calibration approach based product estimator of finite population total with sub-sampling of non-respondents under single and two-phase sampling. *Communications in Statistics - Simulation and Computation*, doi:10.1080/03610918.2014.936468.
49. Rasal A, Roy S, Rana RS, Murali S, Krishna G, Gupta S, Gireesh-Babu P (2016). Molecular cloning and nutritional regulation of putative Δ6 desaturase mRNA from striped catfish (*Pangasianodon hypophthalmus*). *Aquaculture*, 451: 413–420.
50. Roshith CM, Manna RK, Suresh VR, Panda D, Sharma AP, Roy Chowdhury A, Mukherjee M and Banik SK (2016). Electric ray *Narcine timlei* (Torpediniformes: Narcinidae) from Chilika lagoon, Odisha, India. *Current Science*, 110(8): 1408-1410.
51. Roy A, Manna RK and Sharma AP (2016). Socio-economic and livelihood analyses of hilsa (*Tenulosa ilisha*) fishers of lower stretch of Ganga River, India. *Indian Journal of Fisheries*, 63(1): 83-88.
52. Roy A, Pandit A, Sharma AP, Bhaumik U, Majumder S and Biswas D (2015). Socioeconomic status and livelihood of fisher women of Hooghly estuary. *Journal of Inland Fisheries Society of India*, 47(1):49-56.

53. Roy S, Kumar V, Suresh VR and Homechaudhuri S (2015). A survey for shrimp diversity and abundance study in Sundarbans during monsoon, West Bengal, India. *Journal of Interacademicia*, 19(4): 608-611.

54. Saha S, Hassan MA, Sharma AP (2015). Effect of dietary probiotics on growth performance of rohu, *Labeo rohita* fingerlings. *International Journal of Pharmacy and Biological Sciences*, 6(1): (B) 1260 – 1268.

55. Sahebrao NN, Pathak AK, Pati R, Rashid I, Sharma J, Singh S, Singh M, Singh SP, Sarkar UK, Khuswaha B, Kumar R and Murali S (2016). Fish Karyome Version 2.1: A chromosome database of fish and other aquatic organisms. DATABASE. *The Journal of Biological Databases and Curation*, doi:10.1093/database/baw012.

56. Sahoo AK and Sahoo B (2015). Environmental flow estimation under climate change. *Current Science*, 109(9): 1522.

57. Sahoo AK, Sharma AP and Suresh VR (2016). Managing rivers: ecohydrology an effective tool under climate change. *National Academy Science Letters*, doi: 10.1007/s40009-016-0454-0.

58. Sahoo AK, Wahab A, Phillips M, Rahman A, Padiyar A, Velmurugu P, Bangera R, Belton B, De DK, Meena DK, Behera BK, Sharma AP, Bhaumik U, Mohanty BP, Roy Choudhury S, ChadagVishnumurthy Mohan CV (2016). Breeding and culture status of Hilsa (*Tenualosa ilisha*, Ham. 1822) in South Asia: a review. *Reviews in Aquaculture* doi:10.1111/raq.12149.

59. Sahoo, AK, Sharma AP and Suresh VR (2015). Managing rivers: Ecohydrology an effective tool under changing Climate. *National Academy of Science Letters*, doi: 10.1007/s40009-016-0454-0.

60. Samanta S, Debnath D, Maitra N, Banerjee M, Chowdhury AN, Sharma AP and Manna SK (2015). Sediment phosphorus forms and levels in two tropical floodplain wetlands. *Aquatic Ecosystem Health and Management society*, 18 (4): 467 – 474.

61. Sandhya KM, Chakraborty SK, Jaiswar AK, Kumar T and Mohite S (2015). Morphometry and length-weight relationship of *Otolithes cuvieri* (Trewavas, 1974) from Ratnagiri waters, Maharashtra, north-west coast of India. *Indian Journal of Fisheries*, 62(4): 99-103.

62. Sandhya KM, Hassan MA, Kumari S, Mishal P, Lianthuamluaia, Kumar V, Aftabuddin M and Meena DK (2016). Length-weight relationships of four indigenous freshwater fish species from Khalsi wetland in lower Ganga basin, West Bengal, India. *Journal of Applied Ichthyology*, doi:10.1111/jai.13005.

63. Santra S, Sinha A and Mondal C, (2016). Effect of herbal plant (Garlic) against common disease in Gold Fish, *Carassius auratus* (Linn. 1758). *International Journal of Latest Technology in Engineering, Management & Applied Science*, 5(3): 42-44.

64. Sarkar S D, Chaudhari A, Deshmukhe G and. Gireesh Babu P (2015). Assessment of genetic diversity among Sargassum species from selected locations along the north-west coast of India. *Indian Journal of Fisheries*, 62(3):161-165.

65. Sarkar SD, Ekka A, Sahoo AK, Roshith CM, Roy Chowdhury A (2015). Role of Floodplain wetlands in supporting livelihood: A case study of Ansupa Lake in Odisha. *Journal of Environmental Science, Computer Science and Engineering & Technology*, 4(3): 819-826.

66. Sarkar UK, Mahapatra BK, Saxena SR and Singh AK (2015). Mahseer in India: An overview on research status and future priorities. *Journal of Ecophysiology and Occupational Health*, 15 (1&2): 45-52.

67. Seeba I, Jha DN, Thakur S and Dwivedi AC (2015). Age structure of *Labeo calbasu* (Hamilton, 1822) from river Yamuna. *Journal of Inland Fisheries Society India*, 47(2): 81-85.

68. Singh BK, Srivastava K, Joshi KD and Srivastava SK (2015). Biotic parameters of the river Yamuna in relation to pollution status. *Journal of Inland Fisheries Society India*, 47(2): 51-58.
69. Singh SK, Tiwari VK, Chadha NK, Prakash C, Sukham M, Das P, Mandal SC and Chanu TI (2015). Effect of *Bacillus circulans* and fructooligosaccharide supplementation on growth and haemato-immunological function of *Labeo rohita* (Hamilton, 1822) fingerlings exposed to sub-lethal nitrite stress. *The Israeli Journal of Aquaculture - Bamidgeh*, doi: IJA_67.2015.894.
70. Sinha A and Santra S (2016). Integration of high priced small indigenous fish with conventional carp culture for nutritional security and rural livelihood. *International Journal of Agriculture Innovations and Research*, 4 (5): 2319-1473.
71. Sreekanth GB, Varghese T, Mishal P, Sandeep KP, Praveen KV (2015). Food security in India: Is aquaculture a solution in the offing? *International Journal of Science and Research*, 4(3): 553-560.
72. Vass KK, Wangeneo A, Samanta S, Adhikari S and Muralidhar M (2015). Phosphorus dynamics, eutrophication and fisheries in the aquatic ecosystems in India. *Current Science*, 108 (7): 1306-1314.

POPULAR ARTICLES

1. Alam A (2015).Green Fluorescent Protein. *Nilanjali, Anak*, ICAR-Central Inland Fisheries research Institute, Barrackpore, pp. 19-21.
2. Behera BK, Meena DK, Das P, Singh NS and Pakrashi S (2015). Pengba, a prospective species for diversification of carp polyculture: Conservation and future prospects. *World Aquaculture*, 46(4): 52-54.
3. Borah S, Parida PK, Landge AT, Ramteke KK, Vaisakh G and Chetia BR, (2015). Climate smart fisheries and aquaculture. *Aqua International*, pp. 43-46.
4. Debnath D, Saud BJ, Bhattacharjya BK, Yengkokpam S and Yadav AK (2015). Perceived and probable impact of climate change on fisheries ecology of River Brahmaputra in Assam, India. *Fishing Chimes*, 34 (12): 48-51.
5. Kumar V, Karnatak G, Mishal P, Das AK, Hassan MA and Sharma AP (2015). Potential species for cage aquaculture in Indian reservoirs. *World Aquaculture*, pp.46-48.
6. Kumar V, Karnatak G, Mishal P, Das AK, Hassan MA and Sharma AP (2015). Potential species for cage aquaculture in Indian reservoirs. *World Aquaculture*, 46 (3):46-48.
7. Mahapatra BK, Sarkar UK and Lakra WS (2015). Biodiversity of marine ornamental fish in West Bengal: Issues of sustainability and livelihood security. *Souvenir. Uttar Pradesh State Biodiversity Board. Biodiversity for sustainable development*. Lucknow, Uttar Pradesh. pp. 92-95.
8. Rao DSK (2015). Reservoir fisheries for food security, *Deccan Herald*, 24.7.2015.
9. Roy A and Manna RK (2015). Conservation of hilsa fishery vis-à-vis socio-economics of hilsa fishers: Hilsa Fisheries and Conservation. *Proceedings of National Seminar on Hilsa Fisheries and Conservation*. Pp. 104-111.
10. Sarkar UK and Dubey VK (2015). Threats to fish and fisheries in the Ganga Basin: Consequences of changing habitats and altering diversity patterns', *GWF Discussion Paper*, Global Water Forum, Canberra, Australia. Available online at: http://www.globalwaterforum.org/2015/08/27.
11. Sarkar UK, Dubey VK, Pathak AK and Mahapatra BK (2015). Biodiversity of Freshwater Fishes in Uttar Pradesh: Status and Reinforcing Conservation Efforts for Sustainable Management. *Souvenir: U.P State Biodiversity Board. Biodiversity for sustainable development*. Lucknow, Uttar Pradesh. pp.88-91.

12. Sreekanth GB, Varghese T, Mishal P, Sandeep KP, Praveen KV (2015). Food Security in India: Is Aquaculture a Solution in the Offing? *International Journal of Science and Research*, 4(3): 553-560.
13. Varghese T and Mishal P (2016). New insights on old players: specialisations and plasticity of fish hemoglobins. *Aqua International* (April edn). pp. 58-60.
14. Varghese T, Mishal P, Sandeep KP and Pal AK (2015). Nucleotides in aquafeeds: A right step towards sustainable nutrition. *Fishing Chimes*, 35 (7): 49-55.

ABSTRACTS

1. Arpana Singh and S.K. Nag (2015). Presence of pesticide residue in feeds – An assessment. In: Book of extended abstracts, XXIII International Grassland Congress organized by the Range Management Society of India and ICAR-IGFRI and held at New Delhi during November 20-24, 2015. Pp
2. Baitha R, Sinha A, Roy A, Kumari K, Roy S, Saha D, Chowdhury AR and Mitra A (2016). Diversity of Small Indigenous Fishes (SIFs) of river Gandak. In: Book of abstracts, International Conference on Aquatic Resource and Conservation held at Science City, Kolkata during 17-19 February. Pp. 114-115.
3. Bandyopadhyay MK, Manna RK, Pandit A, Mondal S and Bhowmick S (2016). Development of canal fisheries in Sundarbans for livelihood support to dependent fishers. In: Book of abstracts, 11th National Symposium, held at ICAR-IIWM, Bhubaneswar, Odisha, India during January 14-17, 2016. Pp.
4. Banerjee S, Mohanty S, GuhaMazumder DN, Mohanty BP (2015). Identification of biomarkers of hepatotoxicity and chronic liver disease by plasma proteome analysis of arsenic-exposed carp. In: Book of abstracts, 7th Annual meeting of Proteomics Society held at Vellore, India during December 3-6, 2015. Pp
5. Banik SK, Manna RK, Suresh VR, Sajina AM, Sandhya KM, Behera BK, Mukherjee, J and Kar S (2015). Abundance of hilsa (*Tenualosa ilisha*) in relation with physico-chemical properties of water in river Hooghly. Poster presented in National seminar on Hilsa fisheries and Conservation organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015.
6. Behera BK & Kumari K (2016). Application of genetic markers in fisheries and aquaculture. In: Proceedings of the 103rd Indian Science Congress, Mysuru, under section of Animal, Veterinary and Fisheries Sciences, organized by The Indian Science Congress Association, Kolkata during January 3-7, 2016. Pp-69.
7. Bhakta D & Anand MW (2016). Inland fisheries resources of Gujarat and their management strategies. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihhod Security, Sustainability and Conservation' held at NESFA, COF, CAU (I), Lembucherra, Tripura from January 21-22, 2016. Pp-82.
8. Bhakta D & Anand MW (2016). Inland fisheries resources of Gujarat and their management strategies. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihhod Security, Sustainability and Conservation', College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Pp-82.
9. Bhakta D, Das SK & Manna RK (2016). Status of Mullets fishery resources in Narmada estuary and their conservation measures. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihood Security, Sustainability and Conservation', NESFA, COF, CAU (I), Lembucherra, Tripura from January 21-22, 2016. Pp-81.
10. Bhakta D, Rao DSK, Sah RK & Solanki JK (2016). Status on Ecology and Fishery of Ukai reservoir, Gujarat, India. In: Book of abstracts, International Conference on: Aquatic Resources & Sustainable Management organised by Central Calcutta Science & Cultural Organization for Youth, West Bengal and held during February 17-19, 2016. Pp-273.

11. Bhakta D, S.K. Das, R.K. Manna and J.K. Solanki 2016. Impact of construction of dam in decline of *Tenualosa ilisha* catch of Narmada estuary, Gujarat. In: Book of abstracts, International Conference on: Aquatic Resources & Sustainable Management, Central Calcutta Science & Cultural Organisation for Youth, West Bengal during February 17-19, 2016. Pp-109.
12. Borah S, Jain S. K., Manna R. K. and Nirupada T. C. 2016. Estimation of environmental flow requirements of Mahanadi River at Tikiapara, Odisha. In: Book of Abstracts, National Seminar on "Fisheries and Aquaculture, Livelihood Security, Sustainability and Conservation" held at College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Pp. 78.
13. Chakraborty N, Das AK and Mandal B. Rapid Structural Characterization of Plant Extracts–a FT-IR study. In: Chemical Science Review and Letters, 2nd National Conference on 'Fundamental and Applied Chemistry' held at Salem, Tamil Naidu on June 4, 2016. Pp
14. Chakraborty N, Das AK and Sharma AP (2015). Wetland colonizers to anti dandruff dermatitis – a scientific validation of Indigenous Technical Knowledge on Ipomoea. In: Book of abstracts, 25th Asia-Pacific Weed Science Society Conference held at Hyderabad during October 13-16, 2015. Pp
15. Chakraborty N, Das AK and Sharma AP (2015). Wetland colonizers to anti dandruff dermatitis: study with swamp cabbage. In: Journal of natural product chemistry & research, 3rd International conference and exhibition on 'Pharmacognosy, Phytochemistry & Natural Products' held at International Convention Centre, Hyderabad from October 26-28, 2015, 3(6): 107.
16. Chakraborty N, Mandal B, Das AK, Manna RK and Kumar L (2016). Bioactive phyto-compounds: facet of green chemistry - a review. In: Book of abstracts, National Seminar on 'Medicinal Plants (NSMP – 2016)' organized by UGC-DRS-SAP & DST, Department of Botany & Forestry, Vidyasagar University, February16-17, 2016. Pp 53.
17. Chandra G and Ekka A (2015). Tenurial Rights and institutional arrangements in floodplain wetland fisheries of Bihar. In Souvenir cum abstract book, ISEE Golden Jubilee National seminar on strategy to drive skill based agriculture development forward for sustainability and rural employability, organized by Indian society of extension education and held at BHU, Varanasi during November 5-7, 2015. Pp 167.
18. Chandra G and Srivastava M (2016). Startups in Inland fisheries: case study of Chaurs in Siwan and Gopalganj districts of Bihar. In: Souvenir, National conference on 'Rural livelihood security through innovative agri-entrepreneurship' held at ICAR-CPRS, Patna, March 12-13, 2016. Pp 134.
19. Chanu TN, Muralidhar M, Vasanth M, Nagavel A, Karthik, J. S., Koushlesh, S. K., Manna, R. K. and Das, S. K. 2016. Assessment of greenhouse gas emission in the selected coastal open water systems of Tamil Nadu, India. In: Book of abstracts, National Seminar on 'Integrating agri-horticultural and allied research for food and nutritional security in the era of global climate disruption' held at ICAR Research Complex for NEH Region, Imphal, Manipur during March 4-6, 2016. Pp120
20. Das AK and Sharma AP (2015). Cage aquaculture in inland open waters of India: retrospect and prospect. In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerela, India during November 25-28, 2015. Pp.57.
21. Das AK, Sharma AP, Kumar V, Sarkar UK and Philipose KK (2015). Engineering components in cage farming for inland open waters of India. In: Book of abstracts,

5th International Symposium on 'Cage aquaculture in Asia' held at Kochi,Kerela, India during November 25-28, 2015. Pp65.

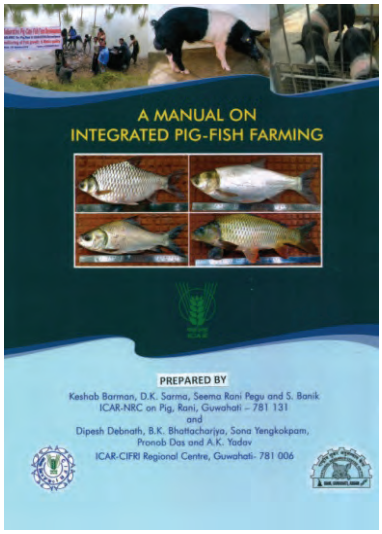
22. Das P, Saharan N, Pal AK, Sahu NP, Prakash C and Tiwari VK (2016). Physiological and ultrastructural changes of *Labeo gonius* (Hamilton, 1822) fingerlings exposed to multiple stressors. In: Book of abstracts, International Symposium on 'Genomics in aquaculture' Bhubaneswar, India, organized by Association of Aquaculturist, AFSIB and CIFA during January 28-30, 2016. Pp 105.
23. Das SK and Manna RK (2016). Seasonal Variation of Litter Fall, Nutrient Contents and in situ Decomposition Pattern of Some Important Mangrove Species of Sunderban. In: Souvenir, National Symposium of ISCAR, held at ISCAR-IIWM, Bhubaneswar during January 14-17, 2016. Pp 79.
24. Das SK and Manna RK (2016). Seasonal variation of litter fall, nutrient contents and in situ decomposition pattern of some important mangrove species of Sunderban. In: Souvenirs and abstracts, National symposium of ISCAR, held at ISCAR-IIWM, Bhubaneswar during January 14-17, 2016. Pp 79.
25. Debnath B, Biradar RS, Krisnan M, Debnath C, Sahoo L & Bhakta D (2016). Trend in annual per capita fish consumption and consumer's price of fish in North Eastern States. In book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihhod Security, Sustainability and Conservation', held at College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Pp-202.
26. Ekka. A., Pandit A., Md. Aftabuddin (2016) Strengthening Rural Sector for Carbon Trading In India: An Analysis. In: Conference issue (Volume 28) on 'Inter-sectoral dynamics in transforming Indian agriculture held at ICAR-CIFE, Mumbai during December 2-4, 2015. Pp 301.
27. Ganguly S, Mahanty A, Mohanty BP (2015). Static headspace GC/MS based volatile analysis of Indian shad *Tenulosa ilisha* for freshness/spoilage detection. In: Book of abstracts, 11th International food Data conference- Food composition and Public Health Nutrition, held at NIN, Hyderabad during November 3-5, 2015. Pp
28. Gogoi R, Saud BJ, Debnath D, Bhattacharjya BK, Yadav AK and Verma VK (2016). Fish catch composition in selected floodplain wetlands of Assam in relation to climatic variables. In: Book of abstracts, National Seminar on 'New horizon in zoological research with special reference to aquaculture and biodiversity' held at Gauhati University, Guwahati during March 14-15, 2016. Pp 13.
29. Hassan MA, Aftabuddin M, Meena DK, Mishal P, Dasgupta S and Sharma AP (2015). Evaluation of Brewery waste based feeds on growth, feed utilization and body composition of cage reared striped catfish, P*angasionodon hypophthalmus* in a tropical reservoir at Maithon Jharkhand. In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerela, India during November 25-28, 2015. Pp103.
30. Jha DN, Joshi KD, Alam A, Das SCS, Srivastava K, Srivastava SK and Kumar V (2016). Flow regime and fishery of the river Ganga at Tehri. In: Souvenir & abstracts, 18th Indian Agricultural Scientists & Farmers Congress organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad during February 20-2, 2016. Pp 39.
31. Jha DN, Joshi KD, Dwivedi AC, Kumar M, Mayank, P Tripathi S and Tiwari A (2016). Status of water resources and fish farming in Allahabad district of Uttar Pradesh. In: Souvenir & abstracts, 18th Indian Agricultural Scientists & Farmers Congress" organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad during February 20-21, 2016. Pp 45.
32. Jha DN, Joshi KD, Dwivedi AC, Mayank P, Kumar M and Tiwari A (2016). Fisheries

and water bodies in Mahoba district of Uttar Pradesh. In: Souvenir & abstracts, 18th Indian Agricultural Scientists & Farmers Congress organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad during February 20-21, 2016. Pp 46.

33. Jha DN, Joshi KD, Dwivedi AC, Tiwari A, Kumar M and Mayank P (2016). Structure of water bodies and fishing activity in Sravasti district, Uttar Pradesh. In: Souvenir & Abstracts, 18th Indian Agricultural Scientists & Farmers Congress organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad during February 20-21, 2016. Pp 46.
34. Johnson C, Mogalekar HS & Bhakta D (2016). Status, utilization and issues of sea Turtles in Gulf of Mannar. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihood Security, Sustainability and Conservation', held at College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Pp-80.
35. Joshi KD, Das SCS, Das MK, Sarkar UK, Khan AU and Pathak RK (2016). Reproductive behavior of rainbow–trout (*Oncorhynchus mykiss*) in reference to climate change. In: Souvenir & abstracts, 18th Indian Agricultural Scientists & Farmers Congress organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad held at Sringerpur, Allahabad during February 20-21, 2016. Pp 48.
36. Joshi KD, Das SCS, Das MK, Sarkar UK, Pathak RK and Khan AU (2016). Studies on breeding attributes of *Cirrhinus mrigala* from ponds of Uttar Pradesh under influence of changes in thermal regime. In: Souvenir & abstracts, 18th Indian Agricultural Scientists & Farmers Congress organized by Bioved Research Institute of Agriculture & Technology, Allahabad held at Sringerpur, Allahabad during February 20-21, 2016. Pp 44.
37. Kar S, Suresh VR, Sajina AM, Sandhya KM, Manna RK, Behera BK, Banik SK, Mukherjee J, Ghosh BB and Mukherjee I (2015). Feeding habit of *Tenualosa ilisha* in Hooghly-Bhagirathi river system. Poster presented in National seminar on 'Hilsa fisheries and conservation' organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015.
38. Karnatak G, Kumar V, Philipose KK, Mishal P and Sharma AP (2015). Comparative evaluation of growth performance in Asian seabass *Lates calcarifer* in seawater and freshwater. In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerala, India during November 25-28, 2015. Pp 39.
39. Kumar V, Das AK and Sarkar UK (2016). Health management practices for cage aquaculture. National Seminar on Fisheries and Aquaculture: Livelihood Security, Sustainability and Conservation, held at Lembucherra, Tripura, India. During January 21-22, 2016. Pp137.
40. Kumar V, Karnatak G, Sahoo AK, Das AK and Sharma AP (2015). Occurrence of ichthyophthiriasis in *Pangasianodon hypophthalmus* cultured in cages in Maithon Reservoir, Jharkhand. In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerela, India during November 25-28, 2015. Pp136.
41. Kumar V, Lianthuamluaia, Sarkar UK, Roshith CM, Panda D, Sandhya KM, Kumari S, Mishal P, Karnatak G, Naskar BK and Ali Y. New record of Indian hill trout *Barilius bendelisis* (Cypriniformes: Cyprinidae) from Kangsabati River, West Bengal, India. In: Book of abstracts, International Conference on Aquatic Resources and Sustainable Management, held at Science City, Kolkata, India during February 17-19, 2016. Pp 128.
42. Kumari S, Sandhya KM, Panda D, Sarkar UK, Karnatak G, Kumar V, Lianthuamluaia

and Mishal P (2016). Seasonal variation in diet composition in comparison with the habitat of *Gudusia chapra* (Hamilton, 1822) from Panchet reservoir in Damodar river basin, India. In: Book of abstracts, International conference on 'Aquatic resources and sustainable management' held at Science City, Kolkata, India during February17-19, 2016. Pp173.

43. Mahanty A, Ganguly S, Mitra A, Mohanty BP (2016). Nutraceutical compounds in *Xenentodon cancila* could be playing synergistic role in controlling nocturnal enuresis. In: Book of abstracts, National Seminar on 'Advances in Marine Natural Products and Nutraceutical Research' held at ICAR-CIFT, Cochin, India on February 26, 2016. Pp
44. Mahanty A, Purohit GK, Mohanty S, Mohanty BP (2016). Liver metabolic changes in *Channa striatus* surviving in high temperature environment. In: Book of abstracts, 2nd International Symposium on 'Genomics in Aquaculture' held at ICAR-CIFA, Bhubaneswar during January 28-30, 2016. Pp
45. Mahanty A, Purohit GK, Mohanty S, Mohanty BP (2016). Nrf-2 induced expression of chaperones and antioxidative enzymes help *Channa striatus* to survive under high temperature stress" in International Symposium on Genomics in Aquaculture' held at ICAR-CIFA, Bhubaneswar during January 28-30, 2016. Pp
46. Manna RK, Aftabuddin Md. Suresh VR and Sharma AP (2016). Major factors influencing fish species spectrum in floodplain wetlands of Assam. In: Book of abstracts, International conference on 'Aquatic Resources & Sustainable Management' held at Science City, Kolkata during February 17-18, 2016. Pp 262
47. Manna RK, Meena DK, Kumari S, Das S, Mandal S and Sarkar UK (2015). Hydrobiological investigation in *Pangasius* cage culture in Saroda Sagar Reservoir, Chattishgarh. In: Book of abstracts, 5th International symposium on 'Cage Aquaculture in Asia' organized by Asian Fisheries Society and CMFRI held at Kochi, Kerala, India during November 25-28, 2015. Pp 132.
48. Manna RK, Sarkar DS, Das SK, Roshith CM, Bose AK, Roychowdhury A and Sharma AP (2016). Improvised crab trap as attachment of bag net: a novel fishing practice in lower Ganges. In: Souvenirs and abstracts, National Symposium of ISCAR, held at ISCAR-IIWM, Bhubaneswar during January 14-17, 2016. Pp 161.
49. Manna RK, Sarkar SD, Das SK, Rosith CM, Bose AK, Roychowdhury A and Sharma AP (2016). Improvised crab trap as attachment of bag net: a novel fishing practice in lower Ganges. In: Souvenirs and abstracts, National Symposium of ISCAR, ISCAR-held at IIWM, Bhubaneswar during January 14-17, 2016. Pp 161.
50. Manna RK, Satpathy BB, Das SK, Roy A, Roshith CM, Sahoo AK, Suresh VR, Bhaumik U and Sharma AP (2015). Fishing gears used in Hilsa fishery in Hooghly estuary and sustainability issues. In: Book of abstracts, National seminar on 'Hilsa fisheries and Conservation' organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015. Pp 132.
51. Meena DK, Hassan MA, Lianthuamluaia, Aftabuddin Md, Naskar B and Saha S (2016). Macro-zoobenthic community structure of two selected ox-bow lakes, in lower Gangetic plains under varying ecological regimes. In: Book of abstracts, International conference on 'Aquatic resources and sustainable management' held at Science City, Kolkata during February17-19, 2016. Pp 281.
52. Mitra T, Mahanty A, Ganguly S, Banerjee S, Bhowmick S, Mahaver LR, Paul SK, Abdullah T, Parida P, Mohanty BP (2016). Fish health assessment in inland open water ecosystem-evaluating stress protein transcript profiles in fish as biomonitoring tools. In: Book of abstracts, 2nd International symposium on 'Genomics in Aquaculture' held at ICAR-CIFA, Bhubaneswar during January 28-30, 2016. Pp
53. Mohanty BP *et a*l. (2016). Neutraceuticals with special emphasis on mineral and



fat soluble vitamin composition of 35 food fishes from India. In: Book of abstracts, National seminar on 'Advances in Marine Natural Products and Nutraceutical Research' at ICAR-CIFT, Cochin on 26th February 2016. Pp

54. Mohanty BP, Mahanty A, Yadav RP, Purohit GK, Mohanty S, (2016) .Upper thermal stress response and thermo tolerance in lower vertebrates - Investigations under omics platform. In: Book of abstracts, National symposium on use of advanced technologies in biochemistry and biotechnology in livestock health, production and reproduction held at Orissa University of Agricultural technology, Bhubaneswar during March 11-12, 2016. Pp
55. Mohanty BP, Ganguly S, Mahanty A, Mitra T, Karunakaran D, Sharma AP (2015). Food data- Nutritional composition of 35 food fishes from India. In: Book of abstracts 11th International food Data conference on 'Food composition and Public Health Nutrition' held at NIN, Hyderabad during November 3-5, 2015. Pp
56. Mohanty BP, Ganguly S, Mahanty A, Paria P, Mitra T, Banerjee S, Behera BK, Sahoo AK (2015). Estimation of arsenic and mercury in fishes from river Ganga for riverine ecosystem health biomonitoring and assessment. In: Book of abstracts, National seminar on 'R&D perspective on rejuvenating river Ganga' held at National Institute of Hydrology, Roorkee during December 16-17, 2015. Pp
57. Mohanty BP, Mitra T, Mahanty A, Ganguly S, Banerjee S, Bhowmick S, Mahaver LR, Paul SK, Abdullah T, Parida P, (2015). Pollution Biomarkers for Aquatic Environmental Monitoring in River Ganga. In: Book of abstracts, National seminar on 'R&D perspective on rejuvenating river Ganga' held at National Institute of Hydrology, Roorkee during December 16-17, 2015. Pp
58. Mohanty I, Banerjee S, Mohanty S, Parija SC, Mohanty BP (2015). Investigations on superior mesenteric artery vascular proteome of *Capra hircus* under acid stress. In: Book of abstracts, National seminar on 'Science &Techology for indigenous development in India' organized by ISCA Bhubaneswar Chapter & KIIT University, Bhubaneswar (Odisha) held at KIIT University, Bhubaneswar, Odisha, India during 12/2015. Pp
59. Mukherjee J, Sandhya KM, Sajina AM, Suresh VR, Manna RK, Behara BK, Banik S K and Kar S (2015). Size distribution, recruitment and exploitation of juveniles of Hilsa in Hooghly Bhagirathi river system. Poster presented in National seminar on 'Hilsa fisheries and Conservation' organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015.
60. Nag SK, Saha K, Bandopadhyay S and Samanta S (2016). Status of heavy metals and pesticide residues in water and fish of River Gomti. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management (ICARSM)" organized by Central Calcutta Science and Culture Organisation for Youth and held at Science City, Kolkata during February 17-19, 2016. Pp 261.
61. Nag SK, Sarkar SD and Manna SK (2016). Triclosan-an antimicrobial compound in water and fish of Indian Rivers. In: Book of abstracts, "National Seminar on 'Fisheries and aquaculture: livelihood security, sustainability and conservation' organized by North East Society for Fisheries and Aquaculture in collaboration with Central Agricultural University (CAU), Imphal, held at College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Abstract No. AAH&E/O-04. Pp
62. Nirupada TC, Landge AT, Manna RK, Borah S and Koushlesh SK (2016). Present Status of fish diversity in Iril River, Manipur. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihood Security, Sustainability and Conservation' held at College of Fisheries, Lembucherra, Tripura during January 21-22, 2016. Pp 74.

63. Nirupada TC, Muralidhar M, Vasanth M, Nagavel A, ShanmugaKarthik J, Koushlesh SK, Manna RK and Das SK (2016). Assessment of greenhouse gases emission in the selected coastal open water ecosystems of Tamil Nadu, India. In: Book of abstracts, National seminar on 'Integrating Agri-Horticultural and Allied Research for Food and Nutritional Security in the Era of Global Climate Disruption' held at ICAR Research Complex for NEH Region, Manipur during March 4-6, 2016. Pp 120.

64. Panda D, Das S and Ali Y (2015). Hilsa: A depleted priced resource. Poster presented in National seminar on 'Hilsa fisheries and conservation' held at CIFRI, Barrackpore on November 18, 2015.

65. Pandit A, Meena DK, Kumar V, Ekka A, Roy A, Saha B, Biswas DK, Chakraborty L, Bhattacharjya (2016). Towards sustainable management of fisheries resource in v Wetlands: assessment of knowledge, attitude and practices of fishers. In: Conference issue (Volume 28) on 'Inter-sectoral dynamics in transforming Indian agriculture held at ICAR-CIFE, Mumbai during December 2-4, 2015. Pp 301.

66. Paul BN, Singh P, Mandal RN, Chakraborty PP and Nag S (2016). Evaluation of pesticide residues in Indian Major Carp reared in waste water. In: Book of abstracts, XVI Biennial Animal Nutrition Conference on Innovative Approaches for Animal Feeding & Nutritional Research (ANSICON 2016) organised by Animal Nutrition Society of India & ICAR-NDRI and held at NDRI, Karnal during February 6-8, 2016. Pp.

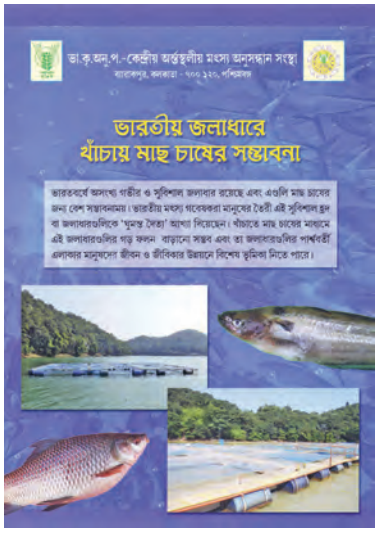
67. Raman RK, Ganguli S, Mahanty A, Mitra T, Das D, Paria P, Abdulla T, Parida PK, Behera BK, Aftabuddin Md. and Mohanty BP (2016). Clinico epidemiological study to correlate the health benefits of fish consumptions on maternal and child health-A cross sectional study at Farakka, West Bengal. In: Book of abstracts, National Seminar on 'Recent Advances in Statistical Tools for Agriculture and Allied Science' held at BCKV, Kalyani, Nadia, West Bengal. Pp 48.

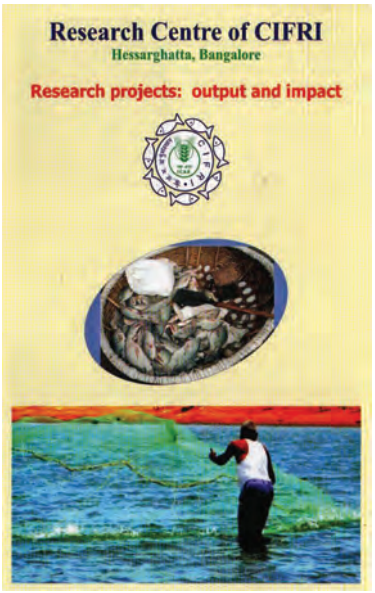
68. Raman RK, Naskar M, Sahu SK and Chandra G (2016). Quantifying effects of physicochemical attributes of water quality on plankton abundance: a case study of Narmada. In: Souvenir, National conference on 'Rural Livelihood security through Innovative Agri-Entrepreneurship' held at ICAR-CPRS, Patna during March12-13, 2016. Pp 114.

69. Roy A, Chandra G, Raman RK, Das AK and Bandopadhyay MK (2015). Skill Development of Bihar Fish on Inland Fisheries: Ex-post facto Analysis. In: Book of abstracts, ISEE golden jubilee national seminar on 'Strategy to drive skill based agriculture development forward for sustainability and rural employability' organised by Indian Society of Extension Education, Division of Agricultural Extension, IARI and Department of Extension Education, Institute of Agricultural Sciences, Banaras Hindu University held at BHU, Varanasi during November 5-7 Varanasi. Pp 56.

70. Roy A, Chandra G, Raman RK, Das AK and Bandopadhyay MK (2015). Skill development of Bihar fish farmers on inland fisheries: An ex post facto analysis. In: Souvenir -cum -abstract book, ISEE Golden Jubilee National seminar on 'Strategy to drive skill based agriculture development forward for sustainability and rural employability' organized by Indian society of extension education and held at BHU, Varanasi, India during November 5-7, 2015. Pp 56.

71. Roy A, Manna RK, Sinha A, Das SK, Majumder S, Biswas DK and Sengupta, A (2016). Change in construction material of traditional fishing traps in Sunderban: Conservation and Sustainability issues. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management' held at Science City, Kolkata, India during February 17-18, 2016. Pp 298.





72. Roy A, Manna RK, Sinha A, Das SK, Majumder S, Biswas DK, Mukherjee CN, Mitra A and Sengupta A (2016). Conservation of Small Indigenous Fish (SIF): A road map to ensure food and nutritional security in coastal Sundarbans. Synoptic view of sustainable family farming for food, nutritional and livelihood security. In: Book of abstracts, National seminar on 'Sustainable family farming for food, nutritional and livelihood security' held at the Department of EES, Palli Siksha Bhavana, Visva-Bharati University, Kolkata, India during 5-6 March, 2016. Pp

73. Roy A, Sinha A, Das SK, Manna RK, Mukherjee CN, Sengupta A and Mitra A (2-16). Small Indigenous Fish (SIF) conservation: A Roadmap to end Poverty in Coastal Sunderbans. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management' held at Science City, Kolkata, India during February 17-18, 2016. Pp 224.

74. Roy S, Kumar V, Chakraborty HJ, Behara BK, Rana RS, Gupta S, Krishna G. and Gireesh-Babu P (2016). In silico structural and sequence based characterization of fatty acyl Δ6 desaturase from *Pangasianodon hypophthalmus*. In: Book of abstracts, National Level 'Young Scientists' Meet, Prof. Hiralal Chaudhuri Commemorative conference held at Centre for Research in Nanoscience and Nanotechnology (CRNN), University of Calcutta, Kolkata-India during February 4–6, 2016. Pp

75. Roy S, Kumar V, Mitra A, Homechaudhuri S and Suresh VR (2016). Comparative study of amylase and protease activity in shrimps and prawns of Sundarbans, West Bengal, India. In: Book of abstracts, National Seminar on 'Fisheries and Aquaculture: Livelihood Security, Sustainability and Conservation' held at College of Fisheries, Lembucherra, Tripura, India during January21-22, 2016. Pp 105.

76. Roy S, Sengupta A, Manna RK, Manas HM, Roshith CM and Das SK (2016). Abundance and diversity study of phytoplankton in Sundarbans, West Bengal, India. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management' held at Science City, Kolkata, India during February 17-18, 2016. Pp 224.

77. Sajina AM Sandhya KM, Suresh VR, Manna RK, Behera BK, Mukherjee J, Banik S K, Kar S and Banerjee GB (2015). Hilsa fishery of Northern Bay of Bengal and Hooghly-Bhagirati riverine system. Poster presented in National seminar on 'Hilsa fisheries and conservation' organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015.

78. Sajina AM, Sandhya KM, Suresh VR, Manna RK, Behera BK, Mukherjee J, Banik S K, Banerjee GB and Kar S (2016). Fishery and catch pattern of *Tenualosa ilisha* along Hooghly-Baghirathi river system and Northern Bay of Bengal. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management' held at Kolkata, India during February 17-19, 2016. Pp 221.

79. Sandhya KM, Sajina AM, Suresh VR, Manna RK, Behera BK, Mukherjee J, Banik SK, Banerjee GB and Kar S (2016). Studies on age and growth of *Tenualosa ilisha* along Hooghly-Baghirathi river system and Northern Bay of Bengal. In: Book of abstracts, International conference on 'Aquatic resources & sustainable management', held at Science City, Kolkata, India during February 17-19, 2016. Pp 212.

80. Sandhya KM, Sajina AM, Suresh VR, Manna RK, Behera BK, Mukherjee J, Banik SK, Banerjee GB and Kar S (2015). Population dynamics, Stock assessment & Management needs of *Tenualosa ilisha* along Hooghly-Bhagirathi river system. Poster presented in National seminar on 'Hilsa fisheries and conservation' organized by IFSI and SoFTI held at CIFRI, Barrackpore on November 18, 2015.

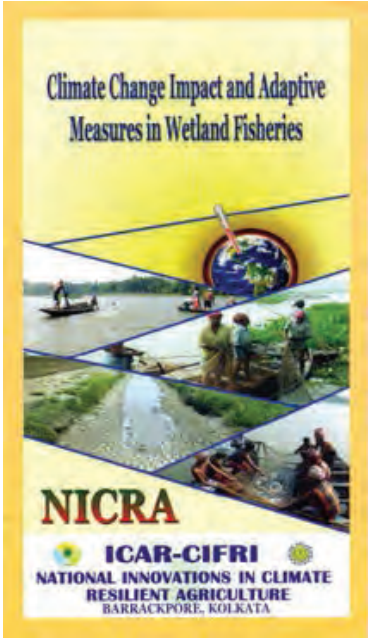
81. Sarkar UK (2016). Status, potentials and prospects of fisheries enhancement in Indian reservoirs: An overview. In: Book of abstract, National level young

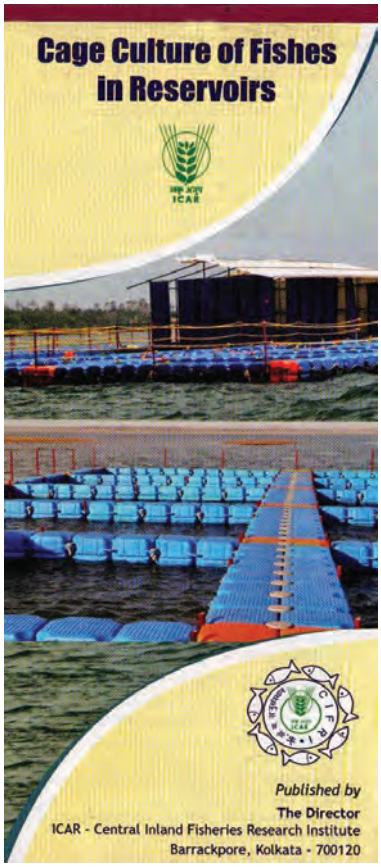
scientists meet- and Prof H.L. Chaudhuri commemorative conference, organized by Zoological Society, Kolkata in collaboration with Department of Zoology, University of Calcutta during February 5-7, 2016. Pp 24-26.

82. Sarkar UK, Naskar M, Nag SK, Joshi KD, Sarkar SD and Sudheesan D (2016). Issues of vulnerability and adaptations of the Inland Fisheries to Climate Change in India. In: In: Book of abstracts, International conference on 'Aquatic resources & sustainable management (ICARSM)" organized by Central Calcutta Science and Culture Organisation for Youth, held at Science City, Kolkata, India from February 17-19, 2016. Pp 259.
83. Sharma AP, Sarkar UK, Mishal P, Karnatak G and Das AK (2015). Present status, potential and prospects of cage culture for fisheries enhancement in Indian Reservoirs. In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerela, India during November 25-28, 2015. Pp 59.
84. Sinha A, Nirupada TC, Roy A and Kumari K (2016). Small indigenous freshwater fishes as catalyzing agent for nutritional and livelihood security in North Eastern India. In: Book of abstracts, National seminar on 'Fisheries and aquaculture: livelihood security, sustainability and conservation' held at College of Fisheries, Lembucherra, Tripura, during January 21-22 2016. Pp 3.
85. Subuddhi UK, Choudhary RK, Biswas N, Das AK and Raman RK 2015. Effect of stocking density on growth of *Tor khudree* fingerlings in floating cages at Kerwa Reservoir, Madhya Pradesh, In: Book of abstracts, 5th International Symposium on 'Cage aquaculture in Asia' held at Kochi, Kerela, India during November 25-28, 2015. Pp 61.
86. Tripathi S, Gopesh A and Joshi KD (2015). Size composition, exploitation structure and sex ratio of C*lupisoma garua* (Hamilton) from middle stretch of the river Ganges at Allahabad, India. In: Biological Sciences (Presidential address & abstracts), 85th Annual Session of NASI, Bhubaneswar, held at National Academy of Sciences, Allahabad, India during December 6-8,2015. Pp 54.
87. Tripathi S, Gopesh A and Joshi KD (2016). Size distribution and exploitation structure of economically important fish species *Eutropiichthys vacha* (Hamilton) from the river Ganga at Allahabad. In: Book of abstracts, National seminar on 'Science and technology for indigenous development in India' held at Allahabad University, Allahabad, UP, India, during February 19-21, 2016. Pp 62.
88. Tripathi S, Gopesh A and Joshi KD, Verma R and Singh M (2016). Molecular characterization of *Clupisoma garua* (Hamilton) and *Eutropiichthys vacha* (Hamilton) from river Ganga at Allahabad. In: Book of abstracts, International symposium on 'Genomics in Aquaculture' held at) ICAR-CIFA, Bhubaneswar, Odisha, India during January 28-30, 2016. Pp 132.
89. Yadav AK, Debnath D, Bhattacharjya BK and Saud BJ (2016). Influence of rainfall as a major climatic variable on fish production of floodplain wetlands (beels) of Assam, India. Book of Abstracts, National Seminar on Fisheries and Aquaculture: Livelihood security, sustainability and conservation, Jan 21-22, 2015, College of Fisheries, Lembucherra, Tripura.

BOOK/BOOK CHAPTERS

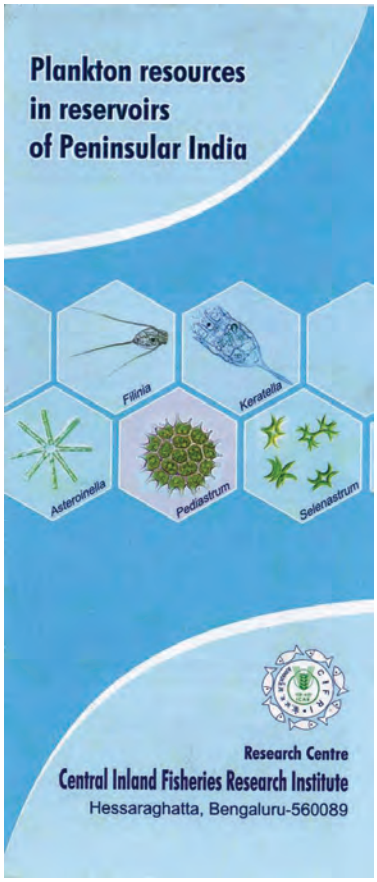
1. Das AK (2015).Conspectus of Inland Fisheries Management Training Manual No-4, ICAR-Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India.(Contributed by: Suresh VR, Mohanty BP, Hassan MA, Manna RK, Samanta S, Manna SK, Aftabuddin MD, Panda D, Sandhya KM, Sahoo AK, Das S, Roshith CM, Pandit A, Roy A, Ekka A, Chandra G, Raman RK, Sahu, SK, Bandopadhyay MK)





2. Das AK (2015). Lecture Compendium on Inland Fisheries Management, Training Manual No-6, ICAR-Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India. .(Contributed by: Suresh VR, Mohanty BP, Sarkar UK, Das AK, Hassan MA, Manna RK, Samanta S, Manna SK, Aftabuddin MD, Panda D, Sandhya KM, Sahoo AK, Das S, Roshith CM, Pandit A, Roy A, Ekka A, Chandra G, Raman RK, Sahu, SK, Bandopadhyay MK, Bahera BK, Meena DK, Sudheesan D, Sajina AM, Kumari S, Kumari K, Roy S, Karnatak G, Baitha R, Mishal P, Manas HM, Kumar V)
3. Alam A and Joshi KD (2016).Vermicompost: A Potential Alternative in Organic Aquaculture. In: Sanjay KG and Bharti PK (eds.), Sustainable Aquaculture Management (Discovery Publishing House Pvt. Ltd., New Delhi, India, pp. 244-254.
4. Bhattacharjya BK, Das P and Behera BK (2015). Background document: Sensitization workshop on Aquatic Animal Diseases in Assam, ICAR-Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India.
5. Behera BK, Das P and Bhattacharjya BK (2015). Diseases of freshwater prawn, *Macrobrachium rosenbergii* and its control. In: Kalita B and Ali A (eds.), Advances in fish disease diagnosis and fish health management (ISBN: 978-93-84679-19-4). College of Fisheries, AAU, Raha, Nagaon, Assam, pp. 128-132.
6. Chandra G, Roy A, Meena DK, and Kumari S (2015). Inland Fisheries Management, Training Manual No-9, ICAR- Central Inland Fisheries Research Institute, Barrckpore, West Bengal, India. (Contributed by: Sahoo AK, Chandra G, Behera BK, Parida P, Meena DK, Baitha R, Hassan MA, Manna RK, Ekka E, Kumari S, Sahu SK, Roshith CM)
7. Das P, Bhattacharjya BK, Sahoo Das S and Behera BK (2015). Prophylactic measures for fish disease management. In: Kalita B and Ali A (eds.), Advances in fish disease diagnosis and fish health management (ISBN: 978-93-84679-19-4). College of Fisheries, AAU, Raha, Nagaon, Assam, pp. 174-208.
8. Edwin L, Gopal N, Remesan MP, Samanta S and Sahu SK (eds). Hilsa Fisheries and Conservation : Proceedings of the National Seminar, held at ICAR-CIFRI, Barrackpore, Kolkata. Jointly organised by Society of Fisheries Technologists (India), Kochi and Inland Fisheries Society of India, Barrackpore on November 18, 2015.
9. Kumar V and Hassan MA (2015). Wetland Fishes. In: Gopal B (ed), Guidelines for rapid assessment of biodiversity and ecosystem services of wetlands, Version 1.0. Asia-Pacific network for global change research (AP-GCR), Kobe, Japan and National Institute of Ecology, New Delhi. Pp 98-120.
10. Mahapatra BK, Sarkar UK and Lakra WS (2015). Biodiversity of Marine Ornamental Fish in West Bengal: Issues of Sustainability and Livelihood Security. In: Souvenir, Uttar Pradesh State Biodiversity Board, Biodiversity for sustainable development. Lucknow, Uttar Pradesh, pp. 92-95.
11. Naskar M, Chandra G and Sahu SK (2015). Hilsa Fisheries on the West Coast of India. In: Edwin L, Gopal N, Rameshan MP, Samanta S and Sahu SK (eds), Hilsa Fisheries and Conservation Proceedings of the National Seminar, held at ICAR-CIFRI, Barrackpore, Kolkata. Jointly organised by Society of Fisheries Technologists (India), Kochi and Inland Fisheries Society of India, Barrackpore on November 18, 2015, pp 45-52.
12. Pandit A and Panda D (2015). Status of Centre-State Coordination I Agricultural Research, Education and Extension in Region II: Andhra Pradesh, Telanagana, Odisha, West Bengal and Andaman and Nicobar Islands. Indian Council of Agricultural Research.

13. Pandit et al (2015). Background document for Lower Gangetic Plain region workshop held at ICAR-CIFRI, Barrackpore on Oct 31, 2015.
14. Parida PK (2015). Food security in the context of National Rural Livelihoods Mission- A case study of Odisha. In Basu R, Alam MB and Ahmad F (eds), Democracy and Good Governance: Reinventing the public Service Delivery system in India. Bloomsbury Publication. India, pp: 95-102.
15. Roy A, Manna RK, Sinha A, Das SK, Majumder S, Biswas DK, Mukherjee CN, Mitra A and Sengupta A (2016). Conservation of Small Indigenous Fish (SIF): A road map to ensure food and nutritional security in coastal Sunderbans. In: Mondal B, Sarkar D, Mukhopadhyay SD, Ghosh S, Roy BC, Chowdhury S (eds), Family Farming Challenges and Opportunities. Renu Publishers 90, Sainik Vihar, Mohan Garden New Delhi, pp. 218-228.
16. Roy A and Manna RK (2015). Conservation of hilsa fishery vis-à-vis socio-economics of hilsa fishers: some propositions. In: Hilsa fisheries and conservation (Eds. Edwin L, Gopal N, Remesan MP, Samanta S and Sahu SK). Society of Fisheries Technologists, Cochin and Inland Fisheries Society of India, Barrackpore. pp. 104-111.
17. Roy A, Manna, RK, Sinha A, Das SK, Majumder S, Biswas DK, Mukherjee CN, Mitra A and Sengupta A (2016). Conservation of Small Indigenous Fish (SIF): A roadmap to ensure food and nutritional security in coastal Sunderbans. In: Family Farming: Challenges and Opportunities (Eds. Mondal B, Sarkar D, Mukhopadhyay SD, Ghosh S, Roy BC, Chowdhury S) Renu Publishers, New Delhi. pp. 218-228.
18. Sarkar UK and Dubey VK (2015). Threats to fish and fisheries in the Ganga Basin: Consequences of changing habitats and altering diversity patterns', GWF Discussion Paper, Global Water Forum, Canberra, Australia. Available online at: http://www.globalwaterforum.org/2015/08/27.
19. Sarkar UK, Dubey VK, Pathak AK and Mahapatra BK (2015). Biodiversity of Freshwater Fishes in Uttar Pradesh: Regarding Status and Reinforcing Conservation Efforts for Sustainable Management. In: Souvenir U.P State Biodiversity Board, Biodiversity for sustainable development, Uttar Pradesh State Biodiversity Board. Lucknow, Uttar Pradesh, pp.88-91.
20. Sarkar UK, Singh SP, Pathak AK and Goswami UC (2015). Fish identification methods, descriptions, digital identification tools, and their importance in conserving Indian fish diversity. In Goswami UC (eds), Advances in Fish Research, Vol.VI, Narendra Publishing House, Delhi, India, pp 1–14.
21. Sharma AP and Panda D (2015). Freshwater cage farming: An Approach to augment inland fish production. In: Malhotra S, Jaiswal N and Singh RK (eds.), National Satellite symposium-skill development manual, workshop on Satellite symposium on emerging trends in skill development held at University of Allahabad, Allahabad,UP during 12-14 April, 2015. pp. 61-69.
22. Sinha A and Roy A (2016). Sundarban mein Ajivika avang Poshkiya suraksha hetu chhoti deshi machhli ka utpadan avang sanrakshan, ICAR-Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India.
23. Kumari S and Bandyopadhyay MK (2015). Rapid Assessment of Biodiversity; Microphytes (Phytoplankon and Periphyton). In: Brij Gopal (eds) Guidelines for Rapid Assessment of Biodiversity and ecosystem services of wetlands. Version 1.0. National Institute of Ecology, Jahangirpuri, Delhi, pp 35-47.
24. Kumari S (2015). Rapid Assessment of Biodiversity; Zooplankton. In: Brij Gopal (eds) Guidelines for Rapid Assessment of Biodiversity and ecosystem services of wetlands. Version 1.0. National Institute of Ecology, Jahangirpuri, Delhi, pp 48-57.



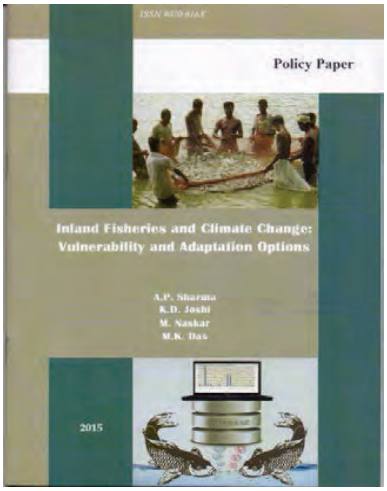
25. Sahu SK (2015). User Manual: e Atlas for water bodies of Punjab. ICAR- Central Inland Fisheries Research Institute, Barrackpore.
26. Sahu SK (2015). User Manual: e Atlas for water bodies of Kerala. ICAR-Central Inland Fisheries Research Institute, Barrackpore.
27. Sahu SK (2015). User Manual: e Atlas for water bodies of Maharashtra. ICAR-Central Inland Fisheries Research Institute, Barrackpore.
28. Mohanty BP, Ganguly S, Mahanty A, Mitra T (2015). Nutrient Profiling of Chilika Fishes: A Hands-On Training Manual - Cum – Report. Technical Report, ICAR-Central Inland Fisheries Research Institute, Barrackpore. DOI: 10.13140/RG.2.1.3283.0164 (e-Publication).

BULLETINS/LEAFLETS/PAMPHLETS/BOOKLET

1. Barman K, Sarma DK, Pegu SR, Debnath D, Bhattacharjya BK, Yengkokpam S, Das, P and Yadav AK(2016). Pig-cum-fish farming for enhanced income of farmers (leaflet). ICAR-National Research Centre on Pig, Rani, Guwahati.
2. Barman K, Sarma DK, Pegu SR, Banik S, Debnath D, Bhattacharjya BK, Yengkokpam S, Das P and Yadav AK (2016). A manual on integrated pig-fish farming. ICAR-National Research Centre on Pig, Rani, Guwahati.
3. Karunakaran D, Sahu SK, Pandit A and Sharma AP (2015). Assessment of water quality using remote sensing for aquatic resource management. Bulletin no 194. ICAR-Central Inland Fisheries Research Institute, Barrackpore.
4. Khan MF, Panikkar P, Rao DSK, Vijaykumar ME (2015). Research impacts and outputs (Booklet). ICAR-Central Inland Fisheries Research Institute, Barrackpore.
5. Rao DSK, Sinivas N, Anjaneyaswamy D, Vijaykumar ME and Jagadeesh TD (2015). Culture of Fishes in Cages (Bochure: English, Telugu and Kannada). ICAR-Central Inland Fisheries Research Institute, Barrackpore.
6. Rao DSK, Sinivas N, Anjaneyaswamy D, Vijaykumar ME and Jagadeesh TD (2015). Reservoir Fisheries Management (Brochure: Telugu and Kannada) ICAR-Central Inland Fisheries Research Institute, Barrackpore.
7. Sarkar UK, Nag SK, Das MK, Karnatak G, and Sudheesan D (2016). Conserving wetlands- An effective climate change adaptation in India. Bulletin No. NICRA/CIFRI/2015-16/2. ICAR-Central Inland Capture Fisheries Institute, Barrackpore.
8. Panikkar P and Khan MF (2015). Cage aquaculture in participatory mode at Wayanad District in Kerala- a case study (Pamphlet). ICAR-Central Inland Capture Fisheries Institute, Barrackpore.
9. Panikkar P and Khan MF and Vijaykumar ME (2015). Plankton resources in reservoirs of Peninsular India (Brochure). ICAR-Central Inland Capture Fisheries Institute, Barrackpore.
10. Panikkar P, Khan MF and. Suresh VR (2015). Exotic fishes in water bodies of South India (Brochure). ICAR-Central Inland Capture Fisheries Institute, Barrackpore.
11. Sarkar UK and Das AK (2015). Cage culture in Indian reservoirs (in Bengali) (Pamphlet). ICAR- Central Inland Fisheries Research Institute, Barrackpore.
12. Sarkar UK, Das MK, Naskar M, Nag SK and Karnatak G (2016). Climate change impact and adoptive measures in wetland fisheries (trilingual pamphlet), ICAR-Central Inland Fisheries Research Institute, Barrackpore.
13. Leaflet in Bengali on Hilsa Conservation.
14. Pamphlet in Bengali on Cage Culture in Indian reservoirs.

POLICY PAPER

1. Sharma AP, Joshi KD, Naskar M and Das MK (2015). Inland Fisheries and Climate change: Vulnerability and adaptation options. Policy paper No. 5. Central Inland Capture Fisheries Institute, Barrackpore.



NEWS LETTER

- ICAR-CIFRI Newsletter "CIFRI News" Vol 19, No. 2 and Vol 20, No.1. (Arun Pandit and RK Manna *eds*)
- ICAR-CIFRI Newsletter "NICSIF" Vol 1(U. K. Sarkar et al *eds*)

OTHERS

- Calender on "Small fishes of River Gandak and conservation".
- Three models were prepared on 'Cage Culture', 'Pen Culture' and 'Fish pass'.

POSTERS

Sl No	Title	Publisher
1.	Cage Culture: Call for Blue Revolution	ICAR-Central Inland Fisheries research Institute
2.	Fish Production through Pen Culture	ICAR-Central Inland Fisheries research Institute
3.	Reservoir Fisheries Management	ICAR-Central Inland Fisheries research Institute
4.	Floodplain Wetland Fisheries Management	ICAR-Central Inland Fisheries research Institute
5.	Management of Hilsa Fisheries	ICAR-Central Inland Fisheries research Institute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ICAR-CIFRI
NATIONAL INNOVATIONS ON CLIMATE RESILIENT AGRICULTURE (NICRA)

NICSIF
National Innovations in Climate Smart Inland Fisheries
NICRA Newsletter, ICAR-CIFRI, Barrackpore, Kolkata-700120

CONTENTS INSIDE
- Achievements
- Adaptation strategies identified / developed
- HRD Programs
- Critical issues and recommendations for adaptation
- Important publications
- Team NICRA

Edited by:
Dr. U.K. Sarkar
Dr. V.R. Suresh
Dr. M.K. Das
Dr. M. Naskar
Dr. S.K. Nag

Mystus tengara
Mystus gulio

About CIFRI NICRA

Climate change is one of important environmental challenges of 21st century. Nearly 700 million rural populations directly depend on climate sensitive sectors (agriculture, forests and fisheries) and natural resources (such as freshwater, mangroves, coastal zones, grasslands and biodiversity) for their subsistence and livelihoods. Any adverse impact on water availability due to recession of glaciers, decrease in rainfall and increased flooding in certain areas would threaten food security. The impacts are already being felt in India. India is bestowed with vast and varied inland open-waters which form the traditional sources of fisheries supporting a large number of landless poor fishers. In recent times, fish production from these resources has declined due to increased man-centric interventions. The resultant impact has been an erosion of livelihood base for the traditional fishers, who depend exclusively on these resources for their livelihood and nutritional security. Fisheries sector is known to supplement protein food to weaker section of the society. Communities that depend on inland fisheries resources are likely to be vulnerable to climate change. Climate change is only one among many environmental and anthropogenic stresses faced by inland fisheries but is likely to exacerbate the effect of other stressors in years to come.

The ICAR-Central Inland Fisheries Research Institute initiated research on climate change way back in 2004 under the ICAR research project 'Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change' and is being continued under the ICAR Project 'National Innovations on Climate Resilient Agriculture' (NICRA). In the last several years the Institute has emerged as the nodal organization on climate change research on Inland Fisheries in the country.

Present Objectives
- Assessment of reproductive biology, spawning behavior of major riverine and estuarine fishes in Gangetic and peninsular river in relation to climatic variability.
- Identify and/or formulate adaptation-mitigation strategies in inland fisheries to climate change.

Principal Investigator's Desk

It is my immense pleasure to bring out this NICRA newsletter from ICAR-CIFRI. We have been involved on this important facet of research since last several years. As climate change is a subtle phenomenon acting on a large spatio-temporal scale, its impact assessment on inland fisheries has been really a challenging task. We have achieved few milestones already and presently working on a number of crucial aspects involving climate change impacts on inland aquatic ecosystems, fish stocks and associated fisher folk communities. This newsletter is a reflection of the enthusiasm of our research team and dissemination of the findings. I acknowledge the valuable inputs of Dr. M.K. Das, former PI, NICRA and Prof. A.P. Sharma, former Director and PI, NICRA for taking this project to newer heights. Since taking responsibility, I have been trying to upkeep the standard of our output so that we can influence and support decision of the key policy makers. Any suggestions are highly solicited.

Dr. U.K. Sarkar

Eutropiichthys vacha *Labeo calbasu* *Channa punctatus* *Johnius coitor* *Mystus cavasius*
Puntius sophore *Odontamblyopus rubicundus* *Anabas testudineus* *Trichogaster fasciata*
Page 1

Fish images: Species selected under study

CIFRI IN
MEDIA AND PRESS

मछलियों के संरक्षण पर बल

কীভাবে এড়াবেন ফরমালিন দেওয়া মাছ

Now a mobile app to net data on fish-catch

B.S. Satish Kumar

FOR A BETTER CATCH

The mobile app has caught the attention of the scientific community as it involves fishermen in collection of the fish-catch data

- The app, developed by the Central Inland Fisheries Research Institute, is being used on a trial basis in Karnataka
- A fisherman can be trained in using it within 10 minutes
- Some fishermen and women have been designated "Fishery Friends" who will upload the data on the mobile phone
- They are given a monthly honorarium for helping CIFR with the fish-catch data

BENGALURU: The process of getting fish-catch data related to inland fisheries is expected to get revolutionised with the development of a mobile-based application. The simple mobile app has caught the attention of the scientific community as it involves fishermen, who are the main stakeholders, in collection of the fish-catch data instead of the normal practice of involving officials.

The app, which has been developed by the Central Inland Fisheries Research Institute (CIFRI), is being used on a trial basis to get details of fish-catch in Karnataka.

M. Karthikeyan, senior scientist in the CIFRI's Hesarghatta centre, who has developed this android app, told *The Hindu* that it is being used on an experimental basis in Tunga reservoir in Shivamogga and Manchanabele reservoir in Ramanagaram district for nearly a year.

Presently the process of getting the fish-catch data involves physical visits by scientists or officials to the water bodies. "But there is no authentic fish-catch data, especially on continuous basis, for the inland water bodies. This is because of the huge number of water bodies, their distant location and the difficulty in last-mile connectivity," he points out. What has further complicated the task is the severe shortage of manpower in the government establishments to make such visits.

"The mobile app takes care of these obstacles. The process of using the app is so simple that a fisherman can be trained in using it within 10 minutes," the scientist notes.

The CIFRI has identified a few fishermen and women who can read, write and send the data. They have been designated as "Fishery Friends" who will upload the data on the mobile phone on the different types of fish caught in the water bodies assigned to them. All that they have to do is to type the numbers against the names of different fish varieties. As soon as the uploading of data is done, it is automatically recorded in the central server.

"The feedback has been good so far. In fact, the fisheries' friend in Manchanable is a fisherwoman, who is the secretary of the local fisheries association, who has been handling the responsibility well," he says.

The institute is presently giving them a monthly honorarium for helping it with the fish-catch data. "We will take up surprise visits occasionally to cross check the data. What is impressive is that we have been able to get the data instantaneously at very economical cost as the visits of officials and scientists earlier was involving huge expenses," he points out, while adding that the mobile app was thought of as smart mobile phones had become widely available even among fishermen.

The CIFRI will take a call on extending this mobile app-based data collection to other parts of the country after studying the pilot project for some more time and after fine-tuning it, he says.

Published in the newspaper "The Hindu" (National & International Edition) on 21.12.2015

THE HINDU

CIFRI launches mobile apps for fishermen

Kerala | Updated: March 21, 2016 05:47 IST | E. M. Manoj

केज कल्चर टैक्नोलॉजी से होगा मछली उत्पादन

চাহিদা বেশি, জোগান কম তাই....

First aqua park starts functioning in Wayanad

E.M. Manoj

আসানসোল Soul Express

Asansol Express

আদর্শ গ্রাম সিদাবাড়িতে মাছ চাষের উদ্বোধন করলেন বাবুল সুপ্রিয়

जल से ही जीवन की कल्पना संभव

जल संरक्षण दिवस पर जल संचयन पर जोर

SEMINAR/SYMPOSIUM/ MEETINGS ATTENDED

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
1.	CARTOSAT 1: 10 year completion	5th April, 2015	S. K. Sahu	National Remote Sensing Centre, Hyderabad
2.	Pre-bid meeting for supply of fish seed for cage culture	7th April, 2015	D. S. K. Rao	Directorate of Fisheries, Government of Karnataka, Bangalore
3.	Horti-Sangam	9-11th April, 2015	Ganesh Chandra	Motihari, Bihar
4.	Meeting on Reactive Nitrogen	13-14th April, 2015	S. Samanta	Indian Nitrogen Group NASC Complex, New Delhi
5.	National workshop on Aquatic resource, sustainability and cutting edge technologies and Satellite symposium on Emerging trends in skill development	14th April, 2015	D. Panda	Allahabad University, Allahabad
6.	Making engineering scientists contribution more meaningful to stake holders and the nation	13-14th April, 2015	S. K. Sahu	NASC complex, New Delhi
7.	Inauguration of model village, demonstration of cage culture and farmers meet	25th April, 2015	U. K. Sarkar M. A. Hassan D. Panda Vikash Kumar G. Karnatak	CIFRI-DVC, Sidhabari, Asansol
8.	Stakeholders forum and workshop on Indian waste water sector	30th April, 2015	U. K. Sarkar	Department of Ecological Studies, Kalyani University, West Bengal
9.	The Essential Electronic Agricultural Library	4-5th May, 2015	S. Samanta	NAAS Complex and KAB I, New Delhi
10.	Workshop on Environmental flow setting for river Ramganga	6th May, 2015	K. D. Joshi	WWF, India, New Delhi
11.	Agri - Search 2050	18th May, 2015	Gunjan Karnatak Suvra Roy	ICAR New Delhi NASC Complex, New Delhi
12.	Meeting with Kerala state fisheries officials	21st May,2015	M. Feroz Khan	Assistant Director of Fisheries, Vythiri, Wayanad, Kerala
13.	Interface meeting on Enhancing the preparedness for agriculture contingencies during Kharif 2015	29th May, 2015	K. D. Joshi	DAC, Ministry of Agriculture and ICAR/ CRIDA Krishi Bhawan, Lucknow

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
14.	New product launch seminar of PerkinElmer India Ltd	2nd June, 2015	S. Samanta	Kolkata
15.	Workshop organized by Directorate of Fisheries, Karnataka	8th June, 2015	D. S. K. Rao	Department of Animal Husbandry and Fisheries, Government of Karnataka
16.	APN workshop on Assessment of biodiversity and ecosystem services for conservation of wetlands	8-9th June, 2015	K.D. Joshi B. K. Bhattacharjya	NIE, ICAR-CIFRI, APN and others NASC Complex, New Delhi
17.	Workshop on Ecosystem evaluation, access and benefit sharing	22nd June, 2015	M. Feroz Khan	Karnataka Biodiversity Board Bangalore
18.	Orientation meeting	23rd June, 15	M. Feroz Khan Preetha Panikkar	TOLIC CPRI, Bangalore
19.	Seminar on Fish culture practices	25th June, 2015	Dibakar Bhakta	Department of Fisheries, Vadodara District, Gujarat
20.	Expert appraisal committee meeting (Thermal Power) of Ministry of Environment, Forest and Climate Change	26th June, 2015	S. Samanta	MoEF & CC, Govt. of India, New Delhi
21.	Foundation laying ceremony of ICAR-IARI, exhibition and farmers scientists meet on fisheries development in Bihar	27-28th June, 2015	U. K. Sarkar	Barhi, Hazaribagh, Jharkhand
22.	Horticulture exhibition	27-28th June, 2015	Ganesh Chandra Anjana Ekka	National Horticulture Board Barhi, Hazaribagh, Jharkhand
23.	Meeting regarding ISO certification	7th July, 2015	All scientists	ICAR-CIFRI, Barrackpore
24.	Meeting on cage culture in Andhra Pradesh reservoirs	15th July, 2015	D. S. K. Rao	Department of Fisheries, Govt. of AP.
25.	85th Expert appraisal committee meeting for environmental clearance of hydro-electric projects	20-21st July, 2015	K. D. Joshi	MoEF & CC, Govt. of India, New Delhi
26.	National conference on Skill oriented interventions in the field of fisheries	26th July, 2015	U. K. Sarkar	KVK, Patna
27.	Meeting of the Bihar State Wetland Development Authority	28th July, 2015	U. K. Sarkar	Department of Environment and Forest, Govt. of Bihar
28.	5th Advisory committee meeting of NASF Hilsa project	6-7th August, 2015	R. K. Manna	ICAR-CIFRI, Barrackpore
29.	National seminar on Second blue revolution	7th August, 2015	M. Feroz Khan	CUSAT, Kochi
30.	Assessment committee meeting of technical officers	11th August 2015	K. D. Joshi	ASRB, New Delhi NBFGR, Lucknow
31.	NICRA annual review meeting	13-14th August, 2015	U. K. Sarkar	CMFRI, Kochi
32.	Session on fisheries at the inaugural event of NRC Integrated farming	21st August, 2015	Ganesh Chandra	Motihari, Bihar
33.	Lecture delivered by Sudhir Bhargava, member, Governing Body, ICAR	22nd August, 2015	R. K. Manna Aparna Roy Manas H. M. Suvra Roy A. Ekka Md. Aftabuddin Suman Kumari	ICAR- NIRJAFT, Kolkata

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
34.	86th Expert appraisal committee meeting for environmental clearance of hydro-electric projects	24-25th August, 2015	K. D. Joshi	MoEF & CC, Govt. of India, New Delhi
35.	Meeting on E-flow assessment for upper stretch of the river Ganga	25th August, 2015	K. D. Joshi	Ministry of Water Resources, River Development and Ganga Rejuvenation, Shram Shakti Bhawan, New Delhi
36.	Performance review committee meeting at NFDB	25-26th August, 2015	S. K. Sahu	NFDB, Hyderabad
37.	National seminar on Aquaculture in NER: realities, potential and challenges	25-26th August, 2015	B. K. Bhattacharjya	St. Anthony's College, Shillong
38.	Meeting with Kerala State Fisheries Department officials	28th August, 2015	M. Feroz Khan	Sulthan Bathery, Wayanad, Kerala
39.	Expert review meeting of Assam state biodiversity board	10th September, 2015	B. K. Bhattacharjya	Guwahati, Assam
40.	Meeting on preparation of vision document of the Department of Fisheries, Assam.	14th September, 2015	B. K. Bhattacharjya	Directorate of Fisheries, Govt. of Assam, Guwahati
41.	Mid-term review meeting of ICAR Regional Committee II	19th September, 2015	U. K. Sarkar Arun Pandit	ICAR-CIFRI, Barrackpore
42.	National consultation on Trout farming	20-21st September, 2015	K. D. Joshi	ICAR-DCFR, Bhimtal
43.	87th Expert appraisal committee meeting for environmental clearance of hydro-electric projects	23-24th September, 2015	K. D. Joshi	MoEF & CC, Govt. of India, New Delhi
44.	Stakeholder meeting on Introducing concept of ecosystem services towards sustainable intensification of agriculture in peri-urban wetlands	26th September, 2015	U. K. Sarkar	South Asian Forum for Environment (SAFE), Earth Watch Institute and International Water Management Institute (IWMI) Science City, Salt lake, Kolkata
45.	Review Meeting of the Technology Up-gradation Project (TUP) funded by NFDB	29-30th September, 2015	U. K. Sarkar	NFDB, Hyderabad
46.	Krishi Unnayan Mela 2015	10th October, 2015	Ganesh Chandra	Bardhaman, West Bengal
47.	Brainstorming on Continuous monitoring of water spread area of tanks and reservoirs using satellite images for the development of fisheries	October 2015	D. S. K. Rao M. Karthikeyan	Dept. of Fisheries, Govt. of Karnataka, Bangalore
48.	Meeting on cage culture in Andhra Pradesh reservoirs	26th October, 2015	D. S. K. Rao	Department of Fisheries, Govt. of AP.
49.	Workshop of Vigilance officers of ICAR institutes	28th October, 2015	S. K. Nag	ICAR, New Delhi
50.	Second meeting of Joint Working Group (JWG) between India and Bangladesh on cooperation in the field of fisheries	28-29th October, 2015	R. K. Manna	Taj Vivanta, Goa
51.	Meeting of the selection committee for the promotion of teaching faculty	30th October, 2015	U. K. Sarkar	UBKV, Kalyani , West Bengal

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
52.	Workshop for preparing roadmap for development of agriculture and allied sector in the lower Gangetic plain region	31st October, 2015	V. R. Suresh B. P. Mohanty U. K. Sarkar B. K. Bhattacharjya S. K. Manna Arun Pandit Suvra Roy Kavita Kumari Mishal P Gunjan Karnatak	ICAR-CIFRI, Barrackpore
53.	ISEE Golden Jubilee National seminar on strategy to drive skill based agriculture development forward for sustainability and rural employability	5-7th November, 2015	Ganesh Chandra Aparna Roy	BHU, Varanasi
54.	Baigyanic sansthano mey rajbhasa karjyonayan: prayog b protsahan	7th November, 2015	S. Samanta	ICAR- NASC Complex, New Delhi
55.	Institute Technology Management Committee meeting of ICAR-CRIJAF	17th November, 2015	Ganesh Chandra	ICAR-CRIJAF, Kolkata
56.	National seminar on Hilsa fisheries and conservation	18th November, 2015	All scientists at HQs and Kolkata centre	SOFTI, Kochi &IFSI, Kolkata ICAR-CIFRI Barrackpore, Kolkata
57.	International krishi mela	19-22th November, 2015	Feroz Khan D. S. K. Rao Preetha Panikkar M. Karthikeyan Sibina Mol S M. E. Vijayakmar	GKVK, Bangalore
58.	5th Agro Protech-towards sustainable food security through "*Green, Blue & White revolution*"	20-21st November, 2015	Ganesh Chandra	ICC, Kolkata
59.	Workshop on Ganga Naadee kee Matsyi kee kavartaman swarup, Ashan kayeva msam vardhan keu pay	21st November, 2015	K. D. Joshi Absar Alam	ICAR-CIFRI, Allahabad Regional Centre
60.	5th International symposium on Cage Aquaculture in Asia (CAA5)	25-28th November, 2015	M. A Hassan A. K. Das R. K. Manna Mishal P Gunjan Karnatak D. S. K. Rao Preetha Panikkar	Kochi, India
61.	Review meeting of vigilance officers of eastern and north eastern ICAR institutes	27th November, 2015	S. K. Nag	ICAR Research Complex for NEH Region, Tripura Centre
62.	23rd Annual conference of Agricultural Economics Research Association (India)	2-4th December, 2015	Arun Pandit Anjana Ekka	ICAR-CIFE, Mumbai
63.	Meeting on Kanhar irrigation project	16-17th December, 2015	K. D. Joshi	National Green Tribunal, New Delhi Lucknow
64.	Delivered invited talk on Functional genomics research in fish and their utility in fish nutrigenomics	17th December, 2015	B. P. Mohanty	ICAR-CIFE, Mumbai

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
65.	Bengal Fish Festival- 2015	18th December, 2015	U. K. Sarkar	Nalban Food Park, Sat Lake, Kolkata
66.	Invited talk on Use of remote sensing data on aquatic resources	18th December, 2015	D. S. K. Rao	Department of Fisheries, Govt. of Karnataka, Bangalore
67.	State level consultation on "FAO voluntary guidelines for securing sustainable small scale fisheries in the context of food security and poverty eradication	19th December, 2015	P. K. Parida	Bhubaneswar, Odisha
68.	Farmers-scientist interaction and exhibition	25th December, 2015	Ganesh Chandra Raju Baitha	Motihari, Bihar
69.	103rd Indian Science Congress 2016	3-7th January, 2016	U. K. Sarkar	Mysore University, Mysore
70.	Meeting of the Parliament Standing Committee on Agriculture	14th January, 2016	V. R. Suresh U. K. Sarkar S. K. Manna	Hotel Novotel, Kolkata
71.	11th National symposium on Innovations in coastal agriculture-Current status and potential under changing environment	14-17th January, 2016	R. K. Manna S. K. Das	ICAR-IIWM, Bhubaneswar
72.	Conference on Livelihood Security, Sustainability and Conservation	21-22nd January, 2016	B. K. Bhattacharjya Archana Sinha S. K. Nag Dibakar Bhakta Vikash Kumar Lianthuamluaia Suvra Roy Nirupada T. C	Lembucherra, Tripura
73.	International symposium on Genomics in aquaculture-II	28-30th January, 2016	B. P. Mohanty Pronob Das P. K. Parida	ICAR-CIFA, Bhubaneswar
74.	Review meeting of ICAR Institute/ Centres located in and around Guwahati	30th January, 2016	B. K. Bhattacharjya	ICAR, New Delhi Guwahati
75.	Regional level training on Voluntary guidelines on small scale fisheries (VGSSF)	3rd February, 2016	S. K. Das	Ramakrishna Mission Ashram, Narendrapur, Kolkata
76.	National Seminar on Research Innovations in Aquatic Genomics and Biotechnology-An Indian Perspective	5-6th February, 2016	A. K. Sahoo	CRNN, University of Calcutta, Kolkata
77.	National level young scientists meet- 2016 and Prof H. L. Chaudhuri commemorative conference	05-07th February, 2016	U. K. Sarkar Suvra Roy	Zoological Society, Kolkata University of Calcutta, Salt lake Campus, Kolkata
78.	91st Expert appraisal committee meeting for environmental clearance of hydro-electric projects	8-9th February, 2016	K. D. Joshi	MoEF & CC, Govt. of India, New Delhi
79.	Awareness cum training program on Climate change impact and adaptation strategies for wetland fisheries	9th February, 2016	All scientists HQs	ICAR-CIFRI, Barrackpore, Kolkata

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
80.	Workshop on Small Indigenous fish for livelihood and nutritional security	10th February, 2016	B. P. Mohanty Archana Sinha Aparna Roy Raju Baitha	Mataiya,Vaishali, Bihar
81.	International conference on Climate change and food security: Ethical perspective	11-13th February, 2016	U. K. Sarkar	Hyderabad, India
82.	National Seminar on Technological options for bringing 2nd green revolution in North-East India and Assam Krishi Unnayan Mela-2016	13-14th February, 2016	B. K. Bhattacharjya S. Yengkokpam D. Debnath Pronob Das Niti Sharma S. Borah	ICAR-ATARI, ICAR Research complex for NEH Region, Umiam, Meghalaya and AAU, Jorhat, Assam, Guwahati
83.	Meeting for selecting consultants for NFDB Regional Centre, Guwahati	16th February, 2016	B.K. Bhattacharjya	Guwahati, Assam
84.	International conference on Aquatic resources & sustainable management	17-19th February, 2016	A. K. Das S. K. Nag R. K. Manna Aparna Roy D. K. Meena Sandhya K. M. Suman Kumari Dibakar Bhakta Raju Baitha	Central Calcutta Science & Cultural Organization for Youth Science city, Kolkata
85.	4th National Symposium on "Transforming Indian Agriculture Towards Food and Nutritional Security"	22-21st February, 2016	Dibakar Bhakta	ICAR-IGFRI, Jhansi, UP
86.	Vigyan Saksharta Utsav-2016	21-23rd February, 2016	Rohan Kumar Raman	Jhanjharpur, Bihar
87.	Meeting for the PUCfor the new research proposal	25th February, 2016	U. K. Sarkar	NFDB, Hyderabad
88.	Seminar cum exhibition on Make in India, start-up India and stand up India	25-26th February, 2016	B. K. Bhattacharjya S. Yengkokpam D. Debnath Pronob Das Niti Sharma S. Borah	NIRD & PR, Guwahati
89.	National Seminar on Advances in marine natural products and nutraceutical research	26th February, 2016	B. P. Mohanty	ICAR-CIFT, Kochi
90.	Brainstorming session on Ornamental fish	29th February, 2016	B. K. Bhattacharjya Archana Sinha	NFDB, Hyderabad
91.	Meeting of advisory committee on Hilsa conservation and research	2nd March, 2016	R. K. Manna	Govt. of West Bengal, Kolkata
92.	National Seminar on Integration agri-horticultural and allied research for food and nutritional security in the era of global climate disruption	4-6th March, 2016	Nirupada T. C	ICAR Research Complex for NEH Region, Manipur Centre, Imphal
93.	International Conference on Aquatic Resources and Sustainable Management	5-6th March, 2016	Aparna Roy	Department of EES, PalliSikshaBhavana, Visva-Bharati

Sl. No.	Name of the Programme	Date	Participants	Organizer and venue
94.	National symposium on Use of advanced technologies in biochemistry and biotechnology in livestock health, production and reproduction	11-12th March, 2016	B. P. Mohanty	OUAT, Bhubaneswar
95.	National Conference on Rural Livelihood security through innovative Agri-entrepreneurship	12-13th March, 2016	Ganesh Chandra	ICAR-CPRI Station, Patna
96.	National Conference on "New Avenues in Microbiology and Biotechnology: Challenges and Prospects"	18-19th March, 2016	Dibakar Bhakta	Department of Microbiology, WBSU and Sarada Ma Girls College, Barasat
97.	Krishi Unnati Mela	19-21st March, 2016	A. K. Das P. K. Parida	ICAR, New Delhi
98.	ISO 9001:2008 internal auditor training	28th March, 2016	Anjana Ekka D. Panda Kavita Kumari Mishal P Gunjan Karnatak Raju Baitha Vikash Kumar Suvra Roy S. K. Koushlesh	ICAR-CIFRI, Barrackpore
99.	International conference on Aquatic exotics: Trends, challenges and policies	28-30th March, 2016	Preetha Panikkar	University of Kerala, Trivandrum
100.	Workshop on Biodiversity of Uttarkhand	29th March, 2016	K. D. Joshi	Gurukula Kangri Vishwavidyalaya, Haridwar, Uttarkhand
101.	National Seminar on Emerging trends in environmental resource management	31st March, 2016	U. K. Sarkar	Dept. of ecological studies, Kalyani University

प्रस्तावना

अंतर्स्थलीय खुला जल मात्स्यिकी क्षेत्र का देश की राष्ट्रीय आर्थिकी, आजीविका के साधन एवं पोषण सुरक्षा तथा पारिस्थितिकीय सेवायें प्रदान करने में विशिष्ट भूमिका रही है। मात्स्यिकी विकास में अंतर्स्थलीय जलस्रोतों जैसे, नदियों, ज्वारनदमुखों, बाढ़कृत आर्द्रक्षेत्रों, जलाशयों, बैकवाटर, झील एवं लैगून अति महत्वपूर्ण हैं। अतः इस दिशा में भाकृअनुप–सिफरी का वैज्ञानिक एवं तकनीकी क्षेत्र में अंर्तविषयी अनुसंधान द्वारा पारिस्थितिकीय सेवाओं एवं मात्स्यिकी क्षेत्र में अन्यतम योगदान रहा है।

वर्ष 2016–16 के दौरान संस्थान के कार्यकलापों में अनुसंधान कार्यक्रमों का विशेष स्थान है और इससे इस अवधि के दौरान कई वैज्ञानिक एवं तकनीकी उपलब्धियां प्राप्त हुई हैं। रिपोर्ट अवधि के दौरान संस्थान की महत्वपूर्ण उपलब्धियां रही हैं, जैसे– खुला जलक्षेत्रों की पारिस्थितिकी एवं मात्स्यिकी पर उन्नत एवं नवीनतम डेटाबेस तैयार करना; ओडिशा और हिमाचल प्रदेश के जलाशयों पर जिलेवार मानचित्र बनाना, ई–एटलस बनाना; ई–डैश मोबाइल एपलिकेशन का डिजाइन बनाना एवं परीक्षण; कई राज्यों के जलाशयों में पिंजरा पालन का प्रदर्शन; घिरे क्षेत्र में मछली पालन हेतु कम लागत वाली मत्स्य आहार को शराबखाने के अवशिष्ट से तैयार करना; चिलिका झील, सुन्दरवन एवं अन्य खुला जलक्षेत्रों की मछलियों तथा हिल्सा मछली के स्टॉक का आंकलन, गंगा नदी की मात्स्यिकी एवं पारिस्थितिकी पर बहु–प्रजातियों के संग्रहण घनत्व से होने वाले परिवर्तनों का आंकलन; नदी जल धाराओं के पर्यावरणीय प्रवाह का आंकलन तथा सुझाव देना; अंतर्स्थलीय मात्स्यिकी पर जलवायु परिवर्तन का प्रभाव; पारितंत्र सेवाओं का मूल्यांकन; इकोसिस्टम मॉडेलिंग; मछलियों में उपस्थित पोषक तत्वों का प्रोफाइलिंग; मत्स्य रोगों का निरीक्षण; नवीन जीन एवं बैक्टीरिया की पहचान करना और परितंत्र सुरक्षा के लिये प्रदूषण संबंधी जैव–सूचकों का आंकलन आदि।

संस्थान की भावी योजनाओं में मत्स्य स्वास्थ्य, गंगा नदी का पुनरूत्थान, जैवसूचना तथा कम्प्युटेशनल बायोलॉजी; रिमोट सेंसिंग और जलक्षेत्रों पर कोयला परिवहन के प्रभाव संबंधी परियोजनायें हैं। मुझे इस बात की अत्यत्त ही खुशी है कि इस वर्ष 40 प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिसमें विभिन्न राज्यों के लगभग 500 से अधिक किसानों ने प्रशिक्षण लिया है। इसके अलावा, संस्थान में महत्वपूर्ण बैठकों/कार्यशाला/संगोष्ठी जैसे, परिषद् की क्षेत्रीय समिति प्प बैठक, गंगा नदी के निचली क्षेत्र में कृषि विकास हेतु योजना तैयार करने पर कार्यशाला, हिल्सा मात्स्यिकी पर राष्ट्रीय संगोष्ठी, जनजागरूकता कार्यक्रम आदि का आयोजन किया गया। केन्द्र सरकार की योजना, 'स्वच्छ भारत' एवं 'मेरा भारत मेरा गौरव' का सफलता पूर्ण संचालन किया गया जिसे बहुत ही सराहना मिली है।

संस्थान ने जनजाति उप–योजना के अंतर्गत उत्तर–पूर्वी क्षेत्रों में नहर/नालों में मात्स्यिकी विकास द्वारा मत्स्य पालन कार्यक्रमों का आयोजन किया जिससे जनजाति मछुआरों को बहुत

ही लाभ पहुँचा है। अन्य उपलब्धियों में एकीकृत पालन, पेन पालन तथा उत्तर–पूर्वी राज्यों में आर्द्रक्षेत्र मात्स्यिकी विकास है।

इस वर्ष संस्थान के मानव संसाधन विकास के अंतर्गत अधिकारियों/कर्मचारियों को प्रशिक्षण के लिये देश एवं विदेशों में भेजा गया तथा कई राष्ट्रीय एवं अंतर्राष्ट्रीय संगोठी, बैठकों आदि का आयोजन हुआ। संस्थान में विभिन्न विषयों के 11 वैज्ञानिकों की नियुक्ति हुई है और मै यह आाशा करता हूँ कि ये अपने कार्यों द्वारा संस्थान को नई ऊँचाइयों पर ले जायेंगे।

मैं संस्थान के कार्यों एवं उपलब्धियों के लिये सचिव, डेयर व महानिदेशक, भारतीय कृषि अनुसंधान परिषद्, उप–महानिदेशक (मात्स्यिकी), सहायक महानिदेशक (अंतर्स्थलीय मात्स्यिकी) के मार्गदर्शन एवं प्रोत्साहन तथा भाकृअनुप–सिफरी टीम के अथक प्रयासों एवं सहयोग के लिये आभारी हूँ।

बैरकपुर
दिनांक 8 जुलाई 2016

वी. आर. सुरेश
निदेशक (कार्यकारी)

विशिष्ट सारांश

भाकृअनुप–केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान का अंर्तविषयी अनुसंधान द्वारा वैज्ञानिक एवं तकनीकी क्षेत्र में अन्यतम योगदान रहा है। संस्थान द्वारा किये गये प्रयासों के कारण खुला जल क्षेत्रों के उत्पादन में निरंतर बढ़ोतरी देखी जा रही है। वर्तमान में संस्थान तथा इसके अधीनस्थ क्षेत्रीय कार्यालयों; इलाहाबाद, गुवाहाटी, बैंगलोर, वडोडरा, कोलकाता तथा कोच्चि में कुल 81 वैज्ञानिक, 60 तकनीकी एवं 50 प्रशासनिक अधिकारी व कर्मचारी तथा 83 कुशल सहायक कर्मचारी कार्यरत हैं।

वर्ष 2015–16 में संस्थान के तीन प्रभागों, नदीय पारिस्थितिकी एवं मात्स्यिकी, जलाशय और आर्द्रक्षेत्र मात्स्यिकी, मात्स्यिकी संसाधन एवं पर्यावरण प्रबंधन तथा सामाजिक–आर्थिक अनुभाग के अंतर्गत 17 परियोजनाओं पर कार्य किया गया। आउटरीच कार्यकलापों के अलावा बाहरी संस्थाओं द्वारा प्रायोजित परियोजनायें, प्रशिक्षण एवं विस्तार कार्यक्रम आदि का क्रियान्वयन किया गया। विभिन्न परियोजनाओं के अंतर्गत हुये अनुसंधान का सारांश निम्नलिखित है–

नदीय एवं आर्द्रक्षेत्र मात्स्यिकी

नदीय एवं आर्द्रक्षेत्र मात्स्यिकी कार्यक्रम के अंतर्गत ब्रह्मपुत्र नदी बेसिन के तोरसा नदी तथा गंगा नदी बेसिन के गंडक नदी की मत्स्य विविधता, जल की गुणवत्ता तथा प्लवक उपलब्धता के अध्ययन द्वारा विभिन्न ऋतुओं में छोटी देशी मछलियों की उपलब्धता का आंकलन किया गया है। प्राप्त परिणाम के अनुसार, गंडक नदी में कुल 65 मत्स्य प्रजातियों में छोटी देशी मछलियों की 45 प्रजातियां तथा अन्य 20 देखी गईं। तोरसा नदी में कुल 53 मत्स्य प्रजातियों में छोटी देशी मछलियों की 37 प्रजातियां देखी गईं। रिपोर्ट अवधि के दौरान तोरसा नदी में एक नई प्रजाति, जीनस बैरिलस को देखा गया है। इसी प्रकार, मदनगंज में इस क्षेत्र के समस्त समुदायों की सहायता से इन छोटी देशी मछलियों के प्रजातियों के संरक्षण की व्यवस्था की गई है।

देश की मुख्य नदियों की पारिस्थितिकी तथा मात्स्यिकी को बनाये रखने के लिये जलप्रवाह को आंकलन अति आवश्यक है। इस दिशा में हरिद्वार के भीमगौड़ा बराज में गंगा नदी के पर्यावरणीय प्रवाह का आंकलन ग्लोबल एनवायरनमेन्टल फ्लो कैलकुलेटर द्वारा किया गया। आंकलित प्रवाह दिसम्बर से मार्च महीनों में 132.48 से 140.84 क्युमेक्स दर्ज किया गया। इसी प्रकार, महानदी में भी दिसम्बर से मार्च महीनों में बड़ी आकार वाली मछलियों की उपलब्धता को दर्ज किया जिससे गहरी नदियों में उपलब्ध मत्स्य प्रजातियों के बारे मे जाना जा सके। इससे यह देखा गया कि औसतन 1950 ग्रा. वाली चीतला प्रजातियां 24 फीट की गहराई वाली जल निकायों में, औसतन 1950 ग्रा. वाली चीतला प्रजातियां 24 फीट की गहराई वाली जल निकायों में तथा औसतन 3500 ग्रा. वाली कतला प्रजातियां, 2500 ग्रा. वाली *लेबियो रोहिता* प्रजातियां एवं 1800 ग्रा. वाली *टोर मेहानडिकस* प्रजातियां 18 फीट की गहराई वाली जल निकायों में पाई जाती हैं।

रिपोर्ट अवधि के दौरान हुगली–भागीरथी आर्द्रक्षत्र तथा बंगाल की खाड़ी के पूर्वी भाग में उपलब्ध अन्यतम प्रजाति, हिलसा का अध्ययन किया गया। इसके लिये हिलसा मछली की प्रमुख प्रजनन स्थलों तथा उनकी सघनता का विश्लेषण किया गया। वर्ष 2015–16 के दौरान हिलसा का कुल उत्पादन 12191 टन आंका गया जो पिछले वर्ष के कुल लैंडिंग का केवल 27 प्रतिशत है। यह उत्पादन इस मछली के उत्पादन में आई ह्रास को दिखाता है जिसका कारण है इस मछली का अधिकतम दोहन होना (लगभग 0.77)। हिलसा के मुख्य प्रजनन स्थल ग्रीष्म काल में हुगली नदी में गोदाखाली और रूपनारायण में कोलाघाट और शीतकाल में कोलाघाट, गोदाखाली, दक्षिणेश्वर, बिचुलीघाट, कल्याणी, बोलागढ़ तथा फरक्का देखा गया है।

गंगा नदी तथा महानदी आर्द्रक्षेत्र की मात्स्यिकी और पारिस्थतिकी का अध्ययन किया गया। गंगा नदी से 77 जेनेरा, 30 फैमिली एवं 10 आर्डर के 125 मत्स्य प्रजातियों को दर्ज किया गया। हरिद्वार क्षेत्र में प्रथम बार पहाड़ी झरनों की प्रजाति, *गेरा लमता* (*Garra lamta*) को देखा गया। महानदी आर्द्रक्षेत्र में केवल एक प्रजाति, *Eleutheronema tetradactylum* की बहुलता दर्ज की गई है तथा महानदी के निचले भाग में प्रथम बार बर्मा की नदियों में पाई जाने वाली प्रजाति, *Gonialosa modesta* को देखा गया है। नर्मदा ज्वारनदमुख में कुल 86 मछली एवं शेल मछली प्रजातियों को दर्ज किया गया जिनमें से षीत ऋतु में गिल जाल (जाल छिद्र – 60 80 मि.मी.) से प्राप्त लैंडिंग में केवल *ओ. पामा* प्रजाति अधिक पाये गये हैं।

सुन्दरवन के मैंग्रोव क्षेत्र की पारिस्थितिकी और मछली एवं शेल मछली की प्रजाति विविधता का अध्ययन किया गया। इस क्षेत्र की कुल उपज 3.51 टन प्रति हे. प्रति वर्ष आंकी गयी है। यहां प्रति 3 महीने पर औसतन 37 प्रतिशत वनस्पतियों का अपघटन होता रहता है जिससे यहां की मिट्टी का पर्याप्त कार्बन सिक्वेस्ट्रशन होता है।

सुंदरवन के लवणीय जल के कारण मत्स्य प्रजातियों, विशेषकर अभिगमन करने वाली मछलियों की बहुलता देखी गई। झारखाली में *हारपेडन नेहेरियस* तथा *सेटीपिना टी* और पाथर प्रतिमा में *एस्कुआलोसा थोरसेटा* अधिक पाये गये। बैगनेट से प्राप्त उपज में 43 प्रतिशत 51–100 मि.मी. लंबे *हारपेडन नेहेरियस* प्रजातियां पाई गईं हैं। ये प्रजातियां 214.5 मि.मी. अथवा इससे कम लंबाई में ही प्रजनन के लिये परिपक्व हो जाती हैं इसलिये छोटी मछलियों का अत्यधिक मत्स्ययन का खतरा बना रहता है। पर रिपोर्ट वर्ष के दौरान शीतकाल में *हारपेडन* के उत्पादन में ह्रास देखा गया।

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रिपोर्ट वर्ष के दौरान कुल 17 जलाशयों की जैवविविधता, इनमें उपस्थित मत्स्य प्रजातियों, मत्स्य आवास विशेषता तथा उपज संबंधी सूचनाओं को अध्ययन किया गया।

कर्नाटक के हेमावती जलाशय की पारिस्थितिकी पर भारतीय मेजर कार्प प्रजातियों के प्रभाव का आंकलन किया गया। चयनित मछलियों का बायोमास पता लगाने के लिये कारापुझा के विभिन्न जलाशयों में हाइड्रो–एकोस्टिक सर्वेक्षण किया गया। इन जलाशयों में न्युनतम 52 एवं अधिकतम 108 मछलियों को दर्ज किया गया। 1.5 कि.ग्रा. से 770 ग्राम वाली कतला मछली का बायोमास –38.7 से –45.0 डेसिबल, 520 ग्राम रोहू मछली का का बायोमास –45.8 डेसिबल, 160 मि.मी. लम्बी *हेटरोपनिस्टस फॉसिलिस* मछली का बायोमास –41.5 से –45.3 डेसिबल, 210 मि.मी. लम्बी *मिस्टस कैवेसियस* मछली का बायोमास –45.2 डेसिबल तथा 760 ग्राम वाली *पिरेक्टस* प्रजाति का बायोमास –38.1 डेसिबल दर्ज किया गया।

चयनित जलाशयों के मत्स्य स्टॉक का आंकलन यह बताते हैं कि जलाशयों में मछलियों को स्टॉक करने से छत्तीसगढ़, ओडिशा, मध्य प्रदेश, झारखंड, कर्नाटक, हिमाचल प्रदेश के जलाशयों के मत्स्य उत्पादन में वृद्धि हुई है। मत्स्य उत्पादन जो वर्ष 2010–11 में 8.2 टन था वह ओडिशा के एक छोटे जलाशय से मेजर कार्प के संयचन से वर्ष 2014–15 (केवल

एक वर्ष में) में 73.6 टन दर्ज किया गया। अधिकतम उपज वर्ष 2014–15 में हिमाचल प्रदेश के गोविन्द सागर जलाशय से 149 कि.ग्रा. प्रति हे. प्रति वर्ष प्राप्त किया हुआ है। तमिलनाडू के जलाशयों में संचयन घनत्व तथा औसत मत्स्य उपज में पारस्परिक संबंध देखा गया है। छत्तीसगढ़ के एक छोटे जलाशय से मत्स्य उपज 1 कि.ग्रा प्रति हे. प्रति वर्ष (वर्ष 2008) से बढ़कर वर्ष 2014–15 में 1858 कि.ग्रा प्रति हे. प्रति वर्ष प्राप्त हुआ।

हिमाचल प्रदेश के गोविन्दसागर और पोंग जलाशयों के अध्ययन यह बताते हैं कि पहले गोविन्दसागर जलाशय में भारतीय मेजर कार्प प्रजातियों की अधिकता थी पर कालान्तर में विदेशी प्रजातियों जैसे सिलवर कार्प और कॉमन कार्प मछलियों की संख्या अधिक पाई जाने लगी। इसी प्रकार पोंग जलाशय में *स्पेराटा सिंघाला* 53 प्रतिशत, *लेबियो रोहिता* 16 प्रतिशत और *सिरहिनस मृगला* 13 प्रतिशत दर्ज किये गये।

पिंजरा पालन में *लेबियो बाटा* मछलियों को दी जाने वाली भोजन को शराब कारखाने से निकले अवशिष्ट पदार्थों से तैयार किया गया है इससे लागत मूल्य लगभग 33.8 प्रतिशत कम हो जाता है। परीक्षण पालन में मछलियों को सोयाबीन से बने भोजन दिया गया जिससे कतला में 68.8 प्रतिशत तथा रोहू मछलियों के शारीरिक भार में में 66.7 प्रतिशत की वृद्धि दर्ज की गई है। इससे यह पता चलता है कि भारतीय मेजर कार्प प्रजातियों के लिये सोयाबीन से बने भोजन उपयुक्त होते हैं।

संस्थान द्वारा विकसित डेटा एक्विजिशन सिस्टम को मोबाइल फोन में लगाया गया है जिससे रियल टाइम आंकड़ों के संग्रहण में आसानी हो। इस तकनीक का टुंगा, मानचलबेलि, कारापुझा और बनासुरा सागर जलाशयों में परीक्षण किया गया।

आर्द्रक्षेत्र परितंत्र एवं मात्स्यिकी

देश के विभिन्न आर्द्रक्षेत्रों के मत्स्य उत्पादन यह दिखाते हैं कि असम (मेर, दमाल, सुकदोल–सारूबरी बील), पश्चिम बंगाल (अकाईपुर, खलसी बील) और उत्तर प्रदेश (लोहसर, गुजवार, बघार, अजीपुरताल) के असंचयित आर्द्रक्षेत्रो की तुलना में संचयित आर्द्रक्षेत्रो का मत्स्य उत्पादन अधिक हैं। कुछ खुले बीलों में कम अवधि के लिये 3000 अंगुलिका प्रति हे. की दर से संचय किया गया पर इससे जल निकाय की गुणवत्ता तथा जीवों पर किसी प्रकार का प्रतिकूल प्रभाव दिखाई नही दिये। अकाईपुर बील के जल एवं तलछट के जैव–रसायनिक तथा सूक्ष्मजैविकी गुणों के कारण कार्बन का खनीजीकरण आदि में वृद्धि से मछलियों के उत्तम संचयन तथा मेक्रोफाइट प्रबंधन में आसानी हुई है।

मेघालय के तीन आर्द्रक्षेत्रों, बोरो, काटुलि तथा कुमलिगांव के अध्ययन से यह पता चला है कि इन आर्द्रक्षेत्रों की पारिस्थितिकी मात्स्यिकी के लिये अनुकूल है। छोटी देशी मछलियों की उपज बोरो बील से 60–70 प्रतिशत, काटुलि बील से 30–40 प्रतिशत तथा कुमलिगांव बील से 25–30 प्रतिशत हुआ है। प्राप्त उपज में अन्य प्रजातियां जैसे, *वलागो अट्टु, स्पेराटा सिंघाला, एस. एओर, चिताला चिताला,* भारतीय मेजर कार्प एवं माइनर कार्प तथा विदेशी प्रजाति, *क्लेरियस गैरिपीनियस* आदि देखी गई हैं।

परितत्र एवं मत्स्य स्वास्थ्य

इस कार्यक्रम के अंतर्गत नदी की पारिस्थितिकी, मत्स्य स्वास्थ्य, प्रदूषण को रोकने वाली बैक्टीरिया की पहचान, प्रदूषण जैवसूचकों का विकास, परितंत्र पुनस्स्थान के लिये प्रोटोकोल का विकास तथा मात्स्यिकी एवंज ल परितंत्र पर जलवायु परिवर्तन के प्रभाव का आंकलन आदि पर कार्य किया गया है। बायोटिक इंटीग्रिटी इंडेक्स (IBI) द्वारा महानदी की पारिस्थितिकी का आंकलन यह बताते हैं कि सिवरीनारायण से पारादीप के बीच का क्षेत्र आंशिक तौर पर प्रदुषित हुआ है।

गोमती नदी के जल में कीटनाशकों का जमाव देखा गया है। नदी से प्राप्त 76 नमूनों में से

36 नमूनों में कीटनाशकों जैसे, ऑरगेनोक्लोरिन, एच सी एच तथा डी डी टी के अंश पाये गये हैं। दो नमूनों में एच सी एच निर्धारित मात्रा (0.25 मि.ग्रा. प्रति कि.ग्रा.) से अधिक पाई गई है जिससे ऐसे जल की मछलियां मानव उपभोग के लिये हानिकारक हैं। अन्य जलीय प्राचल जैसे, विशिष्ट चालकता 421–558 µS प्रति से.मी. अम्लीयता 232–295 पीपीएम, हार्डनेस 117–223 पीपीएम, फॉस्फेट 1.57 पीपीएम तक और बी ओ डी 5.2 पीपीएम तक पाये गये जिससे यह पता चलता है कि गोमती नदी का जल प्रदूषित है।

कीटाणुओं को मारने के लिये प्रचलित, ट्राइक्लोसन का स्तर गोमती नदी के जल में 1.62–9. 65 µg प्रति ली. पाया गया है जो जल में उपस्थित अलगी, प्रोटोजोआ, मेक्रोफाइट, क्रश्टेशिया तथा मोलस्क प्रजातियों के लिये हानिकारक हैं। मछलियों में इसका स्तर 0.36 से 1.12 मि.ग्रा प्रति कि.ग्रा. पाया गया है जबकि मानव उपभोग के लिये निर्धारित मात्रा 0.05 मि.ग्रा/व्यक्ति के शारीरिक भार/दिन है तथा यु एस ई पी ए के अनुसार यह मात्रा 0.03 मि.ग्रा/व्यक्ति के शारीरिक भार/दिन तय की गई है।

जल निकायों में प्रदूषण के प्रभाव को कम करने वाली बैक्टीरिया की पहचान की गई है–*Pseudomonas* spp., *Acinetobacter* spp., *Stenotrophomonas maltophilia*, *Bacillus* spp., *Cupriavidus* sp., *Cloacibacterium normanense*, *Ochrobactrum* spp., *Klebsiella pneumonia*, *Comamonas* spp., *Cupriavidus* sp., *Chryseobacterium* spp., *Flavobacterium* sp., *Alkaligenes faecalis*, and *Citrobacter freundi*। इनमें से कुछ बैक्टीरिया में प्रदूषण का खतम करने की अपार संभावना है।

गंगा नदी के विभिन्न क्षेत्रों, कानपुर, इलाहाबाद, वाराणसी, भागलपुर, फरक्का, श्रीरामपुर, हावड़ा, मछलियों के लीवर एवं गिल के उत्तकों का परीक्षण किया गया। परीक्षण से hsp47, hsp70, hsc70, hsp90 और hsp27 जीन की पहचान की गई है। जीन एक्सप्रेशन पैटर्न और जल की गुणवत्ता के परस्पर संबंध यह बताते हैं जैव प्रदुषण तथा भारी धातुओं के कारण होने वाली प्रदूषण के लिये को hsp27 को जैव सूचक के रूप में प्रयोग कर सकते हैं।

पश्चिम बंगाल और असम से एकत्र की गई संक्रमित मछलियों में से प्रदूषण के प्रभाव को कम करने वाली बैक्टीरिया, *Citrobacter freunddii*, *Acinetobacter baumannii*, *Acinetobacter lwoffii* और *Klebsiellap neumoniae* को अलग किया गया है। ये मछलियां *मिक्सोबोलस, आरगुलस* और *डैक्टीलोगाइरस* से सवंमित हुई थीं। इसी प्रकार पश्चिम बंगाल में *पी मोनोडोन* और *एल वनामी* में WSSV और EHP का संक्रमण देखा गया है।

संसाधन आंकलन एवं मॉडेलिंग

संसाधन आंकलन एवं मॉडेलिंग के अंतर्गत ओडिशा के 70 छोटे जलाशयों की भौगोलिक स्थिति, जलक्षेत्र, उत्पादकता आदि सूचनाओं पर जिलेवार मानचित्र बनाया गया है। छत्तीसगढ़ के 20 जलाशयों तथा ओडिशा के 5 जलाशयों के जलमग्न क्षेत्रों को अध्ययन किया गया और यह देखा गया है कि इन जल निकायों के जलक्षेत्रों में 45 से 3 प्रतिशत की कमी आई है। जनवरी 2015 से दिसम्बर 2015 तक कोई भी जलक्षेत्र पूर्णतः भरा हुआ नही है।

ओडिशा और हिमाचल प्रदेश के 0.5 हे. से अधिक जलक्षेत्रों का इलेक्ट्रोनिक मैप बनाया गया है जिससे वैज्ञानिक तौर पर प्रबंधन योजना तैयार किया जा सके। गुजरात के 0.5 हे. से अधिक जलक्षेत्रों के जलमग्न क्षेत्र संबंधी सूचनायें एलआईएसएस III तथा पैन इमेज द्वारा प्राप्त की गईं। छत्तीसगढ़, उत्तर प्रदेश, ओडिशा, महाराष्ट्र, केरल तथा पंजाब के इलेक्ट्रोनिक एटलस के प्रयोग विधि संबंधी मैनुअल को तैयार किया गया है।

नर्मदा नदी में प्लवक घनत्व पर जेनेरलाइज्ड लिनियर मॉडेल (GLM) तथा जेनेरलाइज्ड नॉन–लिनियर एडिटिव मॉडेल (GAM) आधारित इनफरेन्स पर काम किया गया है। नदियों की जल गुणवत्ता सामान्यतः 4 मुख्य प्राचलों पर निर्भर करती है।

मात्स्यिकी का सामाजिक–आर्थिक पहलु

छत्तीसगढ़ के जलाशयों के सांस्थनिक पक्ष को अध्ययन किया गया। रविशंकर सागर (गंगरेल) तथा दुधवा जलाशय मुख्यतः सिंचाई विभाग द्वारा संचालित होते हैं तथा इनका मात्स्यिकी प्रबंधन छत्तीसगढ़ मछुआरा सहकारी फेडरेशन द्वारा होता है। वर्तमान में पट्टे की अवधि 5 वर्ष की है। वर्ष 2013–14 में मत्स्य उत्पादन 515 मेट्रिक टन था तथा औसत उत्पादन 205 कि.ग्रा. प्रति हे. था। यहां मात्स्यिकी पालन आधारित होता है पर किसी भी आपसी संघर्ष की समस्या देखने का नहीं मिली है।

टसम के दापोर बील के उत्पादन, आजीविका, रोजगार के साधन तथा पर्यटन का आर्थिक मूल्यांकन किया गया। यहां पर्यटन से 16 लाख रूपये की आय हुई है तथा यहां पर्यटन की और भी संभावनायें हैं।

उत्तर–पूर्वी क्षेत्र के कार्यकलाप

उत्तर–पूर्वी क्षेत्र में मात्स्यिकी विकास कार्यक्रम के अंतर्गत असम के नगांव जिले के मेर आर्द्रक्षेत्र तथा बारपेटा जिले के सारभोग आर्द्रक्षेत्र में असम मात्स्यिकी विकास सहकारी निगम, गुवाहाटी के सहयोग से मत्स्य स्टॉक का संवर्धन किया गया। इसी प्रकार, कोकराझार में बोडोलैण्ड टेरिटोरियल कोउंसिल के दो आर्द्रक्षेत्रों में मत्स्य स्टॉक का संवर्धन किया गया।

जनजाति उप–योजना कार्यकलाप

इस योजना के अंतर्गत उत्तर प्रदेश के चंदन चौकी के मत्स्य फार्मों में मत्स्य उत्पादन में वृद्धि तथा मत्स्य संरक्षण के लिये कार्यक्रम का संचालन किया गया। साथ ही, प्रशिक्षण एवं जन–जागरूक कार्यक्रमों का आयोजन किया गया तथा जनजाति मछुआरों के बीच भारतीय मेजर कार्प की अंगुलिकाओं, मत्स्य बीज, चूने आदि का वितरण किया गया।

संस्थान ने सुन्दरवन क्षेत्र में मछुआरों को आजीविका के नये साधन प्रदान करने के लिये यहां के पोखर एवं नहरों में मात्स्यिकी प्रारंभ किया है। इसके लिये सागर द्वीप के खानसाहेबाबाद के जनजाति मछुआरों को भारतीय मेजर कार्प की अंगुलिकाओं, मत्स्य बीज, चूने आदि दिया गया।

सुन्दरवन के बाली और कालितला के कुछ नहरों में पालन आधारित मत्स्य पालन प्रारंभ किया गया है जिससे स्थानीय मछुआरों को आजीविका के साधन मिलने के साथ उनके आय में भी वृद्धि हो। इन नहरों से कुल 17,680 कि.ग्रा. की बड़ी मछलियों का उपज प्राप्त किया गया। संस्थान के इस प्रयास से 1200 मछुआरें लाभान्वित हुये हैं।

वयानाद जिले में फाइबर कांच से बने नाव की मदद से सुरक्षित मात्स्यिकी पर जनजागरूक कार्यक्रम आयोजित किये गये। कर्नाटक के वानिविलासनगर जलाशय के 60 मछुआरों को पिंजरा एवं पेन पालन तथा मोबाइल द्वारा आंकड़ों के संग्रहण पर प्रशिक्षण दिया गया है।

जनजागरूकता एवं मानव संसाधन विकास

रिपोर्ट अवधि के दौरान संस्थान ने बिहार के 538 मछुआरों को अंतर्स्थलीय मात्स्यिकी विकास पर प्रशिक्षण दिया है। अंर्तस्थलीय मात्स्यिकी प्रबंधन से जुड़े 327 छात्रों के लिये मात्स्यिकी के विभिन्न पहलुओं पर प्रदर्शन कार्यक्रम का आयोजन किया तथा 16 छात्रों को देष के विभिन्न भागों में अध्ययन के लिये भेजा है। जलाशय मात्स्यिकी प्रबंधन एवं पिंजरा पालन कार्यकलापों पर ओरियेंटेशन प्रशिक्षण का आयोजन किया गया।

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