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2020

भाकृअनुप
ICAR

भा.कृ.अनु.प.-केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान

ICAR- Central Inland Fisheries Research Institute

बैरकपुर, कोलकाता- 700 120, पश्चिम बंगाल

Barrackpore, Kolkata-700120, West Bengal

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केन्द्रीय अन्तर्देशीय मत्स्यिकी अनुसंधान संस्थान
CIFRI
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Preface

The vast inland open water resources of the country, viz., 45,000 km of rivers, 0.3 million ha of estuaries, 0.19 million ha of backwaters and lagoons, 3.524 million ha of reservoirs, 0.354 million ha of floodplain wetlands and 0.72 million ha of upland lakes provide water, food and nutrition, transport, and livelihood and several other ecological services to a large section of the population besides innumerable economic and social benefits.

During 2018-19 the country produced 8.9 million metric tonnes of fishes from the inland sector, of which 50% were from inland capture fisheries; however, there are enough potentials to increase fish production from these large resources. By virtue of large size and fish production potentials wetlands, lakes, and reservoirs have been heavily emphasized for fish production enhancement to achieve the targeted Second Blue Revolution of the country. Inland open water resources also provide employment and livelihood support to 1.24 million inland fishers, besides being the vital germplasm conservator.

In recent times, the inland open water resources are fraught with several threats and challenges such as declining water availability, habitat degradation, pollution, over-exploitation of natural fish stocks, etc. Further, with increasing pressure and perceptible climatic changes, it becomes necessary to protect these resources for sustained inland fisheries and harness their untapped production potentials. To mitigate the challenges and to enhance the fish production the Institute has formulated its research, extension, HRD and development activities in the sector through several institutional and externally funded research projects, training of fishers and other stakeholders and demonstrations/implementation of its technologies in NEH, TSP, SCSP programmes, etc. The Institute took lead in generating information in the areas of inland open water fisheries through ecosystem based research and community participation. The Institute imparted extensive training to more than 4000 fishers, officials, and students through off-line and on-line modes. It also generated awareness, developed skill and distributed essential resources among SC and tribal fishers during the report period.

Majority of the Institute research projects formulated during 2017-18 are concluded in March 2020. In the last 3 years the Institute investigated the habitat, ecology and fisheries of 8 rivers, including river Ganga and its tributaries; estimated environmental flow requirements of river Kathajodi and Tamas; and bred and ranched Indian major carp seeds for ecosystem restoration and fisheries conservation in river Ganga. Pollution including emerging contaminants like microplastics, their impacts on the ecosystem, and fish health have been studied in several resources. Modern modeling tools were applied to predict river ecology and fish catch. Adaptive measures were recommended to reduce the impact of climate change risk. Fish diseases were investigated and emphasis were given on the development of formulations for the mitigation option of arsenic toxicity and control of infectious diseases using cutting edge methodologies. Some new fish species in rivers were recorded, along with the identification of a new fish species *Barilius torsai* (family, Cyprinidae) from river Torsa.

Ecology, fish diversity, and fisheries potential were studied in 7 reservoirs and 7 floodplain wetlands along with the implementation of enclosure culture technologies for fish production enhancement. The potential fishing zones were assessed through the use of acoustics to help fishers in catching fish in large reservoirs. The Institute demonstrated cage and pen culture technologies in the states of Odisha, Telangana, Bihar, Assam, West Bengal, Arunachal Pradesh, etc. Keeping in view the market demand of fish, the Institute examined suitability of fish species other than

Pangasianodon hypophthalmus with the objective of species diversification in cage culture. Cages were also installed successfully in wetlands, addressing the diversified climate-resilient species and *in situ* raising of fingerlings.

The Institute studied the adoption and impact of cage culture technology and training on fish production with a significant impact on reservoir fish yield, livelihood, social and economic upliftment of fishers. Canal fisheries development was taken up in resource-poor Sundarbans. The Institute also assessed the impact of super-cyclones in Odisha and Sundarbans of West Bengal and extended all possible helps in mitigating the damages to the sector. The Institute had put more thrust on the outreach of its recently commercialized technologies such as CAGEGROW FEED, CIFRI GI CAGE, CIFRI HDPE PEN to make them available at field level for fish production enhancement. Several interactive meetings, virtual workshops, trainings, etc. were organized for the sectoral development.

New projects have been formulated, effective from April 2020 in different priority areas. Temporal assessment of Hooghly-Matlah, Rushikulya, Netravathi-Gurupur and Vembanad estuarine ecosystems will be studied. Similarly, assessment of ecological impacts of dams and barrages, fish catch assessment of 5 Rivers, assessment of fisheries of protected inland waterbodies, impact study of river Yamuna on river Ganga, nutrient fluxes and biotic community interactions of mangrove are some of the other studies in riverine and estuarine sector.

In the reservoir resources, studies have been formulated for understanding the spatio-temporal variations of large, medium and small reservoir ecosystems, and their trophodynamic modelling. In wetland resources, projects have been formulated towards fisheries enhancement in diverse eco-regions, including West Bengal, Bihar, UP, MP and north-eastern states of India. Ecosystem health risks, food safety assessment in relation to chemical contaminants, evaluation and management of environmental health through omics technologies are important areas in fisheries ecosystem secor. In the socio-economics and statistics areas, resource assessment and predictions under AI and BigData Platform and achieving Sustainable Development Goals (SDGs) through inland fisheries will be addressed. Through new projects, the Institute would be able to develop newer protocols for sustainable production enhancement and ecosystem health conservation that would push the inland open water fisheries sector to a new height.

I take the privilege to acknowledge the constant support and guidance received from Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR. I am also grateful to Dr. J. K. Jena, Deputy Director General (Fisheries Science); Dr. B.P. Mohanty, Assistant Director General (Inland Fisheries); Dr. Pravin Puthra, Assistant Director Generals (Marine Fisheries); and other staff members of the Fisheries Division of ICAR for their cooperation and help in our endeavours. Guidelines and recommendations given by IRC, learned RAC, QRT for Institute's development, and streamlining of the Institute's research and activities are also humbly acknowledged.

Dated : 1 February, 2021
Barrackpore

(B. K. Das)
Director

प्रस्तावना

देश का विशाल अंतर्स्थलीय खुला जल संसाधन क्षेत्र में 45,000 किलोमीटर नदियाँ, 0.3 मिलियन हेक्टेयर ज्वारनदमुख, 0.19 मिलियन हेक्टेयर बैकवाटर और लैगून, 3.524 मिलियन हेक्टेयर जलाशय, 0.354 मिलियन हेक्टेयर बाढ़कृत आर्द्रभूमि और 0.72 मिलियन हेक्टेयर भूमि झील सम्मिलित हैं जो देश की विशाल जनसंख्या को आर्थिक और सामाजिक लाभ देने के साथ–साथ जल, भोजन, पोषण, परिवहन, आजीविका तथा कई अन्य पारिस्थितिक सेवाएं प्रदान करते हैं।

वर्ष 2018–19 के दौरान देश में अंतर्स्थलीय क्षेत्र से 8.9 मिलियन मीट्रिक टन मछलियों का उत्पादन हुआ, जिनमें से 50 प्रतिशत अंतर्स्थलीय प्रग्रहण मात्स्यिकी से प्राप्त हुआ है। हालांकि इन बड़े संसाधनों से मछली उत्पादन बढ़ाने की पर्याप्त संभावनाएँ हैं। इनके बड़े आकार और मछली उत्पादन क्षमता के आधार पर, देश की लक्षित दूसरी नीली क्रांति को प्राप्त करने के लिए आर्द्रभूमि, झीलों और जलाशयों में मछली उत्पादन बढ़ाने के लिए बहुत जोर दिया जा रहा है। अंतर्स्थलीय खुला जल संसाधन क्षेत्र महत्वपूर्ण मछलियों के जर्मप्लाज्म संरक्षण के अलावा 1.24 मिलियन अंतर्स्थलीय मछुआरों को रोजगार और आजीविका प्रदान करते हैं।

हाल के वर्षो में यह देखा गया है कि ये अंतर्स्थलीय खुला जल संसाधन कई खतरों और चुनौतियों का सामना कर रहे हैं, जैसे जल की उपलब्धता में कमी, मछलियों के प्राकृतिक आवास की क्षति, प्रदूषण, मछलियों के प्राकृतिक स्टॉक का अत्यधिक दोहन आदि। अतः अंतर्स्थलीय मात्स्यिकी क्षेत्र पर बढ़ते दबाव और प्रत्यक्ष तौर पर जलवायु परिवर्तन के कारण दीर्घकालिक मत्स्य पालन के लिए इन संसाधनों का संरक्षण और इनकी संभावित उत्पादन क्षमता का दोहन करना आवश्यक है। वर्तमान चुनौतियों का सामना करने और मछली उत्पादन को बढ़ाने के लिए संस्थान ने कई संस्थागत और बाह्य वित्त पोषित अनुसंधान परियोजनाओं, मछुआरों और अन्य हितधारकों के प्रशिक्षण और पूर्वोत्तर क्षेत्रों तथा अनुसूचित जनजाति उप–योजना, अनुसूचित जाति उप–योजना कार्यक्रमों के तहत संस्थान द्वारा विकसित प्रौद्योगिकियों के प्रदर्शन तथा कार्यान्वयन के माध्यम से अनुसंधान, विस्तार, मानव संसाधन विकास और विकास गतिविधियों को तैयार किया है। संस्थान ने पारिस्थितिकी तंत्र आधारित अनुसंधान और सामुदायिक भागीदारी के माध्यम से अंतर्स्थलीय खुला जल मात्स्यिकी क्षेत्र संबंधी सूचनाओं को एकत्र कर डेटाबेस बनाया है। देश के लगभग 4000 से अधिक मछुआरों, अधिकारियों और छात्रों को ऑफ–लाइन और ऑन–लाइन मोड के माध्यम से प्रशिक्षण देकर उनका कौशल विकास किया। रिपोर्ट अवधि के दौरान अनुसूचित जाति और आदिवासी मछुआरों में जागरूकता पैदा कर उनका कौशल विकास किया गया और उन्हें आवश्यक संसाधन वितरित किए गये।

वर्ष 2017–18 के दौरान संस्थान की चलित अधिकांश अनुसंधान परियोजनायें मार्च 2020 में संपन्न हो चुके हैं। पिछले 3 वर्षों में संस्थान ने कई महत्वपूर्ण कार्य किये हैं – गंगा और उसकी सहायक नदियों सहित 8 अन्य नदियों के मत्स्य आवास, पारिस्थितिकी और मात्स्यिकी का अध्ययन, काठजोड़ी और तमास नदियों के पर्यावरणीय प्रवाह का अनुमान, तथा और गंगा नदी में पारिस्थितिकी तंत्र के पुनरूत्थान और मत्स्य संरक्षण के लिए इंडियन मेजर कार्प के बीजों का प्रजनन तथा रैंचिंग आदि। संसाधन क्षेत्रों के नदी जल का प्रदूषण जैसे माइक्रोप्लास्टिक और पारिस्थितिकी तंत्र पर उनके प्रभाव तथा मत्स्य स्वास्थ्य सहित कई महत्वपूर्ण पहलुओं का अध्ययन किया गया है। नदीय पारिस्थितिकी और मत्स्य पकड़ पूर्वानुमान के लिए आधुनिक मॉडलिंग उपकरण लागू किए गए। जलवायु परिवर्तन के हानिकारक प्रभाव को कम करने के लिए अनुकूलन उपायों का सुझाव दिया गया। मछलियों मे रोग संक्रमण और बीमारियों की जांच की गई और आर्सेनिक विषाक्तता के निदान विकल्प और संक्रामक रोगों के नियंत्रण के लिए उन्नत पद्धतियों के विकास पर जोर दिया गया। नदियों में कुछ नई मछली प्रजातियों को दर्ज किया गया था।एक नई मत्स्य प्रजाति, *बारिलस टॉर्सई* (परिवार, साइप्रिनिडे) की पहचान टोरसा नदी से की गई थी।

मछली उत्पादन बढ़ाने के लिए देश के 7 जलाशयों और 7 बाढकृत मैदानों में पारिस्थितिकी, मछली विविधता और मत्स्य पालन की संभावनाओं का अध्ययन किया गया जिससे इनमें घेरे में मत्स्य पालन प्रौद्योगिकियों का कार्यान्वयन किया जास सके। बड़े जलाशयों में मछलियों को पकड़ने में मछुआरों की मदद के लिए मछली पकड़ने के क्षेत्र के माध्यम से संभावित मछली पकड़ने के क्षेत्र का मूल्यांकन किया गया। संस्थान ने ओडिशा,

तेलंगाना, बिहार, असम, पश्चिम बंगाल, अरुणाचल प्रदेश आदि राज्यों में पिंजरे और पेन पालन प्रौद्योगिकियों का प्रदर्शन किया। *पंगेसियेनोडोन हाइपोथाल्मस* की कम बाजार की मांग को ध्यान में रखते हुए संस्थान ने पिंजरे में मत्स्य पालन में प्रजातियों के विविधीकरण का उद्देश्य से अन्य मछली प्रजातियों की उपयुक्तता की जांच की। विविध जलवायु–लचीला प्रजातियों और अंगुलिकाओं के इन–सीटू पालन के लिये आर्द्रभूमि में पिंजरों को सफलतापूर्वक स्थापित किया गया।

संस्थान ने जलाशय में मत्स्य उत्पादन, आजीविका विकास तथा सामाजिक और आर्थिक उत्थान को ध्यान में रखकर पिंजरे में मछली पालन प्रौद्योगिकी को अपनाने और इसपर प्रशिक्षण और इसके प्रभाव का अध्ययन किया। संसाधन–हीन सुंदरवन क्षेत्र में नहर में मछली पालन का विकास किया गया। संस्थान ने ओडिशा और पश्चिम बंगाल के सुंदरवन में विनाशकारी चक्रवात के प्रभाव का भी आंकलन किया और इस क्षेत्र में प्रभावित मछुआरों का हर संभव मदद किया। संस्थान ने अपनी हाल ही में मछली उत्पादन बढ़ाने के लिए वाणिज्यिक प्रौद्योगिकियों जैसे केजग्रो फीड, सिफरी जीआई केज, सिफरी एचडीपीई पेन को फील्ड स्तर पर उपलब्ध कराने के लिए अधिक जोर दिया। क्षेत्रीय विकास की दिशा में कई पारस्पारिक संवाद बैठक, ऑनलाइन कार्यशालायें और प्रशिक्षण आदि का आयोजन किया गया।
विभिन्न प्राथमिकता वाले क्षेत्रों में अप्रैल 2020 से प्रभावी नई परियोजनाएँ तैयार की गई हैं। इसके अंतर्गत हुगली–मातलह, रुशिकुल्या, नेत्रवती–गुरुपुर और वेम्बनाड ज्वारनदमुख पारिस्थितिकी प्रणालियों का अस्थायी मूल्यांकन किया जाएगा। इसी प्रकार, बाँधों और बैराजों के पारिस्थितिक प्रभावों का आंकलन, 5 नदियों के मत्स्य पकड़ का आकलन, संरक्षित अंतर्स्थलीय जल निकायों की मात्स्यिकी का आकलन, गंगा नदी पर यमुना नदी के प्रभाव का अध्ययन, पोषक प्रवाह और पोषक तत्वों की जैव समुदाय पारस्परिक क्रियाएँ, नदी और मुहाना क्षेत्र के अन्य अध्ययनों आदि पर ध्यान दिया जायेगा। जलाशयी संसाधनों में बड़े, मध्यम और छोटे जलाशय पारिस्थितिकी तंत्र और उनके ट्रोफो–डायनामिक मॉडलिंग के अनुपात–लौकिक विविधताओं के लिए अध्ययन किया गया हैं। आर्द्रभूमि संसाधनों में, विभिन्न पर्यावरणीय क्षेत्रों में मत्स्य पालन बढ़ाने की दिशा में परियोजनाएं तैयार की गई हैं, जिनमें पश्चिम बंगाल, बिहार, उत्तर प्रदेश, मध्य प्रदेश और भारत के उत्तर–पूर्वी राज्य शामिल हैं। पारिस्थितिकी तंत्र स्वास्थ्य पर खतरा, रासायनिक संदूषकों के संबंध में खाद्य सुरक्षा मूल्यांकन, ओमेक्स प्रौद्योगिकियों के माध्यम से पर्यावरणीय स्वास्थ्य के मूल्यांकन और प्रबंधन मत्स्य पालन पारिस्थितिकी तंत्र आदि महत्वपूर्ण क्षेत्र हैं। सामाजिक–अर्थशास्त्र और सांख्यिकी क्षेत्रों में, एआई और बिगडेटा प्लेटफॉर्म के तहत संसाधन मूल्यांकन और पूवानुमान और अंतर्स्थलीय मत्स्य पालन के माध्यम से सतत विकास लक्ष्यों (एसडीजी) को प्राप्त करने का अध्ययन किया जाएगा। नई परियोजनाओं के माध्यम से, संस्थान स्थायी उत्पादन बढ़ाने और पारिस्थितिकी तंत्र स्वास्थ्य संरक्षण के लिए नए प्रोटोकॉल विकसित करने में सक्षम होगा जो अंतर्स्थलीय खुले जल मत्स्यपालन क्षेत्र को एक नई ऊंचाई पर पहुंचाएगा।

मैं संस्थान के कार्यों एवं उपलब्धियों के लिये डा0 टी महापात्र, सचिव, डेयर व महानिदेशक, भारतीय कृषि अनुसंधान परिषद्; डा0 जे. के. जेना, उप–महानिदेशक (मात्स्यिकी विज्ञान), डा0 बी. पी. मोहांन्ति, सहायक महानिदेशक (अंतर्स्थलीय मात्स्यिकी), डा0 प्रवीण पुत्र, सहायक महानिदेशक (समुद्री मात्स्यिकी) एवं मात्स्यिकी विज्ञान प्रभाग, भारतीय कृशि अनुसंधान परिशद् के समस्त अधिकारियों के मार्गदर्शन एवं निरंतर सहयोग के लिये आभारी हूँ। इस रिपोर्ट में प्रस्तुत सभी गतिविधियों के लिये वैज्ञानिकों और समस्त सहयोगियों हार्दिक धन्यवाद देता हूँ। संस्थान के विकास और संस्थान के अनुसंधान और गतिविधियों को सुव्यवस्थित करने के लिए अनुसंधान सलाहकार समिति, संस्थान अनुसंधान समिति एवं पंचवर्षीय समीक्षा समिति द्वारा दिए गए दिशानिर्देश और सुझावों का हार्दिक स्वागत करता हूँ। मैं संस्थान के समस्त वैज्ञानिकों, अधिकारियों एवं कर्मचारियों और इस वार्षिक प्रतिवेदन के प्रकाशन टीम के अथक प्रयासों एवं सहयोग हेतु आभार प्रकट करता हूँ।

बि. के. दास
निदेशक

दिनांक : 1 फरवरी, 2021
स्थान : बैरकपुर

Director's Desk

2020 – A year marked by the COVID-19 pandemic, brought the world to a standstill and introduced us to terminologies like social distancing, quarantine and lockdown, etc. although along with the constraints, opportunities emerged to cope with those difficulties. The use of digital technologies saw a boom throughout the world and by the end of 2020 Webinars, Online meets and WFH (Work from Home) had become the "new normal" and we learnt to adapt to the situation and yielded the best out of it. It gives me immense pleasure to mention that members of ICAR-CIFRI worked relentlessly despite all the challenges and produced significant improvement in the spectrum of Inland Fisheries. A total of 27 Institute-funded projects were ongoing during 2020, out of which 13 were completed in March 2020; 19 externally funded projects and 7 consultancy projects are also currently under way.

Importance was given to riverine and estuarine fisheries while highlighting the Ganga river by keeping the principles of "Namami Gange" in mind. Various physico-chemical properties of Ganga and its tributaries along with the data from fish landing sites of Varanasi, Uttar Pradesh were rigorously studied and thoroughly analyzed. Captive breeding of IMCs caught from the river was carried out, spawns were grown to fingerling sizes and were used for extensive ranching in different stretches of the river from Varanasi to Barrackpore. Also, tagging of fishes was conducted to focus on the study of the migratory behavior of fishes. Studies on the fishing pattern, hydrological characteristics, fish biodiversity were studied from rivers like Cauvery, Tapti, Sian, and Narmada. *Garra annandalei* Hora, 1921, and exotic species *Amphilophustri maculatus* were recorded for the first time.

Work was conducted in reservoirs of Tamil Nadu, Odisha, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Telangana, Jharkhand, Karnataka, Himachal Pradesh, and Assam. To achieve fish species diversification in cages, the growth rate and survival rate of high-value fish species at different stocking densities were studied. Biological and chemical properties, mortality due to disease in cages, time series analysis of fish catch data, ecological assessment data, and ecosystem-based model were studied from different reservoirs. To gain parity with the ongoing digitalization, the 'SMS' based eDAS was upgraded to 'internet' based eMatsya for data acquisition from reservoirs. Extensive research work is being conducted in various floodplain wetlands of West Bengal in the Ganga and Teesta-Torsa Basin, Bihar, and Odisha to increase the fish yield from these wetlands.

To obtain sustainable output, fish and environmental health needs were assessed. Ecosystem healths of river Godavari, Kathajodi, Tapti were studied; fragmentation and impaired river flow along with pollution due to drainage of sewage water were identified as major threats to these rivers. The environmental health of the river Teesta and the East Kolkata Wetlands were also studied. The presence of microplastics and heavy metals were studied. Fruit extract of *T. arjuna* has been used for producing medicated fish feed supplement to kill fish parasite.

The Institute is assessing the impacts of climate change and finding ways to deal with them. The fish diversity across various wetlands was studied and the results indicated a

biodiversity loss in many wetlands. Adaptation of various climate-resilient technologies is being encouraged. The economic impact of juvenile Hilsa fishing was estimated. The improvement in fish yield with the introduction of technologies like Pen and Cage culture were closely studied and the results assured a positive outcome of these cost-effective technologies. The trainings imparted by the Institute has led to adaptation of various fisheries practices. Empowerment of the ST and SC population is being ensured under the STC and SCSP in various areas of West Bengal and Odisha.

West Bengal suffered the double blow of the COVID-19 pandemic and the super-cyclonic storm, Amphan. The destruction by the storm left the already impaired livelihood due to the nationwide lockdown of the distressed people to even worse conditions. In the aftermath of the storm, ICAR-CIFRI extended all out supports to alleviate the sufferings of the people of Sundarbans and re-establishing fishery. The effect of the nationwide lockdown was studied in River Ganga and many other wetlands, reservoirs etc. to determine the effect of lack of fishing and other activities in these water bodies, and significant improvement in the water quality was observed. Advisories for stakeholders (reservoir fishers, PFCS, and state fisheries officials) were framed during the lockdown and the same was endorsed by the FAO. To deal with the ongoing pandemic all precautionary measures were taken and guidelines by the health department were followed like sanitization of office space, monitoring the temperature of each staff with thermal guns, providing sanitizers at building entrance, distribution of masks, etc. when the institute reopened after the lockdown was removed. RT-PCR test was also conducted on campus for the benefit of the staff.

Despite the challenges presented by the pandemic, the Institute organized 31 off-line and on-line training programmes benefitting more than 4000 fishers, fish farmers, students, officials, etc. The Institute organized several important national and international events such as Conference on Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation (AEHMS12); International Webinar for Enhancing Conservation of River Dolphins Through Sub-regional Cooperation; Global Webinar on Small Scale Fisheries in Inland Open Water: Status and Opportunity; several workshops, stakeholders meets, winter school, etc. bringing laurels to the Institute. More than 140 research papers in reputed peer-reviewed journals were published. I would like to congratulate scientists and research scholars who have bagged several awards and recognitions including coveted NAAS Fellowship, International Best Scientist awards, Best Doctoral Research Awards, best presentation awards, etc. The Institute has filed two patents and one copyright application during 2020. The Institute also generated awareness for Swacchata, plastic-free green India, and COVID-free India and office through cleanliness, mass awareness, workshops etc. Finally, with a heavy heart, I am informing you that we lost three of our staff members during last year and I convey my sincere condolences to their families and would like to acknowledge their contributions to this institute. I extend my best wishes to all the staff members and anticipate CIFRI will achieve greater heights in the days to come.

Dated : 1 February, 2021
Barrackpore

(B. K. Das)
Director

निदेशक की कलम से

वर्ष 2020 : कोविड–19 महामारी के तौर पर चिन्हित एक ऐसा वर्ष जिसके दौराल पूरे विश्व की गतिविधियों पर एक विराम.. एक ठहराव की स्थिति पैदा हो गई। हमारे शब्दकोश को नये–नये पारिभाषिक शब्दों जैसे, सोशल डिस्टेन्सिंग (सामाजिक दूरी), क्वारांटाइन (संगरोध) और लॉकडाउन परिचय हुआ है। हालांकि इन बाधाओं के साथ भी हम इन कठिनाइयों का सामना करन में सक्षम हुये हैं। विश्व भर में डिजिटल तकनीकों के उपयोग में तेजी देखी गई और 2020 के अंत तक वेबिनार, ऑनलाइन मीट और वर्क फ्रॉम होम जैसी बातें बहुत ही सामान्य सी प्रतीत होने लगी। हमने स्थिति के अनुकूल होना सीख लिया और कम से कम संसाधनों में भी अपने कार्यों का पूरा करने का प्रयास किया। यह उल्लेख करने के लिए मुझे बहुत खुशी है कि हमारे संस्थान कर्मियो ने सभी चुनौतियों के बावजूद अथक कार्य किया और अंतर्स्थलीय मत्स्य पालन में महत्वपूर्ण बदलाव लाया। वर्ष 2020 के दौरान चलित कुल 27 संस्थान–वित्त पोषित परियोजनाओं में से 13 परियोजनायें मार्च 2020 में पूरी हुईं हैं। इसके अलावा 19 बाह्य वित्त पोषित परियोजनाएं और 7 परामर्शी परियोजनाएं वर्तमान में चल रही हैं।

"नमामि गंगे" के उद्देश्यों को ध्यान में रखते हुए गंगा नदी में नदीय और ज्वारनदमुख मात्स्यिकी को महत्व दिया गया। उत्तर प्रदेश में वाराणसी के मछली लैंडिंग स्थलों के आंकड़ों के साथ गंगा और उसकी सहायक नदियों के विभिन्न भौतिक–रासायनिक गुणों का अध्ययन कर उनका गहन विश्लेषण किया गया। नदी से पकड़े गए इंडियन मेजर कार्प प्रजाति की मछलियों का प्रजनन घेरे में पालन तकनीक द्वारा किया गया। इनके पोना मछलियों को अंगुलिकाओं में विकसित कर वाराणसी से बैरकपुर तक नदी के विभिन्न हिस्सों में रैंचिंग द्वारा प्रवाहित किया गया। साथ ही, मछलियों के अभिगमन मार्ग के अध्ययन के लिए मछलियों की टैगिंग की गई। कावेरी, ताप्ती, सियान और नर्मदा नदियों की मत्स्ययन पद्धति, जलीय विशेषतायें और मछली की जैव विविधता का अध्ययन से किया गया था। *गर्रा एनांडेली* होरा, 1921 और विदेशी प्रजाति, *एम्फिलोफाइट मैकुलैटस* को पहली बार दर्ज किया गया।

रिपोर्ट अवधि के दौरान तमिलनाडु, ओडिशा, उत्तर प्रदेश, मध्य प्रदेश, छत्तीसगढ़, तेलंगाना, झारखंड, कर्नाटक, हिमाचल प्रदेश और असम के जलाशयों का मात्स्यिकी विकास किया गया। पिंजरों में मछली प्रजातियों के विविधीकरण के लिए, विभिन्न संयचन घनत्वों में उच्च मूल्य वाली मछली प्रजातियों की वृद्धि दर और उत्तरजीविता दर का अध्ययन किया गया। जलाशयों की जैविक और रासायनिक गुणों, पिंजरों में रोग संक्रमण के कारण मछलियों का मृत्यु दर, मछली पकड़ संबंधी समय श्रृंखला आंकड़ों का विश्लेषण, पारिस्थितिक मूल्यांकन संबंधी आंकड़ा और पारिस्थितिक तंत्र–आधारित मॉडल का अध्ययन किया गया। चलित डिजिटाइजेशन की उद्देश्य पूर्ति के लिये जलाशयों से डेटा अधिग्रहण के लिए विकसित एप ई–डास' को इंटरनेट आधारित 'ई–मत्स्य' में अपग्रेड किया गया था। इन आर्द्रक्षेत्रों से मत्स्य उपज वृद्धि के लिए पश्चिम बंगाल के गंगा और तीस्ता–तोरसा बेसिन, बिहार और ओडिशा में विभिन्न बाढ़कृत आर्द्रक्षेत्रों में व्यापक शोध कार्य किया जा रहा है।

दीर्घकालिक उत्पादन प्राप्त करने के लिए, मछली और पर्यावरणीय स्वास्थ्य और इसके सुधार उपायों का मूल्यांकन किया गया। गोदावरी, काठजोड़ी और ताप्ती नदियों के पारिस्थितिकी तंत्र के स्वास्थ्य का अध्ययन किया गया। इन नदियों में अवशिष्ट जल का प्रवाह, प्रदूषण और विखंडित नदीय प्रवाह को एक गंभीर और बड़े खतरे के रूप में देखा जा रहा है। तीस्ता नदी और पूर्वी कोलकाता वेटलैंड के पर्यावरणीय स्वास्थ्य का भी अध्ययन किया गया। टी–डिस्ट्रीब्युटेड स्टॉकेस्टिक नेबरिंग एम्बेडिंग मशीन लर्निंग एल्गोरिथम का उपयोग करके माइक्रोप्लास्टिक्स और भारी धातुओं की उपस्थिति का अध्ययन किया गया था। *टी. अर्जुन* के खनिज प्रोफाइलिंग अध्ययन में परजीवी को मारने के लिए औषधीय मछली के पूरक के रूप में मेथनॉलिक फलों के अर्क को लाभकारी पाया गया।

संस्थान जलवायु परिवर्तन के प्रभावों का आंकलन कर रहा है और निदान उपायों के तरीकें खोज रहा है। विभिन्न आर्द्रक्षेत्रों में मत्स्य विविधता का अध्ययन किया गया और परिणाम यह बताते हैं कि कई आर्द्रक्षेत्रों में जैव विविधता का नुकसान हुआ है। विभिन्न जलवायु–लचीला प्रौद्योगिकियों के अनुकूलता को प्रोत्साहित किया जा रहा है। अपरिपक्व हिलसा मछली पकड़ने के आर्थिक प्रभाव को अनुमानित किया गया। पेन और पिंजरे में मछली पालन जैसी प्रौद्योगिकियों की शुरुआत के साथ मत्स्य उपज में सुधार का अध्ययन किया गया और प्रौद्योगिकियों पर

लागत के सकारात्मक परिणाम को देख गया। संस्थान द्वारा प्रदत्त प्रशिक्षण से प्रशिक्षु मछुआरों की आजीविका सुधार पर सकारात्मक प्रभाव पड़ा है। पश्चिम बंगाल और ओडिशा के विभिन्न क्षेत्रों में अनुसूचित जनजाति और अनुसूचित जनजाति उप–योजना के तहत अनुसूचित जनजाति और अनुसूचित जनजाति मछुआरों का सशक्तीकरण सुनिश्चित किया जा रहा है।

पश्चिम बंगाल ने कोविड–19 महामारी और विनाशकारी चक्रवाती तूफान, आमफान का दोहरा झटका झेला है। एक तो लोगों की आजीविका कोरोना महामारी और के कारण देशव्यापी लॉकडाउन के कारण पहले ही संकट में थी, आमफान के कारण और भी बिगड़ गई। चक्रवात के बाद, सिफरी ने सुंदरवन के लोगों को राहत के तौर पर तकनीकी और सहायता सामग्री प्रदान किया जिससे नष्ट हुई मत्स्य पालन को फिर से स्थापित किया जा सके। इन जल निकायों में मछली पकड़ने और अन्य गतिविधियों के प्रभाव को निर्धारित करने के लिए गंगा नदी और कई अन्य आर्द्रभूमि, जलाशयों आदि में राष्ट्रव्यापी लॉकडाउन के प्रभाव का अध्ययन किया गया। अध्ययन में यह देख गया कि और जल की गुणवत्ता में महत्वपूर्ण सुधार हुआ है। हितधारकों (जलाशय मछुआरे, मछुआरा संगठन, और राज्य मत्स्य अधिकारी) के लिए परामर्शी मार्गदर्शी सलाह तैयार किया जिसे खाद्य एवं कृषि संगठन ने भी समर्थन किया है। कोरेाना महामारी से निपटने के लिए सभी आवश्यक कदम उठाए गए और स्वास्थ्य विभाग द्वारा जारी दिशा–निर्देशों का पालन किया गया था, जैसे कार्यालय स्थल का संपूर्ण सफाई, थर्मल गन से प्रत्येक स्टाफ के तापमान की निगरानी करना, संस्थान के प्रवेश द्वार पर सैनिटाइजर प्रदान करना, मास्क का वितरण आदि। कर्मचारियों के लिए संस्थान परिसर में आरटी–पीसीआर परीक्षण भी आयोजित किया गया था।

यह एक सराहनीय कदम है कि महामारी की चुनौतियों के बावजूद, संस्थान ने 4000 से अधिक मछुआरों, मत्स्य किसानों, छात्रों, राज्य सरकार के अधिकारियों को लाभान्वित करने के लिए 31 ऑफ–लाइन और ऑन–लाइन प्रशिक्षण कार्यक्रम आयोजित किया। संस्थान ने कई महत्वपूर्ण राष्ट्रीय और अंतर्राष्ट्रीय आयोजनों को आययोजित किया जैसे, Conference on Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation (AEHMS12); उप–क्षेत्रीय सहयोग के माध्यम से नदी डॉल्फिन के संरक्षण को बढ़ाने के लिए अंतर्राष्ट्रीय वेबिनार; अंतर्स्थलीय खुला जल में लघु पैमाने पर मत्स्य पालन पर वैश्विक वेबिनार : स्थिति और अवसर; कार्यशालाओं, हितधारकों की बैठक, शीतकालीन स्कूल, आदि। प्रतिष्ठित पियर रिव्यु पत्रिकाओं में 140 से अधिक शोध पत्र प्रकाशित हुए। मैं उन वैज्ञानिकों और शोध छात्रों को बधाई देना चाहता हूँ जिन्होंने प्रतिष्ठित पुरस्कार, फैलोशिप, अंतर्राष्ट्रीय सर्वश्रेष्ठ वैज्ञानिक पुरस्कार, सर्वश्रेष्ठ डॉक्टरेट अनुसंधान पुरस्कार, सर्वश्रेष्ठ प्रस्तुति पुरस्कार आदि सहित कई पुरस्कार और सम्मान प्राप्त किया है। संस्थान ने 2020 के दौरान दो पेटेंट और एक कॉपीराइट के लिये आवेदन किया है। संस्थान ने स्वच्छ भारत, प्लास्टिक मुक्त हरित भारत और कोविड मुक्त भारत और स्वच्छता, जन जागरूकता, कार्यशालाओं आदि के माध्यम से जागरूकता पैदा की। संस्थान ने स्वच्छ भारत सप्ताह, राष्ट्रीय सतर्कता सप्ताह, सद्भाव दिवस मनाकर समाज के प्रति अपनी उत्तरदायित्वों का पालन किया। अंत में, मैं दुख के साथ यह व्यक्त कर रहा हूँ कि हमने पिछले वर्ष अपने तीन संस्थान सदस्यों को खो दिया है और मैं उनके परिवारों के प्रति अपनी संवेदना व्यक्त करता हूँ।

मैं समस्य संस्थान कर्मियों को अपनी शुभकामनाएं देता हूँ और यह आशा करता हूँ कि आने वाले दिनों में हमारा संस्थान सफलता की अधिक से अधिक ऊंचाइयां हासिल करेगा।

बि. के. दास
निदेशक

दिनांक : 1 फरवरी, 2021
स्थान : बैरकपुर

Executive Summary

During 2020 ICAR-CIFRI conducted its research under 27 Institute-funded projects among which 13 projects were completed in March 2020, 19 externally funded, and 7 consultancy projects. The Institute undertook several developmental activities under the Schedule Tribe component, Scheduled Caste SubPlan and NEH programmes, besides training, demonstration, and extension, Mera Gaon Mera Gaurav, Swachh Bharat programmes. Despite COVID-19 pandemic and nation-wide lockdown, the Institute progressed in several aspects of inland fisheries. Salient achievements of the Institute during 2020 are given in the following few paragraphs.

Riverine and Estuarine Fisheries

- Study of the physico-chemical parameters of river Ganga and its major tributaries identified highest levels of BOD, COD, phosphate-P, as well as primary productivity in river Kali as a pollution impact.

- Fish landing at Prayagraj stretch of the river Ganga in Uttar Pradesh was estimated at 13.076 tonnes during May 2020 with the highest contribution of miscellaneous group of fishes (59.87%), followed by exotics (28.21%) and least contribution of Indian major carps (1.84%).

- Invasion of exotic carp *Cyprinus carpio* in river Ganga at Buxar was estimated at 33.85% during 2017-2019 which dominated over all other fishes including Indian major carps. The abundance of common carp in river Ganga was correlated with BOD, total phosphorus, etc. indicating the role of anthropogenic pollution in its dominance.

- In river Cauvery, exotic fishes (*Oreochromis mossambicus, O. niloticus* and *Clarias gariepinus*) contributed 14%, 22%, 21%, 23%, 57.5% and 59% to the total fish landing at Kudige, T-Narasipura, Shivanasamudra, Hogenakkal, Bhavani and Mayanoor, respectively.

- The entire habitat of river Cauvery is considerably altered from dams, barrages, anicuts, etc. with a significant impact on fish fauna. Accordingly, fishers have modified their fishing gears for maximum exploitation of the existing fish stock from all the ecological niches of the river. Five kinds of fishing crafts and 30 different types of fishing gear including destructive fishing methods were recorded from the river.

- *Labeo fimbriatus* and *L. gonius*, which were previously abundant, were not recorded from the Tapti river during 2017-2020. A number of exotic fish species were found in all the three stretches of river Tapti, especially *C. carpio* in the upper and middle stretch, *O. mossambicus* in the middle and lower stretch, and *Pangasianodon hypophthalmus* in the lower stretch showing changing pattern of fish assemblage.

- A total of 41 species were recorded from river Siang, Arunachal Pradesh, dominated by *Barilius barila, Opsarius barna, Crossocheilus latius, Barilius bendelisis, Aspidoparia morar*, and *Puntius sophore*.

- Captive breeding of Indian major carps collected from the river Ganga was carried out producing 75,00,000 spawns. A total of 7,65,000 fingerlings of Indian major carps, raised from these spawns, were ranched on 18 different occasions in different stretches, extending from Varanasi in Uttar Pradesh to Barrackpore in West Bengal, for restoration of ecosystem health and enhancement of carp fisheries in the river.

- Ranching of 2235 adult *Tenualosa ilisha*, including tagging of 656 fish were done to understand the upstream migratory route of the species in the river Ganga. More than 100 numbers of IMC were tagged and released in river Ganga at

Barrackpore to assess their survival, growth, and migration.

- Environmental flows for the river Narmada downstream of Sardar Sarovar Dam was estimated by 2D Mike 11 hydraulic rating method. The estimated 10-daily lean flows was 2700 cusecs.

- *Garra annandalei* Hora, 1921, commonly known as Annandale garra or Tunga garra, was a new record with new distributional ranges from the middle stretch of river Tapti (Savkheda area, 21.29824499 N, 73.03300358 E). Exotic fish species *Amphilophustri maculatus* was recorded for the first time in Cauvery river as well as from outside its native range of distribution.

Reservoir and Wetland Fisheries

- The survival and growth performances of high-value fish species, *viz. Ompok bimaculatus, Puntius sarana*, and *Labeo bata* have been examined at different stocking densities towards fish species diversification in cage culture. *O. bimaculatus* (8.05±1.56 g) stocked @ 15-35 nos./m^3 achieved an average size of 50-62 g with more than 80% survival in 7 months in cages. *L. bata* (6.18±1.32g) stocked @ 50-100 nos./m^3 achieved an average weight of 45-52 g with more than 85% survival in 6 months. *P. sarana* (25±3.6g) stocked @10 nos./m^3 achieved an average weight of 150 g with >90% survival in 3 months.

- In cage culture of *Pangasianodon hypophthalmus* 5-10% incorporation of *Labeo rohita* enhanced fish production through effective control of biofouling of the cage net.

- The stocking density of Amur carp (*Cyprinius carpio*) for table fish production in cages has been optimized in Samaguri beel of Assam and Maithon reservoir, Jharkhand.

- A survey of cages in different reservoirs of Jharkhand estimated an average 7.15% mortality loss from diseases. The use of chemicals for health management and disease control incurs a meagre cost of Rs. 218 per cage per crop.

- High levels of total and available phosphorus, as well as plankton biomass in three wetlands of West Bengal, indicate that the wetlands are moving towards eutrophication and need scientific intervention for maintaining their ecological integrity. Comprehensive trophic state index (mTSI) and rotifer trophic state index ($mTSI_{ROT}$) also showed that the wetlands are succeeding towards eutrophic state.
- Population dynamics study shows that high-value *Gudusia chapra* is under-exploited with scope for enhanced fishing in the Mathura beel.

- Integrated interventions including the production of advanced fingerling through the cage and pen culture, and pond rearing were implemented resulting in production enhancement in five wetlands of East Champaran, Bihar. The catch per unit efforts (CPUE) in these wetlands have increased from 1.4-5.5 kg/fisher/day to 3.02-11.1 kg/fisher/day with the adoption of culture based fisheries management regime.

- With the adoption of culture-based fisheries, the average fish yield of 21 floodplain wetlands of West Bengal has increased to 1165 kg/ha/yr in closed wetlands and 864 kg/ha/yr in open/seasonally open wetlands. The wetlands in the lower Ganga basin showed higher fish yield as compared to those in the Teesta-Torsa basin.

- Assessment of environmental variables and biotic community interactions including sediment enzymes in floodplain wetlands of Teesta-Torsa basin and Ganga basin (Bhagirathi-Hooghly stretch) revealed sectoral and seasonal variations. The study indicated that sediment

enzyme activities can be used as a biological and microbiological proxy for wetland ecosystem health assessment.

- The time series analysis of fish catch data for the period 1998-2018 indicated that the catch of *Labeo calbasu* and *L. rohita* have dominated over *L. catla* indicating that Rihand reservoir in Uttar Pradesh is no more a Catla dominated reservoir.

- The time series (1976-2020) data analysis of the Pong reservoir estimated the average fish catch and fish yield at 411.46 tonnes/yr and 27.43 kg/ha/yr, respectively, with a decline in fish catch in the last few years. However, the prediction model using ARIMA predicted a slight increase in the fish yield in the coming years.

- The ecosystem-based model of the Mettur reservoir estimated the total primary production/total respiration value of 7.8 indicating that the reservoir is vulnerable to disturbances. To sustain the reservoir fisheries, management measures such as practicing closed fishing season during monsoon, repeated fish seed stocking to develop a self-recruiting population, and prohibiting use of drag nets and small mesh size gill nets (< 70mm) are essential.

- Study in 58 small reservoirs of Odisha, 24 small reservoirs of Chhattisgarh, 6 large reservoirs of Madhya Pradesh, Rihand reservoir of Uttar Pradesh, 54 reservoirs of Tamil Nadu, and 4 reservoirs of Jharkhand revealed a significant increase ($p<0.05$) in fish yield due to supplementary stocking of IMC fingerlings; yield was positively correlated to stocking density.

- Ecological assessment indicated a higher productive nature of Derjang reservoir, Odisha among the small reservoirs of eastern India. The Jargo reservoir in Uttar Pradesh is medium productive. Among the peninsular reservoirs, Krishnagiri was most productive owing to high organic load making it an ultra-eutrophic reservoir. Based on water quality Krishnagiri reservoir scored 'D' for ecosystem health indicating a need for restoration of this ecosystem.

- Atlas of Krishnaraja sagar reservoir depicting potential fishing zones were prepared using Sonar-X software. A patent application has been made on portable transducer assembly; another portable assembly suited for operation in coracles was developed and the prototype was successfully tested. A transducer-based coracle system for acoustic survey which requires no outboard motor was developed.

- Freshwater prawn (*Macrobrachium* spp.) catch from Palair reservoir of Telangana has increased, as a beneficial impact of practicing CBF through stocking of prawn (both *M. rosenbergii* and *M malcolmsonii*) seeds along with IMCs.

- The 'SMS' based eDAS was upgraded to 'internet' based eMatsya for data acquisition from reservoirs and was implemented in Tunga reservoir (Karnataka) and Telangana reservoirs for fish catch estimation.

- The Ecopath model developed for Mettur reservoir indicated dominance of low-level trophic organisms. All the attributes of ecosystem maturity and stability explicitly indicate that the ecosystem is in the developmental phase and not resilient to perturbations.

Fish and Environmental Health

- River fragmentation and impaired river flows were identified as the most significant stressors in river Godavari and Kathajodi. Although heavy metal contamination was not a major concern, sewage pollution was the second

most important stressor.

- The fish-based index of biotic integrity (IBI) showed that most of the river stretches of Kathajodi-Devi were in moderately impaired condition while Italnga had severe (>50%) impairment of ecological health due to sewage input from Cuttack city. The Nashik to Nanded stretch of river Godavari was severely impaired with Nashik exhibited a very poor IBI score. The rest of the river stretches were moderately impaired except Dhawaleswaram (near Rajahmundry, Andhra Pradesh) which showed slight impairment and an acceptable IBI score. Sewages from Burhanpur have degraded the water quality of river Tapti during the lean season.

- The river Teesta is not under serious stress conditions from pesticide contamination. Pesticide residues in water were mostly below the USEPA National Recommended Water Quality Criteria value and much lower than tolerance level in fishes in most of the cases. Cypermethrin was detected up to a concentration 0.482 mg/kg in the river sediments raising concern of possible contamination in aquatic food chain.

- Fishes and macro invertebrates of East Kolkata wetlands (EKW) were found to be contaminated with microplastics. High content of toxic metals (As, Cd, Cr, Cu, Ni, Pb and Zn) were also found on the microplastics surfaces in these wetlands. The t-distributed stochastic neighbour embedding machine learning algorithm revealed a strong association between microplastic abundance with turbidity, phosphate, and nitrate. The residues of personal care products such as triclosan and triclocarban were detected in water and few fish samples of sewage fed EKW.

- Gene expressions of α- and β-crystallin were down-regulated in arsenic-exposed fish but the change was insignificant when curcumin was supplemented in the diet.

- Through microbiological, parasitological, histopathology, and molecular techniques, the parasite *Thelohanellus kitawei* was diagnosed as the aetiological agent of a mass mortality of *Labeo catla* fry. There was a general stress-mediated increase in carbohydrate, amino acid and fatty acid metabolisms in the parasitized fish.

- Infestation by parasitic isopod *Alitropus typus* in *Labeo boggut, Oreochromis niloticus, Systomus sarana,* and *Xenentodon cancila* was detected in river Tapti.

- Investigation of a disease outbreak in tilapia in a wetland of East Midnapore revealed significance of Tilapia Lake virus-associated pathogenic bacteria *viz.*, *Aeromonas caviae, A. hydrophila, Edwardsiella tarda, Klebsiella pneumoniae,* and *Pseudomonas aeruginosa* in fish mortality. Altered hydro-ecological parameters and soil chemistry favoured the infection.

- Epidemiological mapping revealed the presence of virulent bacteria (*Aeromonas veronii, A. jandaei, A. caviae, Acinetobacter baumannii, Klebsiella pneumoniae, Plesiomonas shigelloides, P. aeruginosa, Edwardsiella tarda, E. ictaluri* etc.) in different inland open water systems. These pathogens caused frequent disease outbreaks with severe mortality in different commercially important fish species such as *Labeo rohita, L. catla, L. bata, C. mrigala, S. sarana, Ompok bimaculatus, Oreochromis niloticus, Pangasianodon hypophthalmus*, etc.). Environmental parameters were correlated with the occurrence of fish diseases.

- A formulation of antiparasitic chemical has been developed through spontaneous emulsification technique and its bioefficacy has been evaluated against fish

ectoparasite *Argulus bengalensis*.

- Mineral profiling of solvent extracts of *Terminalia arjuna* revealed that the bark powder can be utilized as a supplement for formulating medicated feed for fish and the methanolic fruit extract can be used to mitigate Zn deficiency. Extracts of *T. arjuna* was effective against pathogenic bacterium *A. hydrophila*, and parasite *A. bengalensis*.

- *Graesiella emersonii*, a microalgae, has been identified as a potential source of biodiesel production.

Fishery Resource Assessment

- A modified Verhulst-Schaefer model that takes into account the impact of stocking of fingerlings in reservoirs has been used to estimate the Maximum Sustainable Yield (MSY) for fishery exploitation in stocked reservoirs.

- The software for estimating state-level fish catch estimate for group-I (below 10 ha) water bodies has been upgraded.

Climate Change

- Assessment of enviro-climatological impact on ecology and fish biodiversity indicated 22.85 to 54% decline in fish diversity in all the studied floodplain wetlands of the Ganga basin. The Canonical Correspondence Analysis (CCA) showed varying relationship of climatic and environmental parameters with the occurrence of fishes indicating species-specific adaptive capacity.

- Spatio-temporal change analysis of three floodplain wetlands in the lower Ganga basin using GIS tools in the context of climatic anomaly revealed 37.20-57.68% reduction in water area coupled with reduction in minimum and maximum depths. The analysis of data (1985-2018) indicated considerable change in climate with an average temperature (+1.9°C) and rainfall anomaly (-698.1mm) in study area.

- Studies were undertaken on the impact of regional climatic variability on inland fish and fisheries including breeding phenology of prioritized species, ecological and social vulnerability, and demonstration of climate-resilient adaptation strategies such as pen aquaculture in floodplain wetlands. The ecological resilience has also been assessed.

Fisheries Socio-Economics

- Annual economic loss due to juvenile fishing of *Tenualosa ilisha* in Hooghly estuary was estimated at Rs. 497.84 million (around US$ 7.8 million). Major destructive fishing gears like bag net, set barrier, small mesh gill net, seine net, boat operated lift, etc. need to be regulated to improve the depleted Hilsa fishery.

- Social and economic analysis revealed that cage culture technology is annually contributing around 39,000 metric tonnes of fishes to the food basket of the country and generates 7.46 lakh man-days of labour per year. The technology has not only enhanced the family income but also reduced the occupation migration in Jharkhand (9 % from earlier 29 %). The consumer surplus model estimated total net benefit generation from cage culture at around Rs. 4 crores from 2010 to 2019 in Jharkhand; the net benefit may go up to Rs.14.83 crores during the period of 16 years (2010-2025).
- The fingerlings production through pens in the beels of Assam had a considerable positive impact on fish yield (from 492 kg/ha/yr to 1011 kg/ha/yr) in the wetlands. Adoption of the technology has resulted in a 49.6% increase in the mean monthly income of the fishers.

- The trainings imparted during 2012-13 to 2018-19

had 87.86% overall effectiveness enabling the trained farmers to build up their knowledge, skill, and attitude helping them in the adoption of fisheries as livelihood. About 82 % of trained farmers adopted composite fish culture practices. In Bihar, 7 % of the farmers have adopted fisheries as their principal occupation while 23 % of the farmers have taken up fisheries as a secondary occupation.

COVID-19 and Disaster Management

- ICAR-CIFRI assessed the loss caused by the cyclonic storm 'Amphan" and extended technical advisories and input supply to improve the water quality of water bodies and re-establish fishery in the cyclone-ravaged Sundarbans.

- During the nationwide lockdown due to COVID-19 pandemic, the water quality of Ganga river has considerably improved.

- Fishing activities in reservoirs, wetlands, rivers, etc. decreased to different extents or stopped completely during lockdown. Farm-gate as well as market sale price of fish varied widely with a reduction in the price in some areas like Sundarbans in West Bengal but increase in other areas including Assam, Bihar, Gujarat, etc.
- The Institute framed advisories for stakeholders (reservoir fishers, PFCS and state fisheries officials) during COVID-19 lockdown. The advisories were endorsed by FAO.

NEH, STC, SCSP Activities

- Under NEH programme, the Institute has initiated & executed two projects on sustainable fisheries enhancement in beels of Assam through the empowerment of communities and stakeholders' participation, and pilot-scale validation of cage culture technology in Loktak Lake of Manipur, besides modelling and forecasting of fish production in Assam.

- The Institute extended its technical knowhow and resources such as fish seed, feed, medicines, fishing nets, submersible pump, etc. for restoration of fisheries in "Bulbul" and "Amphan"-ravaged Sundarbans; in Birbhum, Purulia, and South 24-Parganas districts of West Bengal; Mayurbhanj, Balasore and Khurda districts of Odisha and Bundelkhand region of Uttar Pradesh; cage culture in Meghalaya and pen culture in Kerala towards women empowerment, nutritional security and livelihood options through fisheries development.

- SCSP programme was carried out for socio-economic improvement of the SC community through fisheries development in Chamordaha, Beledanga, Kumli, Panchita and Chamta beels in West Bengal, Kespura-Paikasida wetland of Odisha, and cage culture in Salia dam of Odisha, etc.

Human Resource Development and Other Activities

- The Institute organized 31 off-line and on-line training programmes benefitting more than 4000 fishers, fish farmers, students, officials, etc. It also showcased its technologies in 4 exhibitions in different parts of the country, besides extending its know-how in MGMG adopted villages.

- The Institute organized several important national and international events such as Conference on Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation (AEHMS12); International Webinar for Enhancing Conservation of River Dolphins through Sub-regional Cooperation; Global Webinar on Small Scale Fisheries in Inland Open Water: Status and Opportunity; several workshops, stakeholders meets, winter school, etc.

bringing laurels to the Institute.

- The Institute published more than 140 research papers in reputed peer-reviewed journals. Scientists, research scholars have bagged several awards and recognitions including coveted NAAS Fellowship, International Best Scientist awards, Best Doctoral Research Awards, best presentation awards, etc.
- The Institute has filed two patents and one copyright applications during 2020.
- The Institute also generated awareness for Swacchata, plastic-free green India, and COVID-free India and office through cleanliness, mass awareness, workshops, regular thermal-scan of all personnel entering the office premises, distribution of masks, etc.
- The Institute also mourns untimely demise of three staff members.

वर्ष 2020 के दौरान भाकृअनुप–केन्द्रीय अंतर्स्थलीय मात्स्यिकी ने 27 परियोजनाओं को वित्त पोषित कर शोध किया, जिनमें से 13 संस्थान परियोजनाएं, 19 बाह्य वित्त पोषित और 7 परामर्शी परियोजनाएं मार्च 2020 में पूरी हुईं। संस्थान ने प्रशिक्षण, प्रदर्शन और विस्तार, मेरा गाँव मेरा गौरव, स्वच्छ भारत कार्यक्रमों के अलावा अनुसूचित जनजाति योजना, अनुसूचित जाति उप–योजना और पूर्वोत्तर राज्यों के विकास कार्यक्रमों के तहत कई विकासात्मक गतिविधियों को पूरा किया। कोविड–19 महामारी और देशव्यापी लॉकडाउन के बावजूद, संस्थान ने अंतर्स्थलीय मत्स्य पालन के कई पहलुओं में प्रगति की है। वर्ष 2020 के दौरान संस्थान की प्रमुख उपलब्धियों को निम्नलिखित तौर पर दिखाया गया हैं –

नदीय एवं ज्वारनदमुख मात्स्यिकी

- गंगा नदी और इसकी प्रमुख सहायक नदियों के भौतिक–रासायनिक मापदंडों के अध्ययन से यह पता चला कि इन नदियों के बीओडी, सीओडी, फॉस्फेट–पी के उच्चतम स्तर और काली नदी में प्राथमिक उत्पादकता प्रदूषण का संकेत देते हैं।
- मई 2020 के दौरान उत्तर प्रदेश में गंगा नदी के प्रयागराज खंड से अनुमानित मत्स्य पकड़ 13.076 टन दर्ज किया गया, जिसमें मछलियों के विविध समूह (59.87 प्रतिशत) सबसे अधिक था। इसके बाद विदेशी प्रजातियां (28.21 प्रतिशत) और इंडियन मेजर कार्प का योगदान सबसे कम, 1.84 प्रतिशत देखा गया।
- वर्ष 2017–2019 के दौरान गंगा नदी में बक्सर क्षेत्र में विदेशी कॉमन कार्प, *साइप्रिनस कार्पियो* का परभक्षण 33. 85 प्रतिशत अनुमानित किया गया था। यह परभक्षी प्रजाति मुख्य रूप से इंडियन मेजर कार्प सहित अन्य सभी मछलियों पर हावी देखा गया। गंगा नदी में कॉमन कार्प की प्रचुरता को बीओडी, कुल फॉस्फोरस आदि के साथ सहसंबद्ध किया गया, जो मानवजनित कार्यकलापों के कारण होने वाले प्रदूषण को दर्शाता है।
- कावेरी नदी में, विदेशी मत्स्य प्रजातियों (*ओरियोक्रोमिस मोसाम्बिकस, ओ. नाइलोटिकस* और *सी गैरिपीनियस*) की उपलब्धता विभिन्न स्थलों जैसे कुडिगे, टी नदसीपुरा, शिवानासमुद्र, होजनकाल, भवानी और मयानुर में कुल मछली बायोमास का क्रमशः 14 प्रतिशत, 22 प्रतिशत, 21 प्रतिशत, 23 प्रतिशत, 57. 5 प्रतिशत 59 प्रतिशत पाये गये।
- कावेरी नदी में मछलियों का आवास स्थल बांध, बैराज, एनिकट आदि के निर्माण के कारण बहुत अधिक प्रभावित हुये हैं। तदनुसार, मछुआरों ने नदी के सभी पारिस्थितिक क्षेत्रों से वर्तमान मतस्य भण्डारण के अधिकतम दोहन के लिए मछली पकड़ने के गियर जालों में तदनुसार रूपान्तरण किया है। इस नदी में पांच प्रकार में मत्स्ययन क्राफ्ट और 30 विभिन्न प्रकार के मछली पकड़ने के विनाशकारी गियर सहित मछली पकड़ने के पद्धतियों को दर्ज किया गया।
- ताप्ती नदी में प्रचुर मात्रा में पाये जाने वाले *लेबियो फिम्ब्रिएटस* और *एल गोनियस* प्रजातियों को वर्ष 2017–2020 के दौरान इस नदी से दर्ज नहीं किए गए। ताप्ती नदी के तीनों विस्तार क्षेत्रों में कई प्रकार की विदेशी मछली की प्रजातियाँ पाई गईं, विशेष रूप से ऊपरी और मध्य खंड में सी. कार्पियो, मध्य और निचले खंड में ओ. मोसांबिकस, और निचले खंड में *पंगोसियानोडोन हाइपोथालमस,* जो मछली के बदलते संचयन घनत्व को दर्शाता है।
- सियांग, अरुणाचल प्रदेश से कुल 41 प्रजातियां दर्ज की गईं, जिनमें *बेरिलियस बेरिला, ऑप्सेरीयस बार्ना, क्रॉसोचिलस लेटियस, बरिलियस बेंडेलिसिस, एस्पिडोपारिया मोरार,* और *पुंटियस सोफोर* का प्रभुत्व देखा गया हैं।
- गंगा नदी से एकत्र किए गए भारतीय प्रमुख कार्प प्रजातियों के घेरे में प्रजनन से 75,00,000 स्पॉन का उत्पादन किया गया। इन स्पॉन से भारतीय प्रमुख कार्प की कुल 7,65,000 अंगुलिकाओं में विकसित किया गया और उत्तर प्रदेश के वाराणसी से लेकर पश्चिम बंगाल के बैरकपुर तक, पारिस्थितिकी तंत्र के स्वास्थ्य की बहाली और कार्प मछली पालन को बढ़ाने के लिए नदी के 18 अलग–अलग स्थलों पर रैंचिंग द्वारा प्रवाहित किया गया।
- गंगा नदी में *तेनुआलेसा इलिशा* के 2235 वयस्क मछलियों को रैंचिंग द्वारा प्रवाहित किया गया। इनमें से 656 मछलियों की टैगिंग की गई थी और इस रैंचिंग का उद्देश्य इस प्रजाति के अपस्ट्रीम प्रवासी मार्ग के अध्ययन के लिए किया गया था। इंडियन मेजर कार्प की 100 से अधिक मछलियों को

उनके अतिजीविता, विकास और अभिगमन के आंकलन करने के लिए टैगिंग कर बैरकपुर में गंगा नदी में प्रवाहित किया गया था।

- सरदार सरोवर बांध के नर्मदा नदी के बहाव के लिए पर्यावरणीय प्रवाह का अनुमान 2 डी माइक 11 हाइड्रोलिक रेटिंग विधि द्वारा लगाया गया था। अनुमानित 10–दैनिक कम प्रवाह 2700 क्यूसेक दर्ज किया गया।

- ताप्ती नदी के मध्य खंड में एक नई प्रजाति, *गर्रा एनांडेली* होरा, 1921, जिसे आमतौर पर अन्नडेल गर्रा या तुंगा गर्रा के रूप में जाना जाता है को पकड़ा गया। यह एक से एक नया रिकॉर्ड था। कावेरी नदी में विदेशी मत्स्य प्रजाति, *एम्फिलोफास्ट मैक्युलाटस* को पहली बार वितरण की अपनी मूल क्षेत्र के बाहर से रिकॉर्ड किया गया था।

जलाशय और आर्द्रक्षेत्र मात्स्यिकी

- पिंजरे में मछली पालन में मत्स्य प्रजातियों के विविधीकरण की दिशा में उच्च मूल्य वाली मछली प्रजातियों, *ओमपोक बिमाकुलैटस, पुंटियस सराना* और *लेबियो बाटा* की उत्तरजीविता और विकास के लिये विभिन्न संचयन घनत्वों पर जांच की गई है। पिंजरों में *ओमपोक बिमाकुलेटस* (8.05 $\pm$ 1.56 ग्राम) का संचयन 15–35 मछली प्रति घन मीटर की दर से किया गया। लगभग और 7 महीनों में इनका औसत आकार 50–62 ग्राम हो गया हो गया (80 प्रतिशत की वृद्धि)। *एल. बाटा* (6.18 $\pm$ 1.32 ग्राम) के 50–100 मछली प्रति घन मीटर की दर से संचयित किया गया। इसके 6 महीने में इन मछलियों का भार 45–52 ग्राम तथा उत्तरजीविता 85 प्रतिशत देखा गया। *पी. सराना* (25 $\pm$ 3.6 ग्राम) मछलियों को 10 मछली प्रति घन मीटर की दर से संचयित किया गया। 3 महीने में इन मछलियों का भार 150 ग्राम तथा उत्तरजीविता 90 प्रतिशत से अधिक दर्ज किया गया।
- पिंजरों में *पंगेसियनोडोन हाइपोथाल्मस* पालन में, लेबियो रोहिता को 5–10 प्रतिशत सम्मिलित करने से पिंजरे के जाल में बायोफाउलिंग के वृद्धि को नियंत्रण किया जा सकता है जिससे मछली उत्पादन में भी वृद्धि देखी गई है।

- पिंजरों में बड़ी मछली उत्पादन के लिए अमूर कार्प (*साइप्रिनियस कार्पियो*) का संचयन घनत्व असम के समागुरी बील और मैथन जलाशय, झारखंड में अनुकूलित किया गया है।

- झारखंड के विभिन्न जलाशयों में पिंजरों के एक सर्वेक्षण में बीमारियों से औसतन 7.15 प्रतिशत मछलियों की मृत्यु दर का अनुमान लगाया गया है। स्वास्थ्य प्रबंधन और रोग नियंत्रण के लिए रसायनों का उपयोग में कुल लागत में प्रति फसल रु. 218 प्रति पिंजरे का व्यय होता है।

- पश्चिम बंगाल के तीन आर्द्रक्षेत्रों में उपलब्ध फास्फोरस के उच्च स्तर के साथ–साथ प्लवक संचयनयह संकेत मिलता है कि आर्द्रभूमि के यूट्रोफिकेशन में वृद्धि हो रही है। इसलिये पारिस्थितिक अखंडता को बनाए रखने के लिए वैज्ञानिक हस्तक्षेप की आवश्यकता है। व्यापक ट्रॉफिक स्टेट इंडेक्स (mTSI) और रोटिफर ट्रॉफिक स्टेट इंडेक्स (mTSIROT) ने भी दिखाया कि इन आर्द्रक्षेत्रों में यूट्रोफिकेशन बढ़ती जा रही हैं।

- जनसंख्या गतिकी के अध्ययन से पता चलता है कि मथुरा बील में मछलियों का दोहन कम किया जा रहा है जिससे उच्च मूल्य वाली *गुडुसिया चापरा* की उपज में वृद्धि की जा सके।

- पिंजरे और पेन में मछली पालन के माध्यम से उन्नत अंगुलिकाओं के उत्पादन हेतु इनका एकीकृत पालन किया गया, जिसके परिणामस्वरूप पूर्वी चंपारण, बिहार के पांच आर्द्रभूमि में उत्पादन में वृद्धि देखी गई। इन आर्द्रक्षेत्रों में प्रति यूनिट प्रयासों (CPUE) की पकड़ पालन आधारित मत्स्य प्रबंधन को अपनाने के साथ 1. 4–5.5 किग्रा प्रति मछुआरा प्रति दिन से बढ़कर 3.02–11.1 किग्रा प्रति मछुआरा प्रति दिन हो गई है।

- पालन आधारित मत्स्य पालन को अपनाने के साथ, पश्चिम बंगाल के 21 बाढ़कृत मैदानों की औसत मत्स्य उपज बंद आर्द्रभूमि में 1165 किलोग्राम प्रति हेक्टेयर प्रति वर्ष और खुले/मौसमी आर्द्रभूमि में 864 किलोग्राम प्रति हेक्टेयर प्रति हेक्टेयर दर्ज की गई है। निचले गंगा बेसिन के आर्द्रभूमि की उपज तीस्ता–तोरसा बेसिन की मत्स्य उपज की तुलना में अधिक देखी गई।

- तीस्ता–तोरसा बेसिन और गंगा बेसिन (भागीरथी–हुगली विस्तार) के बाढ़कृत आर्द्रभूमि में तलछट एंजाइमों सहित पर्यावरणीय चर और जैविक समुदाय के

पारस्परिक संबंध के मूल्यांकन से इसके विभिन्न खंडों के मौसमी विविधताओं का पता चला। अध्ययन से संकेत मिलता है कि तलछट एंजाइम गतिविधियों का उपयोग आर्द्रभूमि पारिस्थितिकी तंत्र स्वास्थ्य मूल्यांकन के लिए जैविक और सूक्ष्मजीवविज्ञानी मानक के रूप में किया जा सकता है।

- वर्ष 1998–2018 के लिए मछली पकड़ने के समय श्रृंखला आंकड़ों के विश्लेषण से संकेत मिलता है कि *लेबियो कलबसु* और *एल. रोहिता* की पकड़ में *एल कतला* का प्रभुत्व रहा है। इससे यह पता चलता है कि उत्तर प्रदेश में रिहंद जलाशय में कतला मछलियों की बहुलता कम हुई है।

- पोंग जलाशय के समय श्रृंखला आंकड़ों (1976 से 2020) के विश्लेषण के अनुसार, औसत मत्स्य पकड़ और औसत मत्स्य उपज क्रमशः 411.46 टन प्रति वर्ष और 27.43 किलोग्राम प्रति हेक्टेयर प्रति दर्ज किया गया। ये आंकड़े यह संकेत देते हैं कि पिछले कुछ वर्षों में मत्स्य पकड़ में गिरावट देखी गई है। हालांकि, मत्स्य उपज पूर्वानुमान मॉडल (ARIMA) के अनुसार, आने वाले वर्षों में मत्स्य उपज में वृद्धि की संभावना व्यक्त की गई है।

- मेट्टूर जलाशय के पारिस्थितिक तंत्र–आधारित मॉडल के अनुसार, अनुमानित कुल प्राथमिक उत्पादन कुल श्वसन मान 7.8 है जो जलाशय पारिस्थितिकी में खराबी को दर्शाता है। जलाशय के मत्स्य उत्पादन स्तर को बनाए रखने के लिए कुछ प्रबंधन उपाय अपनाना चाहिये जैसे, मानसून के दौरान मत्स्ययन निषेध अवधि का पालन, प्राकृतिक तौर पर प्रजनन करने वाली मछलियों को विकसित करने के लिए मछली के बीज का बारंबार संचयन और ड्रैग नेट और छोटे जाल आकार के गिल जाल (<70 मिमी) के उपयोग को प्रतिबंधित करने जैसे प्रबंधन के उपाय आवश्यक हैं।

- ओडिशा के 58 छोटे जलाशयों, छत्तीसगढ़ के 24 छोटे जलाशयों, मध्य प्रदेश के 6 बड़े जलाशयों और उत्तर प्रदेश के रिहंद जलाशय, तमिलनाडु के 54 जलाशयों, और झारखंड के 4 जलाशयों में इंडियन मेजर कार्प के संपूरक संचयन के कारण मत्स्य उपज में अध्ययन में उल्लेखनीय वृद्धि ($p<0.05$) हुई। मत्स्य उपज का संचयन घनत्व के साथ पारस्परिक संहसंबंध देखा गया।

- पूर्वी भारत में पाये जाने वाले छोटे जलाशयों के अंतर्गत ओडिशा के डेरजंग जलाशय की पारिस्थितिक मूल्यांकन से इसकी उच्च उत्पादक प्रकृति का संकेत मिलता है। प्रायद्वीपीय जलाशयों जैसे कृष्णगिरि जलाशय उच्च जैविक भार के कारण सबसे अधिक उत्पादक पाया गया। इसलिये इसे अल्ट्रा–यूट्रोफिक जलाशय की श्रेणी में रखा गया है। उत्तर प्रदेश का जारगो जलाशय मध्यम उत्पादक वर्ग का जलाशय है। जल गुणवत्ता के आधार पर कृष्णगिरि जलाशय की पारिस्थितिकी तंत्र को उपयुक्त नही पाया गया इसलिये इसकी जलीय पारिस्थितिकी तंत्र के पुनरूत्थान के लिए तत्काल निदान उपायों की आवश्यकता है।

- कृष्णराजसागर जलाशय के संभावित मछली पकड़ने के क्षेत्र को दर्शाने वाले मानचित्र को सोनार एक्स सॉफ्टवेयर की मदद से तैयार किया गया था। पोर्टेबल ट्रांसड्यूसर असेंबली पर एक पेटेंट लगाया गया। नाव संचालन के लिए इसके उपयुक्त एक और पोर्टेबल को विकसित किया गया था और इसके प्रारूप का सफलतापूर्वक परीक्षण किया गया। ध्वनिक सर्वेक्षण के लिए एक ऐसी ट्रांसड्यूसर आधारित नाव बनाई गई, जिसे आउटबोर्ड मोटर की आवश्यकता नहीं थी।

- तेलंगाना के पालियर जलाशय में पालन आधारित मत्स्य पालन से मीठाजल प्रजाति झींगा, *मैक्रोब्रैकियम* एसपीपी के उपज में वृद्धि देखी गई। झींगा प्रजातियां (*एम. रोजेनबर्गी* और *एम मालकोमसोमी*) के बीज के साथ इंडियन मेजर कार्प के बीज का संचयन किया गया।

- ज्लाशयों से आंकड़ा संचयन हेतु मोबाइल आधारित एपलिकेशन, 'ई–डास' को इंटरनेट आधारित ई–मत्स्य' एपलिकेशन में अपग्रेड किया गया तथा इसे तुंगा जलाशय (कर्नाटक) और तेलंगाना के जलाशयों को क्रियान्वित किया गया।

- मेट्टूर जलाशय के लिए विकसित इकोपैथ मॉडल के द्वारा निम्न–स्तरीय ट्रॉफिक जीवों की बहुलता का संकेत मिलता है। पारिस्थितिकी तंत्र की परिपक्वता और स्थिरता की सभी विशेषताएं स्पष्ट रूप से इंगित करती हैं कि पारिस्थितिकी तंत्र विकास के चरण में है और बदलते जलवायु के उन्मुख नही है।

मछली और पर्यावरणीय स्वास्थ्य

- गोदावरी और काठजोड़ी नदी में नदी विखंडन और क्षीण नदी प्रवाह को सबसे महत्वपूर्ण समस्याओं के रूप में पहचाना गया है। हालांकि जल में भारी धातु संदूषण एक गंभीर समस्य नही है पर अपरद प्रदूषण दूसरा सबसे महत्वपूर्ण समस्या देखी गई।

- जैविक अखंडता (IBI) के मछली–आधारित सूचकांक से पता चला है कि काठजोड़ी–देवी विस्तार क्षेत्र में अधिकतर भाग क्षीण स्थिति में पाये गये, जबकि कटक शहर से अवशिष्ट के कारण इटेल्जाना क्षेत्र की पारिस्थितिक गंभीर (> 50:) से प्रभावित पाई गई। गोदावरी नदी के नासिक से नांदेड़ खंड गंभीर रूप से प्रभावित हुआ था, जिसमें नासिक नदी का आईबीआई स्कोर सबसे अधिक चिंताजनक पाया गया। नदी के बाकी भाग, धवलेश्वरम (राजमुंदरी, आंध्र प्रदेश के पास) को छोड़कर मध्यम रूप से प्रभावित हुआ था। बुरहानपुर से प्रवाहित अवशिष्ट ततवें के कारण सीवेज मानसून रहित मौसम में ताप्ती नदी के पानी की गुणवत्ता को खराब हो गया है।

- तीस्ता नदी में कीटनाशकों के कारण प्रदूषण का स्तर गंभीर नहीं है। यहां पानी में कीटनाशक के अवशेष अधिकतर यूएसईपीए राष्ट्रीय अनुशंसित जल गुणवत्ता द्वारा निर्धारित मानदंड से नीचे थे और अधिकांश मामलों में मछलियों की सहिष्णुता स्तर से बहुत कम थे। नदी के तलछट में साइपरमेथ्रिन की सांद्रता 0.482 मिलीग्राम प्रति किग्रा तक पायी गयी, जो जलीय खाद्य श्रृंखला में संभावित संदूषण के लिये चिंताजनक स्थिति है।

- ईस्ट कोलकाता वेटलैंड (EKW) की मछलियों और सूक्ष्म केशरूकी जीवों में माइक्रोप्लास्टिक संदूषण पाया गया। इस आर्द्रक्षेत्र के सतह पर पाई जाने वाली माइक्रोप्लास्टिक में जहरीली धातुओं (जैसे, आर्सेनिक, कैडमियम, क्रोमियम, कॉपर, नाइट्रोजन, फॉस्फोरस और जिंक) का स्तर उच्च पाया गया। टी–डिस्ट्रीब्युटेड स्टॉकेटिक नेबर एम्बेडिंग मशीन लर्निंग एल्गोरिथम से माइक्रोप्लास्टिक बहुतायता के साथ गंदलापन, फॉस्फेट और नाइट्रेट के बीच एक मजबूत सहसंबंध का पता चलाा। ट्राईक्लोसन और ट्राइक्लोकार्बन जैसे सौन्दर्यवर्द्धन उत्पादों के अवशेष जल में और अपरद भोजी मछली के नमूने में पाये गये।

- आर्सेनिक–प्रभावित मछलियों के α– और β–क्रिस्टैलिन के जीन अभिव्यक्ति में डाउन रेगुलेटेड किया गया था। पर यदि मछलियों को कर्क्यूमिन युक्त आहार दिया जाय तो मछलियों के जीन अभिव्यक्ति में अधिक परिवर्तन देखने को नहीं मिलता है।

- परजीवी प्रजाति, थेलोनेलस किटावी पर सूक्ष्मजैविकी, परजीवीय, हिस्टोपैथोलॉजी और आणविक तकनीकों के माध्यम से परीक्षण किया गया। इसका यह परिणाम देखने को मिला कि इस परजीवी संक्रमण से *लेबियो रोहिता* के पोना मछलियों की मृत्यु हो जाती है। इसके संक्रमण से मछली में कार्बोहाइड्रेट, अमीनो एसिड और फैटी एसिड चयापचय में एक सामान्य तनाव उपस्थित होता है।

- ताप्ती नदी के मछलियों में संक्रमण पाये गये जैसे *लेबियो बोगुट, ओरिओक्रोमिस नाइलोटिकस, सिस्टोमस सराना* और *जेनेंटोडोन कैनिला* में परजीवी प्रजाति, आइसोपोड *एलिट्रोपस टाइपस* का संक्रमण पाया गया।

- पूर्वी मिदनापुर के एक आर्द्रक्षेत्र में तिलापिया में एक बीमारी के प्रकोप की जांच से पता चला कि तिलोपिया झील के वायरस से जुड़े रोगजनक बैक्टीरिया अर्थात *एयरोफिला कैविटी, ए. हाइड्रोफिला, एडवर्ड्सियाला मार्दा, क्लेबसिएला न्यूमोनिया* और *स्यूडोमोनस एरुगिनोसा* का मछलियों की उत्तरजीविता के लिये उत्तरदायी है। परिवर्तित हाइड्रो–इकोलॉजिकल प्राचल और मृदा रसायन के कारण संक्रमण और भी गंभीर था।

- महामारी विज्ञान के एपीडेमिओलॉजिकल मानचित्रण में कई विषाक्त बैक्टीरिया जैसे – *एरोमानस वेरोनि, ए. जेन्डेई, ए. कैवियेट, एसिनेटोबैक्टेर बाउमनी, क्लेबसिएला निमोनिया, प्लिसिओमोनो शिगेलॉइड्स, पी. एरुगिनोसा, एड्विसिएला तर्डा, ई. डिक्टालुरी* आदि की उपस्थिति का पता चला। इन रोगजनकों के कारण विभिन्न व्यावसायिक रूप से महत्वपूर्ण मछली प्रजातियों जैसे *लेबियो रोहिता, एल. कैटला, एल. बाटा, सी. मृगला, एस. सराना, ओमपोक बिमाकुलेटस, ओरिओक्रोमिस नाइलोटिकस, पैंगसियनोडोन हाइपोथैलेमस,* आदि में रोग संक्रमण हुआ। इन मछली के रोगों के साथ पर्यावरणीय मानकों का पारस्परिक संबंध देखा गया।

- स्पॉनटेनियस इमल्सीफिकेशन तकनीक के माध्यम से परजीवी रोधी अणु का एक सूत्रण विकसित किया गया है और मछली के एक्टोपारासाइट *अर्गुलस बेंगालेंसिस* के संदर्भ में इसकी जैव क्षमता का मूल्यांकन किया गया है।
- *टर्मिनलिया अर्जुन* के विलायक के अर्क के खनिज प्रोफाइलिंग से पता चला है कि इसका छाल पाउडर का उपयोग मछली के लिए औषधीय फीड तैयार करने के लिए पूरक के रूप में किया जा सकता है। मेथनॉलिक फलों के अर्क का उपयोग नींद की कमी को कम करने के लिए किया जा सकता है। *टी. अर्जुन* का अर्क रोगजनक जीवाणु *ए. हाइड्रोफिला,* और परजीवी, *ए बेंगालेंसिस* के संकंमण में प्रभावी था।
- मीठे पानी की हरित सूक्ष्मशैवाल, *ग्रेसिएला एमर्सोनि* को बायोडीजल उत्पादन के संभावित स्रोत के रूप में पहचान की गई है।

मत्स्य संसाधन मूल्यांकन

- जलाशयों में अंगुलिकाओं के संचयन के प्रभाव के आंकलन के लिये एक संशोधित वेरहुलस्ट–शेफर मॉडल का उपयोग कियो गया। इस मॉडल से संचयन जलाशयों में मछलियों के दोहन के लिए अधिकतम सतत उपज (MSY) का अनुमान किया गया है।
- जलनिकाय समूह– I (10 हेक्टेयर से नीचे) के लिए राज्य–स्तरीय मत्स्य पकड़ के अनुमानित आंकड़ा संबंधी सॉफ्टवेयर को अपग्रेड किया गया है।

जलवायु परिवर्तन

- गंगा बेसिन के सभी बाढ़कृत आर्द्रभूमि में पारिस्थितिकी और मत्स्य जैव विविधता पर पर्यावरण–जलवायु प्रभाव का आकलन किया गया जिसमें मछली विविधता में 22.85 से 54 प्रतिशत की गिरावट देखी गई। कैनोनिकल कॉरस्पॉन्डेंस एनालिसिस (CCA) में मछलियों की प्रजातियों के साथ जलवायु–विशिष्ट और पर्यावरणीय मानकों के अलग–अलग संबंध दिखाई दिए, जो प्रजातियों–विशिष्ट अनुकूली क्षमता का संकेत देते हैं।
- जलवायु संबंधी विसंगतियों के संदर्भ में जीआईएस उपकरणों द्वारा निचले गंगा बेसिन में तीन बाढ़कृत मैदानों का अध्ययन किया गया। इसमें इन मैदानी भागों के अनुपात–अस्थायी परिवर्तन विश्लेषण से न्यूनतम और अधिकतम गहराई में कमी, 37.20–57.68 प्रतिशत दर्ज की गई। वर्ष 1985–2018 के आंकड़ों के विश्लेषण से यह पता चलता है कि इस क्षेत्र में औसत तापमान (1.9 डिग्री सेल्सियस) और वर्षा में अनियमितता (–698.1 मिमी) के साथ जलवायु परिवर्तन का संकेत मिलता है।
- अंतर्स्थलीय मत्स्य पालन पर क्षेत्रीय जलवायु परिवर्तनशीलता के प्रभाव का अध्ययन किया गया था, जिसमें प्राथमिकता वाली प्रजातियों के प्रजनन विज्ञान, पारिस्थितिक और सामाजिक भेद्यता और बाढ़कृत आर्द्रभूमि में पेन में मछली पालन जैसी जलवायु–लचीला अनुकूलन रणनीतियों का प्रदर्शन शामिल है। साथ ही, पारिस्थितिक लचीलापन का भी आंकलन किया गया है।

मत्स्य सामाजिक–अर्थशास्त्र

- हुगली मुहाना में *टेनुआलोसा इलिशा* के अपरिपक्व मछली पकड़ने के कारण वार्षिक आर्थिक नुकसान का अनुमान 497.84 मिलियन (यूएस + 7.8 मिलियन के आसपास) दर्ज किया गया। यह देखा गया कि मछली पकड़ने के प्रमुख विनाशकारी गियर जाल जैसे बैगनेट, सेट बैरियर, छोटे जाल गिल नेट, साइन नेट, नाव संचालित लिफ्ट, आदि को हटाकर हिलसा मात्स्यिकी को उन्नत किया जा सकता है।
- सामाजिक और आर्थिक विश्लेषण से पता चला है कि पिंजरे में मछली पालन तकनीक देश में लगभग 39,000 मीट्रिक टन मछलियों का उत्पादन हो रहा है और प्रति वर्ष 7.46 लाख लोगों को दैनिक आजीविका मिल रही है। इस तकनीक ने न केवल पारिवारिक आय में वृद्धि हुई है, बल्कि झारखंड में प्रवासी कार्यो में भी कमी (9 प्रतिशत से 29 प्रतिशत) आई है। उपभोक्ता अधिशेष मॉडल के आंकलन के अनुसार पिंजरे में मछली पालन से झारखंड में वर्ष 2010 से 2019 तक 4 करोड़ का शुद्ध लाभ प्राप्त हुआ है। अनुमानित तौर पर 16 वर्ष (2010–2025) की अवधि के दौरान यह लाभ लगभग रु0 14.83 करोड़ तक हो सकता है।
- असम के आर्द्रभूमि में पेन में मछली पालन से अंगुलिका उत्पादन में वृद्धि 492 कि.ग्रा. प्रति हेक्टेयर प्रति वर्ष से 1011 किलोग्राम प्रति हेक्टेयर प्रति वर्ष हुआ है। इस प्रौद्योगिकी को अपनाने से मछुआरों की औसत मासिक आय में 49. 6 प्रतिशत की वृद्धि हुई है।

- वर्ष 2012–13 से 2018–19 के दौरान संस्थान द्वारा प्रदत्त प्रशिक्षण की समग्र प्रभावशीलता 87.86 प्रतिशत आंकी गई है। इससे प्रशिक्षित किसानों को अपने ज्ञान, कौशल वुद्धि के साथ मत्स्य पालन को आजीविका के रूप में अपनाने दृष्टिकोण में मदद मिली है। लगभग 82 प्रतिशत प्रशिक्षित किसानों ने मिश्रित मछली पालन पद्धति को अपनाया है। बिहार में, मत्स्य पालन को 7 प्रतिशत किसानों ने अपने प्रमुख व्यवसाय के रूप में जबकि 23 प्रतिशत किसानों ने अतिरिक्त व्यवसाय के रूप में अपनाया है।

कोविड–19 और आपदा प्रबंधन

- संस्थान ने चक्रवाती तूफान अम्फान से होने वाले नुकसान का आंकलन किया और जल निकायों की जल गुणवत्ता में सुधार लाने और सुंदरवन में मत्स्य पालन को फिर से स्थापित करने के लिए तकनीकी सलाह देने के साथ सामग्री आपूर्ति भी वितरित की है।

- कोविड–19 महामारी के दौरान देशव्यापी लॉकडाउन के दौरान, गंगा नदी की जल गुणवत्ता में काफी सुधार हुआ है।

- लॉकडाउन के दौरान जलाशयों, आर्द्रक्षेत्रों, नदियों आदि में मत्स्ययन गतिविधि बहुत कम हो गई या पूरी तरह से रुक गई थी। पश्चिम बंगाल में सुंदरबन जैसे कुछ क्षेत्रों में फार्म–गेट के साथ–साथ मछली के बाजार बिक्री मूल्य में व्यापक रूप से मछली की कीमत में कमी आई है, लेकिन असम, बिहार, गुजरात सहित अन्य क्षेत्रों में वृद्धि हुई है।

- संस्थान ने कोविड–19 लॉकडाउन के दौरान हितधारकों (जलाशयी मछुआरे मछुआरा संगठनों और राज्य मत्स्य अधिकारी) के लिए मार्गदर्शी सलाह तैयार किया जिसे खाद्य एवं कृषि संगठन ने भी समर्थन किया है।

पूर्वोत्तर क्षेत्र, जनजाति उपयोजना तथा अनुसूचित जाति उपयोजना संबंधी गतिविधियां

- पूर्वोत्तर क्षेत्र कार्यक्रम के तहत, संस्थान ने असम के बील में स्थायी मत्स्य संवर्धन पर दो महत्वपूर्ण परियोजनाओं की शुरुआत की है जिससे मछुआरा समुदाय और हितधारकों को सशक्तीकरण हो सके। इसके अलावा मणिपुर की लोकतक झील में पिंजरे में मछली पालन प्रौद्योगिकी का सत्यापन और असम में मछली उत्पादन का पूर्वानुमान मॉडलिंग का क्रियान्वयन किया है।

- संस्थान ने "बुलबुल" और "अम्फान" आपदाओं में सुंदरवन में मत्स्य पालन के पुनरूत्थान के लिए अपने तकनीकी ज्ञान और संसाधनों जैसे मछली के बीज, चारा, दवाइयां, मछली पकड़ने के जाल, पनडुब्बी पंप आदि का भी वितरण किया है। पश्चिम बंगाल के बीरभूम, पुरुलिया और दक्षिण 24–परगना जिलों में, ओडिशा और उत्तर प्रदेश के बुंदेलखंड क्षेत्र के मयूरभंज, बालासोर और खुर्दा जिला और मेघालय में पिंजरे में मछली पालन तथा केरल में पेन में मछली पालन द्वारा महिला सशक्तीकरण, पोषण सुरक्षा और मछली पालन विकास के माध्यम से आजीविका के विकल्प को स्थापित करने में मदद मिली है।

- अनुसूचित जाति उपयोजना के अंतर्गत पश्चिम बंगाल के चमोरदाहा, बेलेडांगा, कुमली, पंचिता और चामता बील तथा ओडिशा के केसपुरा–पिकासीदा आर्द्रभूमि में मत्स्य विकास और ओडिशा के सलिया बांध में पिंजरे में मछली पालन आदि के माध्यम से इन मछुआरा समुदाय का सामाजिक–आर्थिक सुधार किया गया।

मानव संसाधन विकास और अन्य गतिविधियाँ

- संस्थान द्वारा 4000 से अधिक मछुआरों, मछली किसानों, छात्रों, अधिकारियों आदि को लाभान्वित करने के लिए 31 ऑफ–लाइन और ऑन–लाइन प्रशिक्षण कार्यक्रमों का आयोजन किया गया। सस्थान ने देश के विभिन्न हिस्सों में 4 प्रदर्शनियों में अपनी तकनीक का प्रदर्शन तथा विकसित प्रौद्योगिकी का प्रसार किया है। 'मेरा गांव मेरा गौरव' के तहत कई गांवों को गोद लिया गया है।

- संस्थान ने कई महत्वपूर्ण राष्ट्रीय और अंतर्राष्ट्रीय कार्यक्रमों का आयोजन किया है– जैसे Conference on Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation (AEHMS12); उप–क्षेत्रीय सहयोग के माध्यम से नदी डॉल्फिन के संरक्षण को बढ़ाने के लिए अंतर्राष्ट्रीय वेबिनार; अंतर्स्थलीय खुला जल में लघु पैमाने पर मत्स्य पालन पर वैश्विक वेबिनार : स्थिति और अवसर; कार्यशालाओं, हितधारकों की बैठक, शीतकालीन स्कूल, आदि

- संस्थान ने प्रतिष्ठित पीयर–रिव्यू जरनल में 140 से अधिक शोध पत्र प्रकाशित किए। वैज्ञानिकों, शोध छात्रों ने कई पुरस्कार और सम्मान प्राप्त किया हैं जिनमें प्रतिष्ठित एनएएएस फैलोशिप, अंतर्राष्ट्रीय सर्वश्रेष्ठ वैज्ञानिक पुरस्कार, सर्वश्रेष्ठ डॉक्टरेट अनुसंधान पुरस्कार, सर्वश्रेष्ठ प्रस्तुति पुरस्कार आदि शामिल हैं।
- संस्थान ने वर्ष 2020 में दो पेटेंट और एक कॉपीराइट आवेदन दायर किया है।
- संस्थान ने स्वच्छ भारत, प्लास्टिक मुक्त हरित भारत और कोविड मुक्त भारत के माध्यम से स्वच्छता, जन जागरूकता, कार्यशालाओं, कार्यालय परिसर में प्रवेश करने वाले सभी कर्मियों के नियमित थर्मल–स्कैनिंग, मास्क वितरण आदि के लिए जागरूकता पैदा की।
- संस्थान तीन संस्थान सदस्यों के असामयिक निधन पर शोक व्यक्त करता है।

Vision

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

Mission

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

Mandate

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

History

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

The plan priorities of Government of India during the late sixties and seventies were on aquaculture research and development. The Planning Commission sanctioned five All-India Coordinated Research Projects, namely, Composite Fish Culture, Riverine Fish Seed Prospecting, Air-breathing Fish Culture, Ecology and Fisheries Management of Reservoirs and Brackishwater Fish Farming during 1971-1973. The Institute, besides several other technologies, developed induced breeding and composite fish culture technologies that ushered blue revolution in the country and laid down a solid foundation for development of freshwater aquaculture.

Since 1980s, the Institute focused its research on inland open water fisheries of rivers, reservoirs, floodplain wetlands, estuaries, lagoons and backwaters. This resulted in development of fisheries management/ development protocols for large, medium and small reservoir and for wetlands, progressive production enhancement from these large resources. A vast amount of information was generated on ecology and fisheries status of nearly all the major river systems, reservoirs, wetlands and lagoons with technologies, protocols and policy recommendations for fisheries management and development in inland open water resources of the country. In recent past, to address the national need, focus of the Institute has been inclined towards Natural Resource Management, sustainable production enhancement and ecosystem health with revision in 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, Bengaluru, and Vadodara with Research stations at Kochi and Kolkata. In 2020 ICAR has granted two more Divisions in the Institute. The research activities are now taken up through five Research Divisions, viz.,

- Riverine and Estuarine Fisheries Division
- Reservoir and Wetland Fisheries Division
- Fisheries Enhancement and Management Division
- Fisheries Resources Assessment and Informatics Division
- Aquatic Environmental Biotechnology and Nanotechnology Division

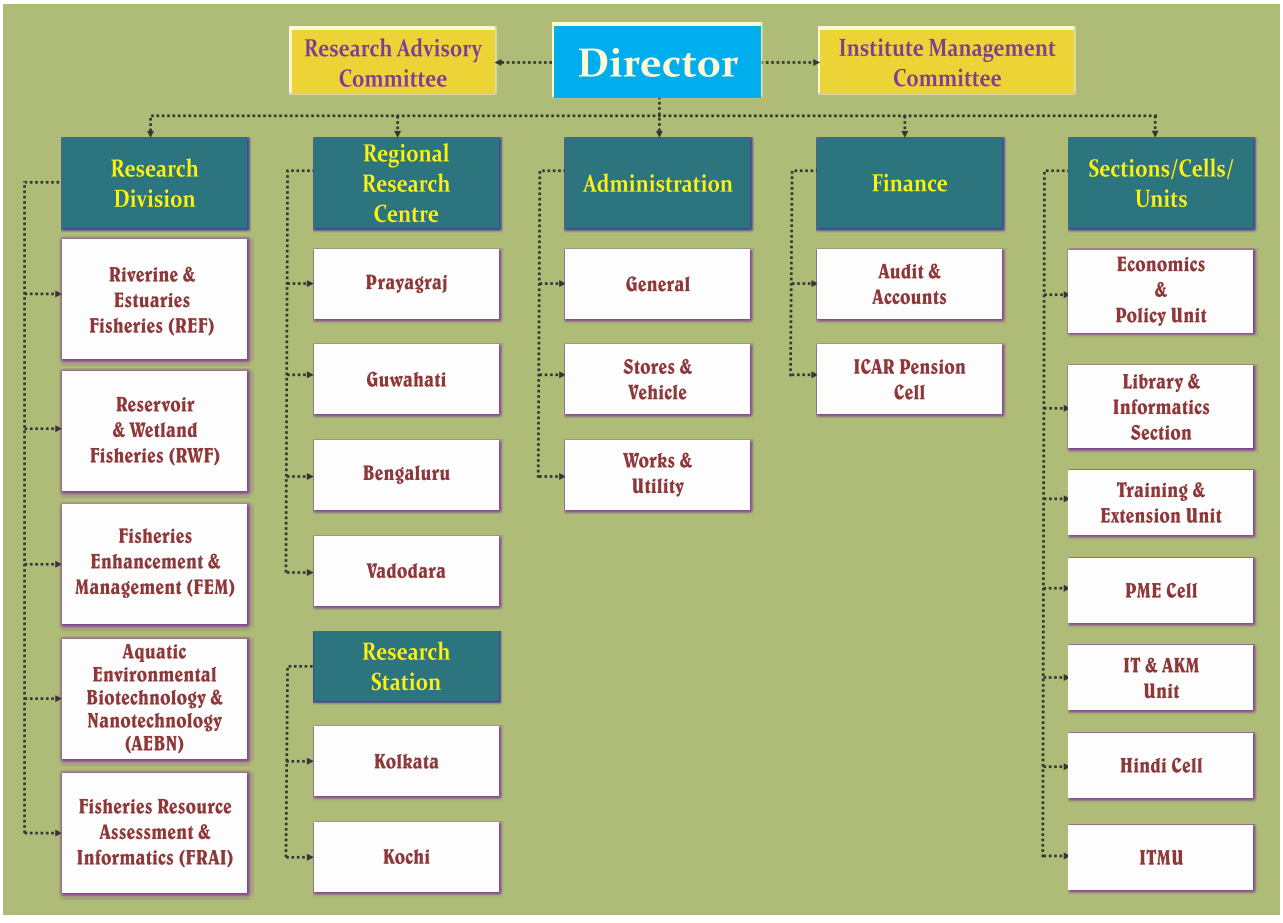
Besides these, Socio-economic research, Extension and Training activities are carried out through the 'Economics and Policy Unit' and 'Extension and Training Cell',

respectively. The research activities of each division are led by Head of Division appointed by ICAR. While the Regional Research Centers at Allahabad, Guwahati and Bengaluru are administered by Heads of Regional Centers appointed by ICAR, other centres and stations are administered by Officers-in-Charges. The Institute has sanctioned cadre strength of 88 Scientists, 81 Technical Officers, 67 Administrative and 65 Supporting personnel.

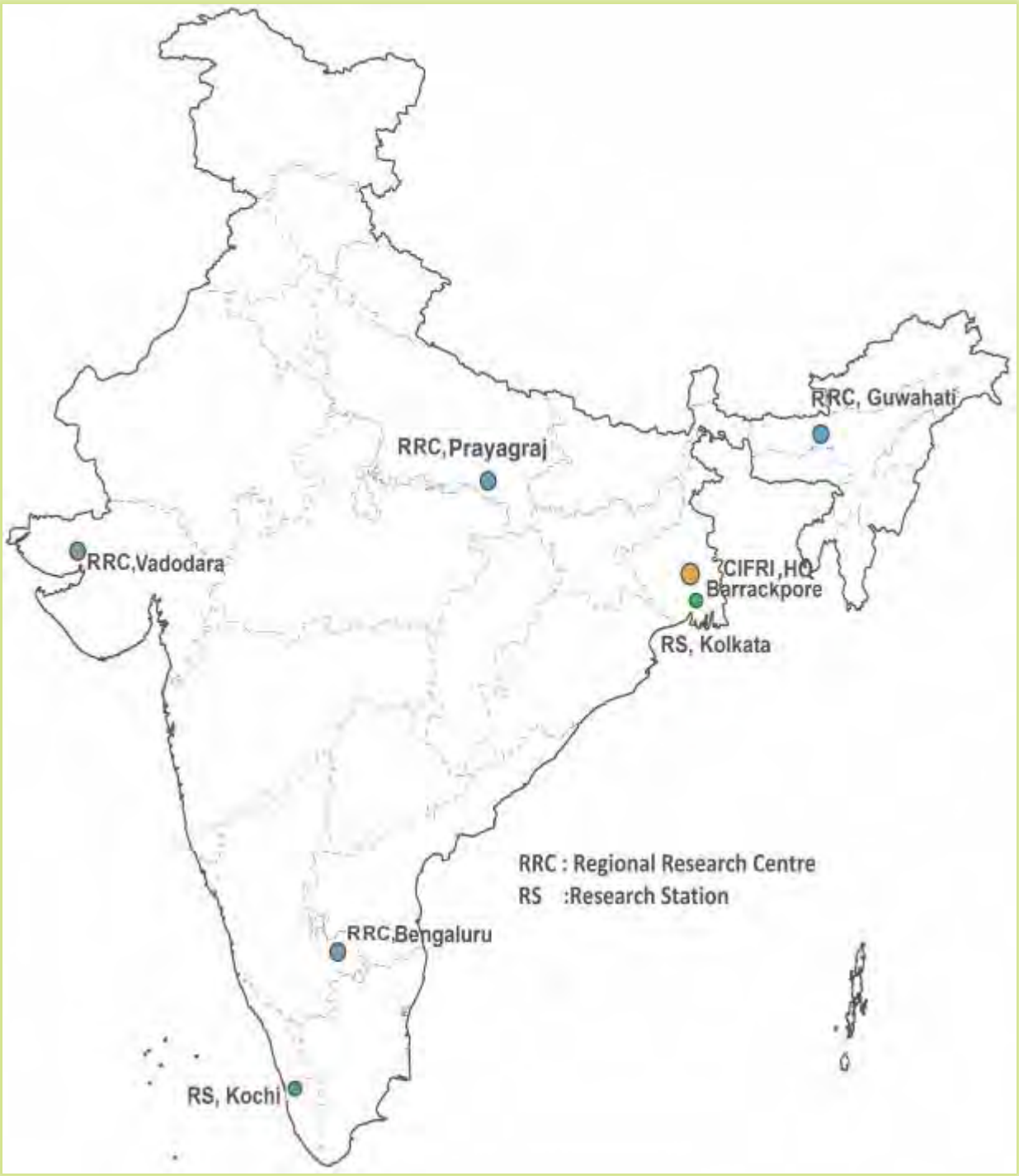
The head-quarters of the Institute has a number of support services, viz. Administration Section, Audit and Accounts Section, PME Cell, Hindi Cell, AKM Unit, Library and Informatics Section, Institute Technology Management Unit, Stores Section, Vehicle Section, and Nodal Officers for MGMG programm, TSP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

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

Organogram of ICAR-CIFRI



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



Budget of the Institute for the year 2020-21 (up to 31.12.2020) (Rs. in Lakh)

Head of Accounts	Budget (RE)	Expenditure
Pay and Allowance including OTA*	10138.51	7806.60
TA	25.00	15.11
Other charge including Equipment, Library Books, IT & HRD	1238.00	524.06
Works	40.00	0.00
Grand Total	**11441.51**	**8345.77**
*includes Pension also		

The Budget & Expenditure under Institute for the financial year 2020-21 (up to 31.12.2020) (Rs. in Lakh)

Budget Head	Budget	Expenditure
Revenue		
Estt. Charges	3088.31	2296.89
OTA	0.20	0.00
TA	25.00	15.11
Other charges	557.00	308.24
Office Building	30.00	24.86
Residential Building	18.00	1.06
Minor Works	15.00	0.39
Misc. Expenses including HRD	21.00	5.51
TSP General	45.00	24.98
NEH General	110.00	42.85
Capital		
Equipment	105.00	4.15
Information Technology	50.00	22.85
Library Books	5.00	0.17
Vessels / Vehicles	30.00	0.00
Furniture & Fixture	50.00	2.76
Works	0.00	0.00
Minor Works	40.00	0.00
TSP Capital	20.00	3.76
NEH Capital	40.00	24.37
SCSP Capital	28.00	17.25
SCSP General	114.00	40.85
Total	**4391.51**	**2836.05**
Pension	7050.00	5509.72
Total	**11441.51**	**8345.77**
Loans & Advances	**0.00**	**0.00**

Other Projects (From 01.04.2020 to 31.12.2020) (Rs. in Lakh)

Budget Head	Receipts including opening balance	Expenditure	Refund
NICRA	37.91	18.95	0.00
CABIN	8.85	5.95	0.00
NASF	10.02	2.25	0.00
ITMU	3.50	2.25	0.00
SIF-EXMU	0.00	0.00	0.00
Fish Health	13.47	7.80	0.00
Deposit Schemes (Externally funded)	117.59	295.24	0.00
Consultancies	40.65	57.65	0.00

Revenue Receipts (01.01.20 to 31.12.20) (Rs. in lakh)

Head	ICAR	Institute
Income from Sales / Services	18.30	
Fee / Subscription	0.80	
Income from Royalty, Publication etc.	1.57	
Other income	12.48	81.52
STD Interest	6.13	
Sale of Assets	0.00	
Recoveries on Loans and Advances	13.97	
CPWD / Grants Refund	0.00	
Total	53.25	81.52

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

Project code : REF /17-20/07
Project duration : 2017-2020
Scientific personnel : S. Samanta (PI since 30.11.2019), B. K. Bhattacharya, S. K. Das, R. K. Manna, F. Khan, Roshith C. M., D. Bhakta (since 01.10.2018), K. Kumari, R. Baitha, D. Sudeeshan (since 01.04.2018), T. T. Paul, S. P. Kamble, W. A. Meetei, Vaishak G., A. Saha, Sibinamol S., T. N. Chanu (upto 07.09.2019), S. K. Koushlesh (upto 07.9.2019), S. K. Sharma (upto 30.09.2019), S. Borah, N. S. Singh (except 09.03.2018 to 01.02.2020), P. Gogoi, L. Kumar (since 01.10.2018), S. K. Sahu, A. Roy, C. Jana (since 01.10.2018), S. M. Nair (since 05.10.2019), Manas H. M. (upto 29.09.17)

River Cauvery

Impact of modified river habitat on water quality

Cauvery is one of the water-scarce rivers of India providing less than 1000 m^3 water per capita in her catchment area. To meet the ever-increasing water requirements, several obstructions have been made along the entire river basin, both on the main river channel as well as on its tributaries/distributaries. At least 19 major obstructions (dams, barrages, anicuts, etc.) are there on the main river channel including Mettur dam, Grand anicut, Lower anicut, etc.

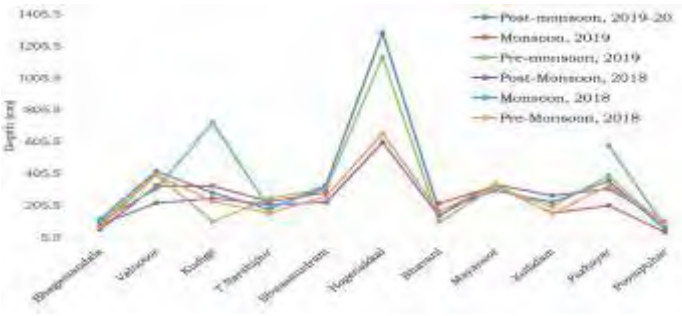
Water release from the dams and barrages controls the habitat of the Cauvery river. Water depth is found to be too low at most of the sampling stations, except on few occasions when water discharge or flood-like situations in monsoon. At Hogenakkal, higher water depth was recorded below the waterfalls area due to presence of a deep pool there. Higher depth was found at Mayanoor, as compared to adjacent stations, due to water retention by the barrage.

Stagnant water conditions above barrage areas influence water parameters like dissolved oxygen as observed in Mayanoor above barrage areas. Higher dissolved oxygen levels were observed at Mayanoor on most of the occasions as compared to Bhavani or Kollidam, the adjacent sampling stations, contributed by higher photosynthetic production in stagnant water. Higher water flow at Hogenakkal throughout the year contributed to sufficient dissolved oxygen here.

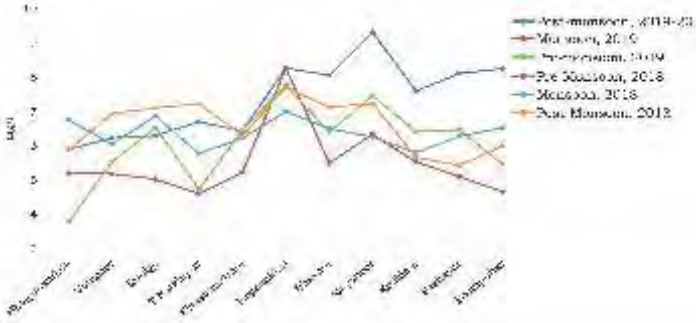
Water pH is also observed to be higher at Mayanoor above barrage due to higher photosynthetic activity by plankton in this stagnant water condition. Higher pH at Sivanasamudram during pre-monsoon may be contributed by higher photosynthetic activity by dense submerged

Dams, barrages and anicuts on the main channel of river Cauvery

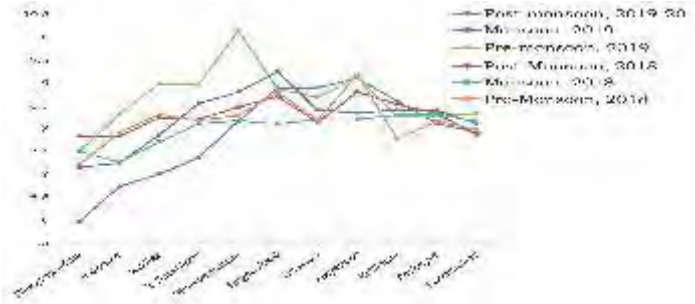
Name	Latitude	Longitude
Kattepura dam	12°36'25.0"N	76°02'44.0"E
Chamarajendra anicut	12°31'15.2"N	76°14'24.6"E
Chunchunkatte dam	12°30'11.7"N	76°17'33.5"E
Krishnarajasagar (KRS) dam	12°25'31.8"N	76°34'20.8"E
Madhavmantri Mini Hydel station	12°12'33.0"N	77°01'24.1"E
Satthegela Mini Hydel Power station	12°15'10.5"N	77°09'22.4"E
Mettur dam (Stanley reservoir)	11°54'16.2"N	77°49'53.0"E
Chekkanur dam	11°43'39.9"N	77°46'47.9"E
Poolampatti Hydro Powerhouse	11°38'35.3"N	77°45'28.7"E
Kuthiraikalmedu Hydro Electric power station	11°34'31.0" N	77°44'30.7"E
Uratchikottai barrage	11°29'4.88" N	77°42'12.2"E
Bhavani Kattalai barrage	11°23'9.94"N	77°42'53.0"E
Vendipalayam barrage	11°19'56.1"N	77°45'32.0"E
Pasur dam	11°14'33.9"N	77°51'52.1"E
Jedarpalayam dam	11°09'33.8"N	77°52'54.1"E
Mayanoor barrage	10°57'51.6"N	78°14'39.8"E
Mukkombu dam (Upper anicut)	10°53'11.1"N	78°34'46.4"E
Grand anicut	10°49'47.0" N	78°49'6.15"E
Lower anicut	11°08'34.9"N	79°27'2.44"E



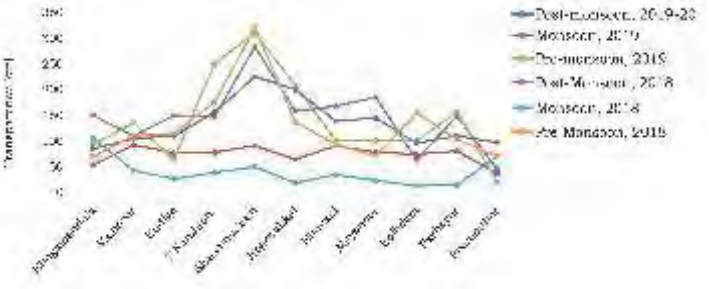
Water depth (cm) of River Cauvery



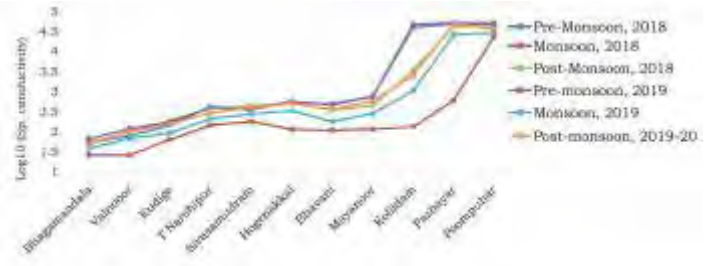
Water dissolved oxygen levels of River Cauvery



Water pH of River Cauvery



Water transparency (cm) of River Cauvery



Specific conductivity (µS/cm) of River Cauvery (Log_{10} values)

macrophytes at this stretch as controlled water discharge supports the growth of macrophytes / filamentous algae.

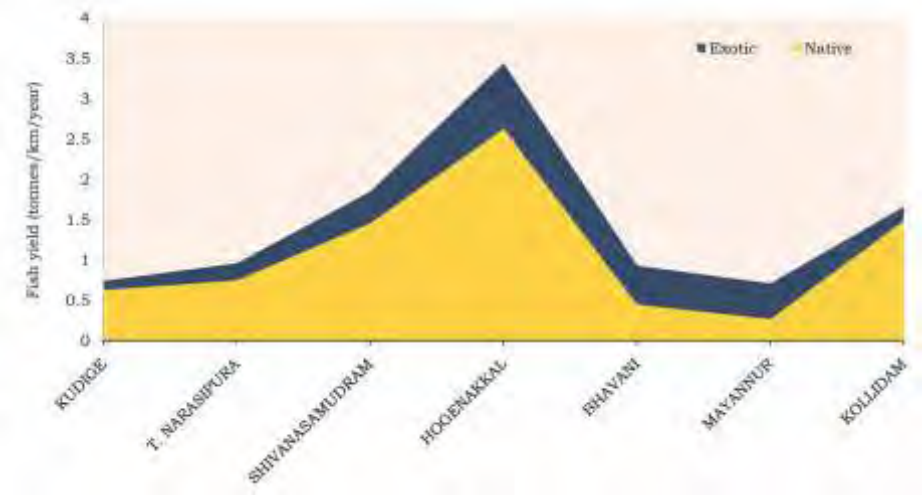
Submerged macrophytes and sluggish flow often contributed to high water transparency at Sivanasamudram (and T. Narshipura on some occasions) during non-monsoon.

Habitat of River Cauvery is now entirely modified and longitudinal connectivity is poor or lost in 190 km stretch from Mayanoor barrage to Kollidam which remains mostly dry as water released from Mettur dam gets totally blocked at Mayanoor barrage and diverted through Mayanur barrage Right canal depriving the main channel of the river, especially during non-monsoon months. Dried and exposed riverbed of this stretch is entirely sandy in nature with some pools here and there. This has a visible impact on water specific conductivity at Kollidam which is significantly higher during pre-monsoon months as compared to other seasons due to lack of freshwater discharge from upstream. This has a visible impact on fish diversity in an estuarine stretch of river Cauvery as observed at Kollidam with the dominance of brackishwater fishes during the pre-monsoon period.

Fish and fisheries

During the surveys, a total of 146 fish species belonging to 52 families were recorded. The highest recorded fish diversity was at Hogenakkal (76 species) owing to the high habitat heterogeneity (falls, cascades, runs, riffles and pools) as it is situated in the transition zone between Deccan Plateau and the plains of Tamil Nadu. Lowest diversity was observed at Bhagamandala (23 species) as this site represented a narrow

hill stream with low habitat heterogeneity. The high fish diversity at Hogenakkal could also be attributed to the presence of fish fauna that generally inhabits the plains such as *Labeo bata, L. boggut, Cirrhinus reba* and *Puntius chola*. During monsoon, the water spread area of Mettur extends to the Hogenakkal Falls and has enabled many fish species inhabiting the plains to colonise the plateau region upstream of Hogenakkal.



Fish yield (tonnes/km/year) at different sampling stations of River Cauvery

The average fish yield during 2019 - 20 was highest at Hogenakkal (3.44 tonnes/km/year) and lowest at Mayannur (0.71 tonnes/km/year) with an average of 1.4 tonnes/km/year for the entire studied stretch of the Cauvery. Though the average landings per day were high at Mayannur (398 kg/day) in winter months, the average fish yield was low due to the reduced fishing activities during peak discharge in monsoon and lower catch rates in peak summer months.

Native fish fauna dominated the fish catch in the upper (riverine) and lower (estuarine) stretch of Cauvery, whereas the scenario was different for stations in the middle stretch (Bhavani and Mayannur) where the exotic fishes contributed 57.4 % to the total riverine fish landings. The stagnant water conditions due to reduced flow and abundance of submerged aquatic vegetation have favoured establishment of exotic fish communities in middle stretch of the river.

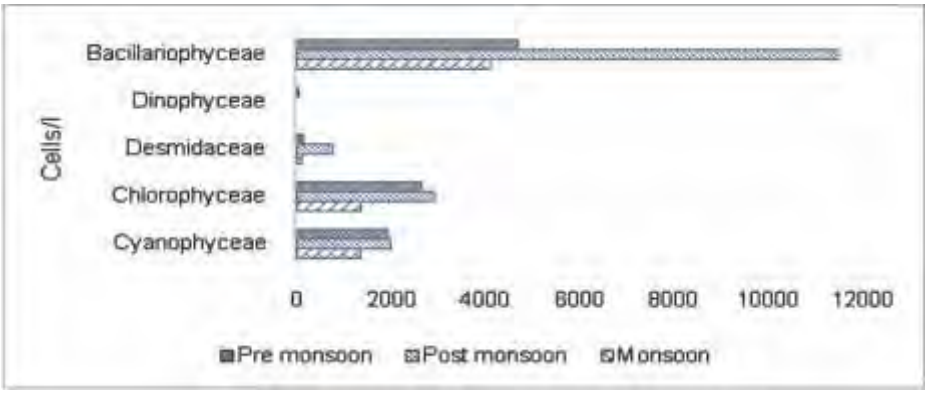
Details of non-native fish species recorded in the River Cauvery

Family	Species	Length range (cm)	Weight range (kg)
Cichlidae	*Oreochromis niloticus*	20.0 – 39.5	0.16 – 1.10
	Oreochromis mossambicus	20.0 – 31.0	0.13 – 0.60
	Amphilophus trimaculatus	11.0 – 20.1	0.02 – 0.17
Claridae	*Clarias gariepinus*	33.5 – 89.0	0.30 – 4.50
Loricariidae	*Pterygoplichthys disjunctivus*	18.0 – 33.0	0.07– 0.25
Cyprinidae	*Cyprinus carpio*	34.0 – 75.0	1.00– 7.00
	Ctenopharyngodon idella	59.0 – 87.0	3.00– 8.00

Non-native fish in River Cauvery

Seven species of non-native fish belonging to four families and three orders were recorded from the river *viz. Oreochromis niloticus, O. mossambicu, Clarias gariepinus, Cyprinus carpio, Ctenopharyngodon idella, Pterygoplichthys disjunctivus* and *Amphilophus trimaculatus*. Of the 11 stations surveyed, non-native fish were not recorded from 4 stations, *viz.* Baghamandala, Valnur, Poompuhar and Pazhayar. Non-native fish were most abundant in the middle stretch of the river with the highest abundance at Mayanur, followed by at Bhavani. Highest contribution (78%) of exotics to the total fish catch was recorded at Mayanur during monsoon season. Among the exotics, *O. niloticus* was the most dominant across all stations which contributed about 71% to the total exotic fish catch, followed by *C. gariepinus* (18%), *O. mossambicus* (4%), *C. carpio* (3%) and *C. idella* (3%).

Abundance of non-native fish at different stations of River Cauvery



Seasonal variations in density of phytoplankton in River Cauvery

Plankton diversity

Seasonal surveys conducted at 11 stations on river Cauvery during 2017-2020 identified sixty-seven genera of phytoplankton belonging to five classes. Phytoplankton density at various stations ranged between 188-2163 cells/l. The seasonal variations in the average density of different phytoplankton classes in the river is given in figure.

Fishing crafts

Fishing crafts of River Cauvery are primitive as the river flow and depth are highly controlled and entirely dependent on water release from dams and barrages on the river. Bamboo made coracle was the major fishing gear which has been slowly replaced with fiber-made coracle. Large wooden fishing boats which are common in many Indian rivers like Ganga or Krishna has not been observed here. Only for a limited period of heavy discharge during monsoon, fishers find it difficult to operate coracles; this fishing craft is good enough for fishing in the river for rest of the year. A total of five types of fishing crafts, *viz.* wooden raft, catamaran, coracle, canoe and fibre boat have been recorded from river Cauvery.

Wooden raft

Catamaran

Fiber coracle

Fiber boat

Distribution of fishing crafts in different stretches of river Cauvery

Local name	VLN	KDG	TNP	SSM	HGL	BVN	MYN	GAN	LAN	KLD	PZR	PMR
Wooden raft									■			
Catamaran											■	
Bamboo coracle	■	■	■	■	■	■	■					
Fiber coracle					■	■	■					
Wooden canoe											■	
Fibre canoe										■	■	
Fibre boat												■

VLN: Valnoor, KDG: Kudige, TNP: T. Narasipura, SSM: Sivanasamudra, HGL: Hogenakkal, BVN: Bhavani, MYN: Mayanoor, GAN: Grand anicut, LAN: Lower anicut, KLD: Kollidam, PZR: Pazhayar, PMR: Poompuhar

Fish-based tourism at Hogenakkal falls

The fish-based tourism model at Hogenakkal falls was studied to understand the role of fish-tourism as an additional livelihood for inland fishers. The fish-based tourism in Hogenakkal employed about 1200 people from two villages of which about 72% belong to the fishing community and 60% are women. The estimated average monthly income of the fisher family in Hogenakkal was Rs. 11800/- which was higher than the income of fisher families in the other stretches of the same river indicating fish-based tourism as a potential additional livelihood option for inland fishers.

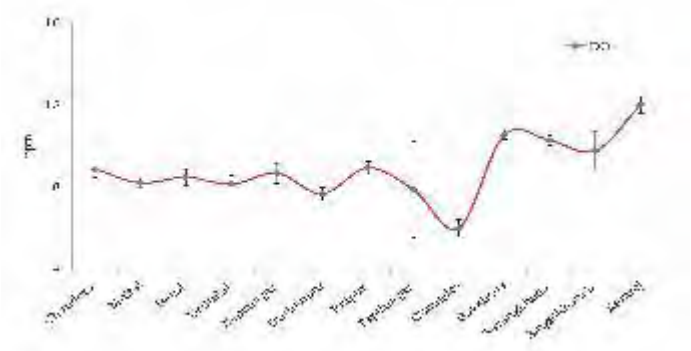
The idea was taken forward as 'Fish-tourism village' (an amalgamation of fish tourism, rural tourism, eco-tourism, and food tourism) for the development of inland fishers in a sustainable way. The concept suggests the adoption of tourism with various activities such as display of local fishes in the aquariums, native fish diversity museums, fish observatories, traditional fish delicacies, promotion of fish as nutri-food, ranching of native fish, and cage culture to ensure a continuous supply of fresh fish besides the water sports activities of the fishing community to address the issues of low income of inland fishers, conservation of aquatic ecosystem and its biodiversity, women empowerment, migration and hidden hunger among the fishers. Possible sources of funds necessary for the successful implementation of this concept were also mentioned in this model.

The concept was awarded third prize in the 6th Indian International Science Festival-2020, jointly organized by the Ministry of Science and Technology, the Ministry of Earth Sciences & Vijnana Bharati (VIBHA) during 22-25 December 2020.

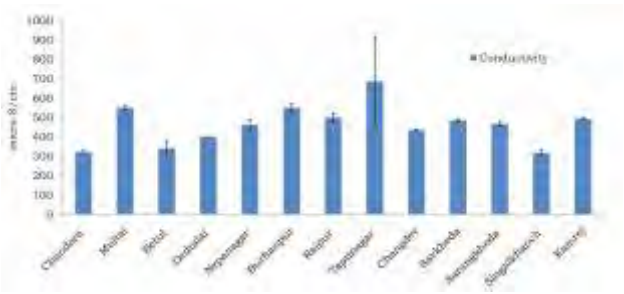
River Tapti

Physico-chemical parameters of water and sediments

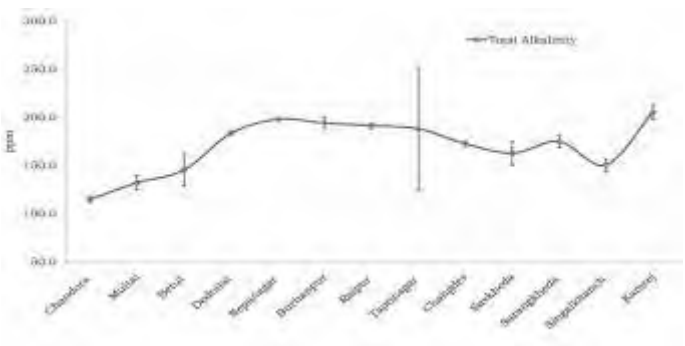
Post-monsoon sampling from all 10 stations were performed during January 2020, which was also coincidentally the last such activity under the project. The river was not dried up in any of the designated stations because of good rain received during the monsoon of 2019. Water transparency was high at all the stations (≥ 80 cm), at Multai water was too less to measure the transparency and at Burhanpur also the Sechi reading could not be taken. Dissolved oxygen didn't vary throughout the upper and middle stretch of river Tapti, but it was recorded to increase in the lower stretch and went up to 12 ppm at Kamrej, the lowermost station. Specific conductivity varied from 300 to 700 µS/cm, lowest (300 µS/cm) was at two dam sites - Chandora and Singalkanch (Ukai), and highest (700 µS/cm) was measured at Taptinagar (Bhusawal) which is under huge anthropogenic stress. Total alkalinity of the stretch ranged between 100 to 200 ppm, but it was above 150 ppm for majority of the stations excepting a few in the lower stretch. Major nutrients, e.g., nitrate and inorganic phosphate, varied widely with higher quantities in middle stretch and gradual reduction on both ends. Burhanpur was the most nutrient-rich station, because



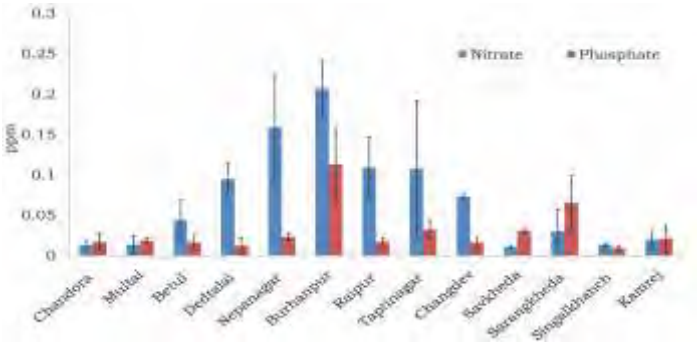
Variations in water dissolved oxygen in river Tapti during post-monsoon 2019-20



Variations in water specific conductivity in river Tapti during post-monsoon 2019-20



Water total alkalinity changes in river Tapti during post-monsoon 2019-20



Variations in water nitrate and phosphate in river Tapti during post-monsoon 2019-20

of all sorts of anthropogenic activities, and the mixing of sewage and dye-industry washings through a point source. Taptinagar was showing higher standard deviations for many parameters because of its highly differentiated habitat systems during post-monsoon.

Based on water quality analysis of pre-monsoon data for consecutive two years - 2018 and 2019 - it was observed that the quality status was almost similar during the two years. An equation of Water Quality Index (WQI) was developed based on standard values of six important water quality parameters [Conductivity (3 mS/cm), pH (8.5), Temperature (30 °C), DO (5 ppm), TA (120 ppm), TH (300 ppm)]. A reference chart is provided to know the water quality status based on WQI. Burhanpur exhibited extremely poor' water quality (WQI=71-90) followed by Bhusawal (Taptinagar) (WQI=52-72), which was categorized in 'poor' water quality. The lower stretch of Tapti had 'good' to marginally 'poor' quality water.

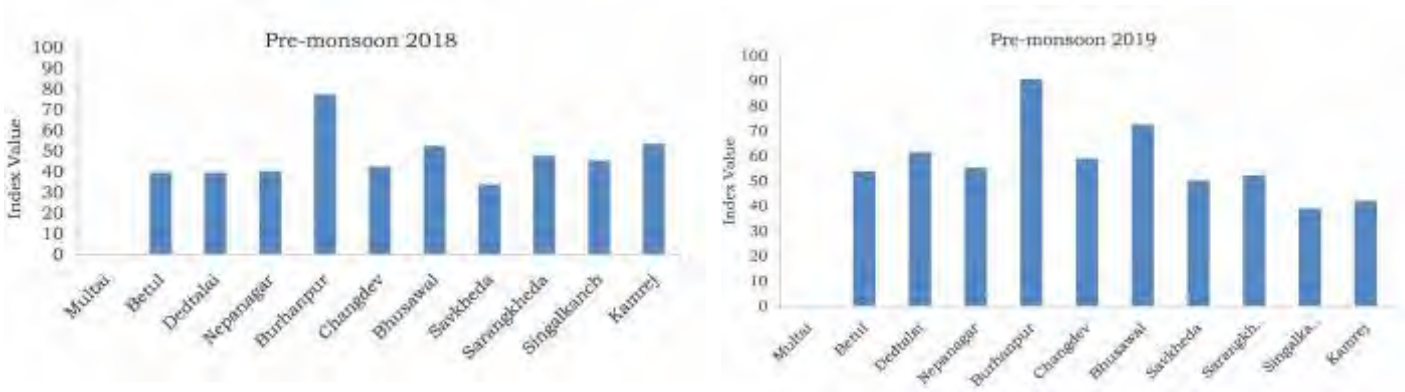
Post-hoc analysis of water quality data from 2018-19 and 2019-20 comparing the seasons was performed. From the analysis, it was revealed that water temperature, specific conductivity and total N were significantly different in pre-monsoon, whereas transparency and sulfate were significantly different during monsoon.

Status of water quality based on WQI for drinking purpose

Water Quality Index	Water Quality
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unfit for drinking

Fish and fisheries

A total of 80 fish species was recorded from the river Tapti during the period of investigation. From the upper stretch, a total of 28 fish species belonging to 11 families were recorded. Betul recorded highest species richness followed by Burhanpur and Nepanagar and the lowest was at Multai



Comparison of water quality indices at different stations of River Tapti during pre-monsoon seasons of the years 2018 and 2019 ($WQI=\Sigma q_n Wn/\Sigma Wn$)

(4) which is an intermittent riverine stretch. Raipur village contributed a huge catch of *Chanda nama* and *Corica soborna* in Burhanpur during the post-monsoon period. The upper and middle stretch of Tapti is dominated by the family Cyprinidae. Other than the dominant species, the major catch of the sampling stretch included *Labeo boggut, Schistura dayi, Amblypharyngodon mola*, and *Pethia ticto*. *Salmostoma bacaila* was uniformly distributed in all the sampling locations except at Multai. Raipur, Burhanpur, Nepanagar and Betul have high species richness followed by Dedtalai and Chandora dam. The exotic fish *Oreochromis mossambicus* was spotted in Chandora dam while the catch composition of Raipur village was dominated by small indigenous fishes.

From the lower stretch, a total of 62 fish species were recorded during 2017-19. More than 80% of the recorded species belong to four orders, *viz*. Cypriniformes (27 species), Siluriformes (12 species), Perciformes (12 species) and Synbranchiformes (4 species). Cyprinidae forms the family with a maximum number of species followed by the catfish family Bagridae. About 70% of the fish species were distributed in six families, *viz*. Cyprinidae (42%), Bagridae (8%), Ambassidae (5%), Channidae (5%), Mastacembelidae (5%) and Siluridae (5%). The species diversity and the catch was less along the stretch during premonsoon and monsoon season due to less water during the former and flood conditions during the later season. Exotic fish such as *Oreochromis niloticus, Hypophthalmicthys molitrix* and *Pangasius hypophthalmus* were also recorded from the lower stretches of the river. Among the exotics, *Oreochromis niloticus* was observed in most of the sampling sites.

Carps formed the major share of the catch at all the sampling stations throughout the seasons followed by catfishes. Spiny eels under the order Synbranchiformes, especially *Mastacembelus armatus*, also formed a major fishery contributing most to the subsistence and other small-scale fishery along the stretch. Under the Clupeids *Corica soborna* and *Tenualosa ilisha* formed important fishery. The average catch (kg/km) of river stretch was 10.9 during the pre-monsoon season, 13.2 during monsoon season, and 7.1 during post-monsoon season. A tradition of 'smoking' of fresh fish was seen and local people said that process increases the market value of those fishes.

Biological parameters of commercially important species

A total of 372 specimens pertaining to 8 species (*Cirrhinus reba, Labeo boggut, Labeo calbasu, Tor tor, Systomus sarana, Ompok bimaculatus, Sperata seenghala, Xenentodon cancila*) under 4 families were taken into consideration for the established length-weight relationships and estimation of length-frequency

Station-wise one-way ANOVA for different water quality parameters, post-hoc analysis (pre-monsoon, 2018-19 and 2019-20); P=0.05

Stations	Sp. Cond. (µS/cm)	Total N (mg/l)	Total P (mg/l)	Phosphate (mg/l)	Sulfate (mg/l)
Multai	325^{a}	0.87^{ab}	0.381^{a}	0.080^{a}	0.005^{a}
Betul	395^{a}	0.62^{ab}	0.276^{a}	0.048^{a}	0.002^{a}
Dedtalai	570^{ab}	1.04^{ab}	0.3745^{a}	0.109^{a}	0.001^{a}
Nepanagar	430^{a}	0.62^{ab}	0.526^{a}	0.040^{a}	0.002^{a}
Burhanpur	2660^{c}	3.29^{b}	2.474^{b}	1.155^{b}	0.015^{b}
Changdev	470^{a}	0.50^{a}	0.409^{a}	0.036^{a}	0.004^{a}
Bhusawal	975^{b}	0.74^{ab}	0.285^{a}	0.073^{a}	0.003^{a}
Savkheda	305^{a}	1.29^{ab}	0.252^{a}	0.043^{a}	0.003^{a}
Sarangkheda	435^{a}	0.94^{ab}	0.138^{a}	0.042^{a}	0.004^{a}
Singalkanch	330^{a}	1.06^{ab}	0.293^{a}	0.048^{a}	0.002^{a}
Kamrej	375^{a}	0.69^{ab}	0.221^{a}	0.043^{a}	0.003^{a}

Note: In the superscript, same alphabet means values are not significantly different

Pool and riffle habitat system in Tapti at Taptinagar during post-monsoon 2019-20

'Smoked' fish at Chandora dam during post-monsoon 2019-20

Chandora dam upstream side during post-monsoon 2019-20

Fishing activity in Tapti at Kamrej using 'Maha-jaal' (drag net) during post-monsoon 2019-20

Fish catch at various stations in River Tapti

distribution in the middle and lower stretches of the river. The body depth (BD) ranged from 1.0 to 9.5 cm (3.65±0.84) with the lowest for *X. cancila* and highest for *S. sarana*, respectively. The estimated LWRs for all the fish species were found highly significant ($p<0.005$) with the values of coefficient of determination (r^2) ranging from 0.970 (*O. bimaculatus*) to 0.996 (both for *L. calbasu* and *X. cancila*). The values of allometric coefficient b showed that all the species exhibited isometric and positive allometric growth patterns and ranged from 2.97 (*T. tor*) to 3.29 (*C. reba*).

Plankton assemblages

Analysis of plankton samples revealed that Cyanophyceae dominated in terms of abundance (38% of total phytoplankton) and Bacillariophyceae in diversity (50 species) in the river. Among Cyanophyceae, *Oscillatoria* spp. accounted major percentage of the total blue-green algae assemblage across the seasons. Significant changes have been recorded in terms of phytoplankton species richness, with maximum species richness during the low water period (116 species), and minimum (77 species) during the high water (monsoon) period. Mean seasonal abundance of phytoplankton revealed a peak in post-monsoon

Station-wise number of fish species recorded in each season

Season-wise average catch (kg/km) at different river stretches

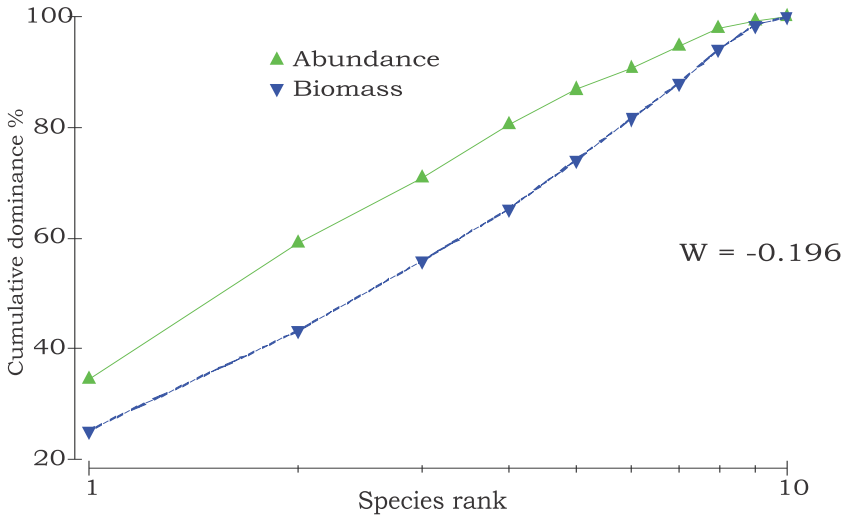
Tor tor collected from River Tapti

Xenentodon cancila collected from River Tapti

(18,167±11,081/µl), and the lowest in monsoon season (2,307±1,609/µl). The zooplankton abundance ranged from 77–3,532 nos./l, with maximum and minimum recorded at Burhanpur (middle stretch) and Surat (lower stretch) respectively. Out of 25 species of Rotifera, *Brachionus fulcatus, B. diversicornis, B. caudatus, Keretella tropica, K. cochlearis, Lecane* sp., *Haxarthra* sp., and *Filinia* sp. were perennially present in the river, which highlighted the broad thermal tolerance of those species. Shannon diversity (H') and Margalef richness index (d') showed a peak in post-monsoon (7.22 and 2.37) and lowest in monsoon (2.77 and 1.61) for the phytoplankton and zooplankton, respectively. Analysis of abundance biomass curve (ABC) reflected that the test statistic; W= – 0.196, represents the abundance dominates over biomass, indicating that the system was moderately impacted by allochthonous sources during low water period as compared to high water period. The calculation of Lamperelli (2004) trophic state index value revealed that all the stretches *viz.* Upper (36.21±4.21), middle (37.65±5.06), and lower (40.33±11) are in a mesotrophic state.

Status of fish health

Health of the riverine fish was investigated which recorded the presence of parasites at four out of total of nine sampling sites. The level of infection was low to moderate. The stations in the middle stretch at which fishes were found positive for parasitic load were: Dedtalai (Burhanpur), Raipur and Changdev (Bhusaval) and Nepanagar (Burhanpur). During the investigation, *Puntius* spp. and *P. ranga* were found infected with 'Blackspot', while *Wallago attu* with 'diplostomiasis' caused by *Isoparorchis hypselobegri*. The recurrence of *Posthodiplostomum* sp., a causative agent for "blackspot" disease in *Parambasis ranga* at Dedtalai, Nepanagar, Changdev and Raipur was observed during



Abundance-biomass curve of plankton in River Tapti

winter sampling. The annual prevalences of *Posthodiplostomum* sp. in *P. ranga* and *Puntius* spp. were 10% and 5.2% respectively, while *Isoparorchis hypselobegri* prevalence was 5.88%.

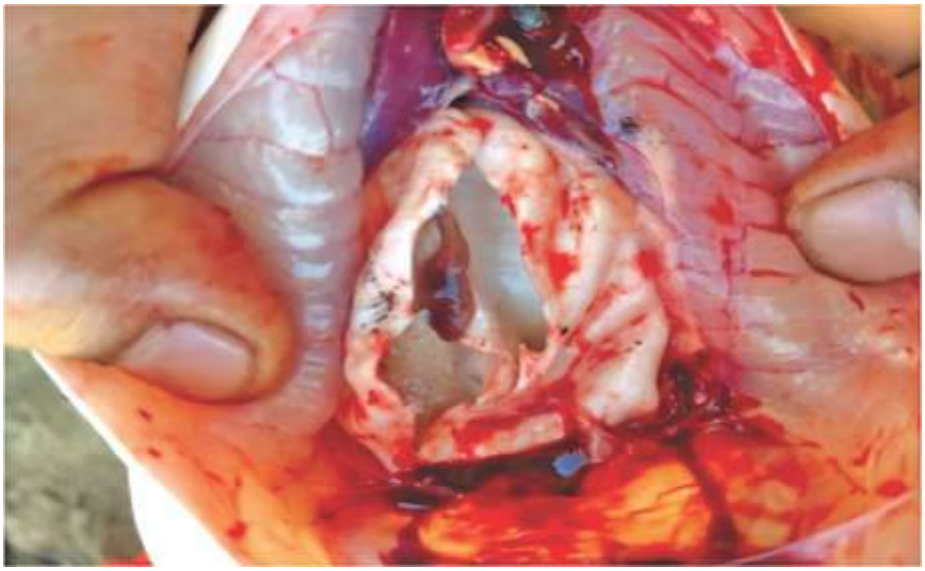
Black spot in *Puntius* spp.

Black spot in *P. ranga*

River Chaliyar

Physico-chemical parameters of water

The water of Chaliyar river was neutral to slightly alkaline with pH 6.2-8.35 and sufficient dissolved oxygen (6.23-8.34 mg/l). Cholamala and Arrepatta (upper stretch) had highest dissolved oxygen and low temperature of water compared to other sampling stations. Lower temperature ranges, recorded at upper reaches, could be associated with altitudinal and latitudinal differences. Depth and transparency were almost synonymous in upper stretches; however, turbidity was very high in the lower stretch, particularly at Areecode station. Conductivity (70-33859 µS/cm), total dissolved solids (47-22685 mg/l), alkalinity (30-90 mg/l) and total hardness (37-3775 mg/l), chlorinity (3-538 mg/l) increased downstream with values several folds higher at estuarine zone (Azhinjilam and Feroke). The higher values at lower stretches are due to the tidal influence of the Arabian sea. Silicate content varied between 1.5 to 13.65 mg/l, however the contents of nutrients, like nitrate (0.01-0.44 mg/l) and phosphate (0.013-0.12 mg/l) were extremely low. With reference to the fisheries and aquaculture perspective also, all the parameters were conducive; however, alkalinity and hardness values were low which indicates the low productivity of the river.



Isoparochis hypselobegri in swim bladder of *Wallago attu*

Plankton diversity

A total of 38 genera of phytoplankton belonging to 9 algal groups were recorded from eight sampling stations. The total plankton diversity ranged from 20-11220 units/l, of which 98% is contributed by phytoplankton. The plankton diversity studies in the river across all stations over three years of sampling period indicated dominance of Desmidaceae (33.43%), followed by Chlorophyceae (26.97%) indicating a

Water quality parameters of river Chaliyar during post-monsoon 2019-2020

Parameters	Value (range)
Depth (m)	0.5-8.0
Transparency (m)	0.3-0.91
Water Temperature (°C)	21.1-30.5
pH	6.20 to 8.35
Dissolved oxygen (DO) (mg/l)	6.23 to 8.34
Sp. Conductivity (µS/cm)	70-33859
TDS (mg/l)	47-22685
Total alkalinity (mg/l)	30-90
Total hardness (mg/l)	37-3775
Chlorinity (mg/l)	3-538
Nitrate-N (mg/l)	0.01-0.44
Phosphate-P (mg/l)	0.01-0.12
Silicate (mg/l)	1.5 - 13.65

productive environment for fish survival.

Declining status of fish diversity in post-flood period

A comparative analysis of fish diversity in river Chaliyar in a post and pre-flood scenario indicated a loss in diversity in the post-flood period. The post-flood period exhibited the absence of orders such as Siluriformes, Synbranchiformes, Engrauliformes, and Anabantiformes.

Fishing crafts and gears

Four main gears, namely, gill nets, cast nets, hook and line and lift nets are used for fishing in river Chaliyar. Four-boat lift nets are used in the lower stretch of the river. Ring nets are specialized gears for crab fishing. Dug-out canoes, plank-built boats and fibre boats are the fishing crafts used in river Chaliyar.

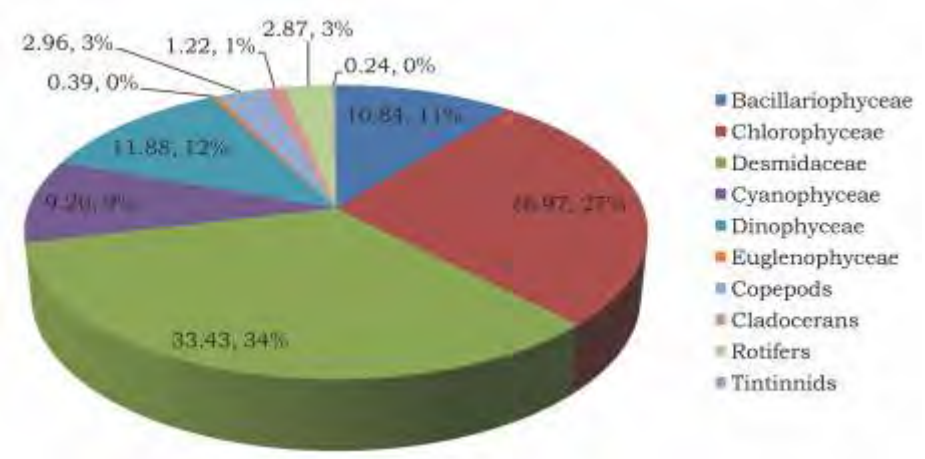
River Siang

Water quality

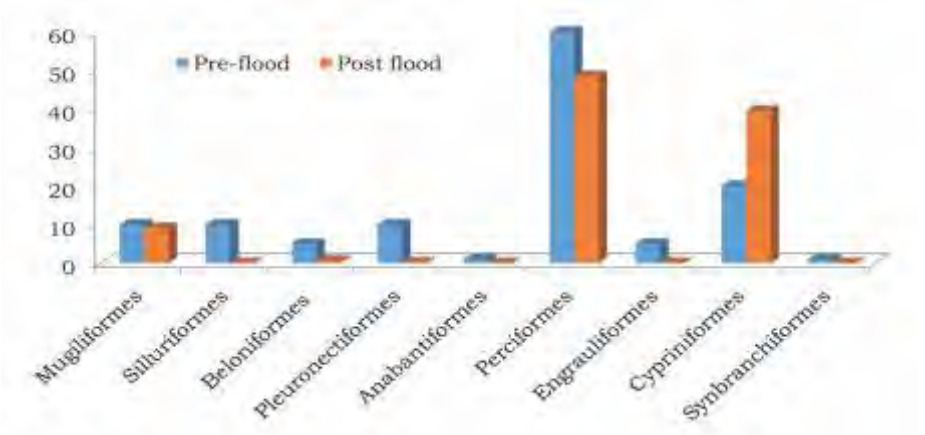
Water quality at six different stations of river Siang *viz.* Puging and Yingkiong (upper stretch), Boleng and Komsing (middle stretch), Pasighat and Oiramghat (lower stretch) were analyzed and are presented in table.

Fish diversity

Sampling was carried out



Plankton diversity of the River Chaliyar



Fish diversity in River Chaliyar

across six stations in Arunachal Pradesh and Assam. A total of 77 fish species under 14 families has been recorded during the survey with Cyprinids being the most dominant group contributing 50.65% of the total number of species reported.

The highest number of species was reported from Oiramghat (65 species) followed by Pasighat (53 species) along the lower stretch of the river. A total of 24 species was reported from Puging and 31 species from Yingkiong from the upper stretch, with 36 species from Boleng and 27 species of fish were reported from Komsing from the middle stretch.

Plankton assemblage

Out of 84 species (58 genera) of phytoplankton recorded, 43 species were diatoms and accounted for 61% of the total phytoplankton assemblage. Species *Synedra ulna*, *Nitzschia* sp. and *Fragilaria capucina* were conspicuous in all the stations. Phytoplankton species composition similarity study revealed maximum similarity (60%) between the stations Komsing and Oiramghat (middle and lower stretch) which indicated variations in community compositions compared to the other stations/ stretches. However, k–dominance curve portrayed that the species abundance and diversity were similar as

A view of River Siang

Cast net

Ring net for crab fishing

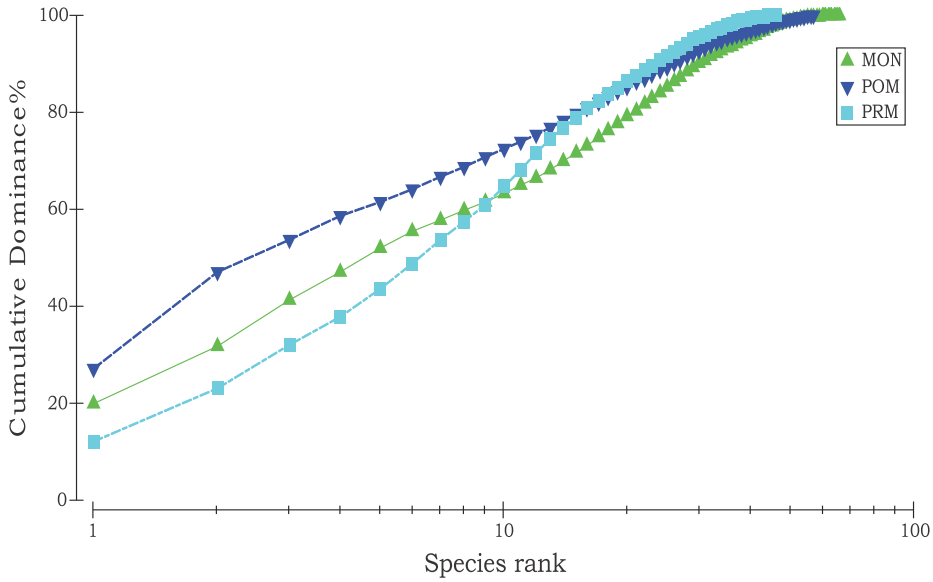
Dug-out boat

Fiber boat

Water quality parameters (January-February 2020)

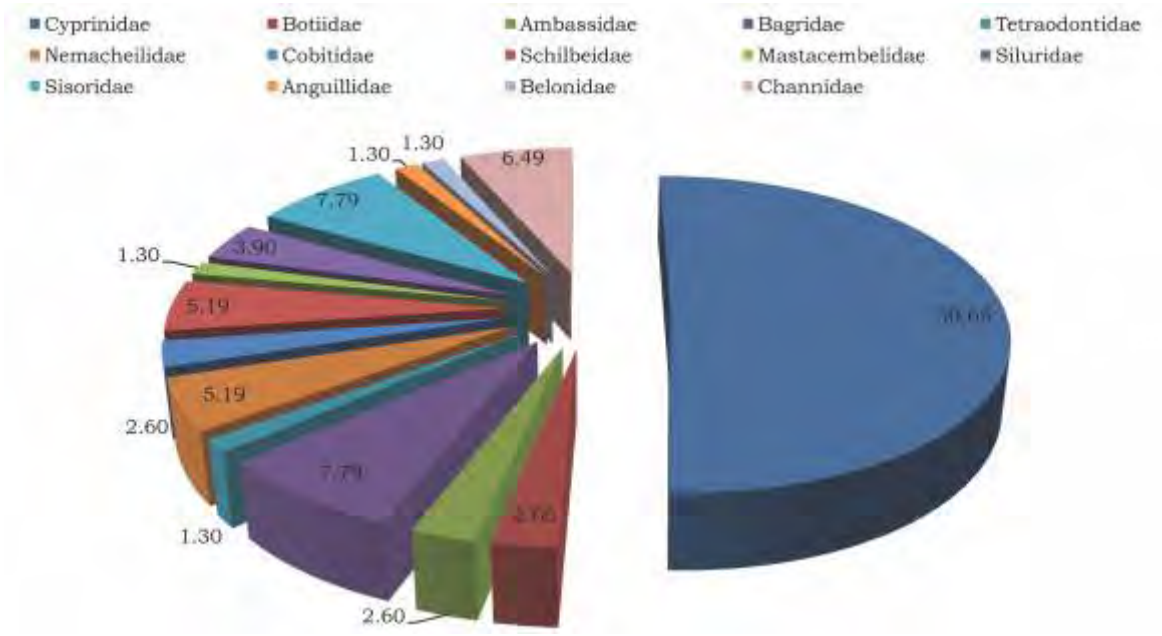
Station	Puging	Yigkiong	Boleng	Komsing	Pasighat	Oiramghat
Water temp (°C)	13.40	12.7	12.73	12.2	14.2	17
Transparency (cm)	67	60	94	62	52	48
Sp. Conductivity (µS/cm)	349	431	305	364	433	499
pH	7.44	7.25	6.68	6.73	6.92	6.89
DO (mg/l)	10.26	10.45	10.57	9.73	10.49	9.55
Free CO_2 (mg/l)	0.8	0.8	0.8	0.6	0.5	0.8
Total Alkalinity (mg/l)	114	110	120	122	92	108
Salinity (ppt)	0.08	0.13	0.1	0.12	0.14	0.15
ORP (mV)	148.1	120.3	154.9	135.8	139.9	86.8
TDS (mg/l)	223	279	199	236	281	323

Tor putitora collected from River Siang



Cumulative dominance (k-dominance curve) of phytoplankton in River Siang

the curves overlap on each other across seasons. Seasonal diversity of H′ calculated maximum in pre-monsoon (2.37±0.27), and lowest during monsoon (1.86±0.46). H′ and d′ of zooplankton also exhibited a similar pattern with a maximum during pre-monsoon season. Pielou's evenness index stated the even distribution of phytoplankton across the stations with the calculated value of 0.95±0.02. The quantitative spectrum of zooplankton ranged from 12 to 135 nos./l, which was primarily dominated by groups, viz. Crustacean nauplii (54%), Cladocera (24%), insect larvae (12%) and Copepoda (8%).



Family-wise percentage contribution to the total number of fish species

Project title : Exploration of canal resources of Punjab and Sundarbans (West Bengal) for fisheries development

Project Code : REF/17-20/08
Duration : 2017-2020
Scientific personnel : A. Sinha (PI), A. Roy, P. Gogoi, M.H. Ramteke, Manas H.M. (up to 29.09.2017), T. Tayung
Associates: A. Mitra, S. Mondal, A. Sengupta

Culture of Indian major carp in canals of Sundarbans

Based on the water quality, soil quality, and plankton availability, Kostala canal in Fraserganj, Sundarbans was selected for the culture of Indian major carps to enhance the fish production and productivity of canals for improvement of livelihood and socio-economic status of the local stakeholders.

Fish culture in Kostala canal

The Kostala canal is located in Fraserganj (21°34'46.1"N; 88°16'21.1"E), Bakkhali, Sundarbans. The total length and width of the canal are 350 m and 50 m (approximately 1.75 hectares) respectively. The canal was stocked with Indian major carps i.e. *Labeo catla* (avg. wt. 8.45 ± 0.61 g), *Labeo rohita* (avg. wt. 13 ± 0.53 g) and *Cirrhinus mrigala* (avg. wt. 7.09 ± 0.21 g) at the ratio 40: 30: 30 respectively @ 2nos. /m^2. No supplementary feed was provided during the culture period. The water quality parameters and growth performance of fish were monitored regularly. After 180 days of culture, the highest growth performance was recorded for *Labeo catla* (188.98 ± 11.94 g), followed by *Labeo rohita* (159.93 ± 8.07 g) and *Cirrhinus mrigala* (153.07 ± 7.01 g).

Water quality parameters of Kostala canal

Parameters	Mean value	Range
Depth (cm)	236.05 ± 27.12	167 - 310
Air temperature (°C)	30.56 ± 1.02	27.4 – 31.9
Water temperature (°C)	29.15 ± 1.45	24.8 – 31.3
Transparency (cm)	86.92 ± 8.55	68 - 107
Specific conductivity (mS/cm)	1.08 ± 0.09	0.816-1.315
TDS (mg/l)	760.87 ± 59.95	571 - 896
pH	7.62 ± 0.12	7.4 – 7.6
DO (mg/l)	5.15 ± 0.49	3.8 – 6.4
Free CO_2 (mg/l)	4.37 ± 1.17	2 - 7
Total Alkalinity (mg/l)	86.17 ± 2.21	81 - 92
Salinity (ppt)	0.43 ± 0.04	0.35 – 0.52
Total hardness (mg/l)	184.33 ± 26.37	132 - 250
Total N (mg/l)	0.47 ± 0.18	0.043 – 0.854
Nitrate (mg/l)	0.01 ± 0.004	0.003 – 0.0218
Total phosphate (mg/l)	0.51 ± 0.08	0.24 – 0.712
Phosphate - P (mg/l)	0.11 ± 0.02	0.06 – 0.199
Silicate (mg/l)	8.62 ± 2.82	2.75 – 15.58
Sulphate (mg/l)	26.41 ± 15.19	0.074 – 58.67
Ca^{2+} (mg/l)	16.57 ± 3.55	9.62 – 28.06
Mg^{2+}(mg/l)	34.30 ± 4.20	25.91 – 50.38

Social issues and options

The canals in Indian Sundarbans were excavated for freshwater resource by erection/ setting up of sluice gate in the connecting channel of the parent river. Human settlement are predominant in the banks of these canals. The unregulated fishing activity primarily hinders natural fishery in these canals.

A perception-based study was conducted to identify the people's attitude and perception regarding canal fisheries development in the area. Both beneficiaries and Non-beneficiaries were taken as respondents. It was found that the perception towards canal fisheries development differs between the beneficiaries and non-beneficiaries. Majority of the beneficiaries (86%) and non-beneficiaries (56%) perceive that initiative of canal fisheries development will enhance the production and help in income generation, but canal fisheries development will create conflict between fisheries and aquaculture. The non–beneficiaries believe that it will destruct the indigenous fish stock, though 60% of the beneficiaries disagreed to that matter. Most of the non-beneficiaries also perceive that net-barrier culture-based canal fisheries will restrict the water movement and will also cause loss of livelihood. The beneficiaries (56%) also

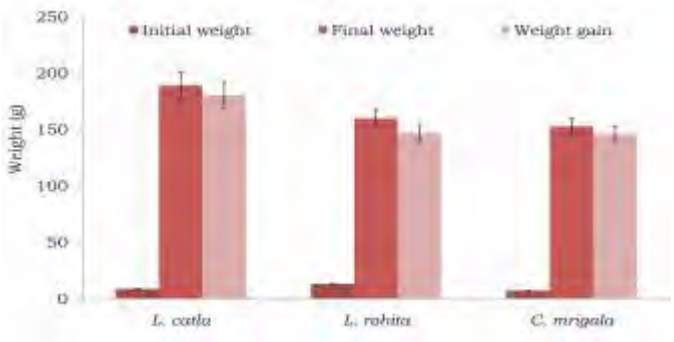
Sediment quality parameters of Kostala canal

Parameters	Mean value
Sand (%)	43.33 ± 0.667
Silt (%)	42.33 ± 2.028
Clay (%)	14.00 ± 2.887
pH	7.10 ± 0.058
Specific conductivity (mS/cm)	1.91 ± 0.098
Available nitrogen (mg/100g)	19.03 ± 1.049
Available P (as P_2O_5 mg/100g)	4.00 ± 0.488
Organic carbon (%)	1.87 ± 0.012
Free $CaCO_3$ (%)	2.10 ± 0.231

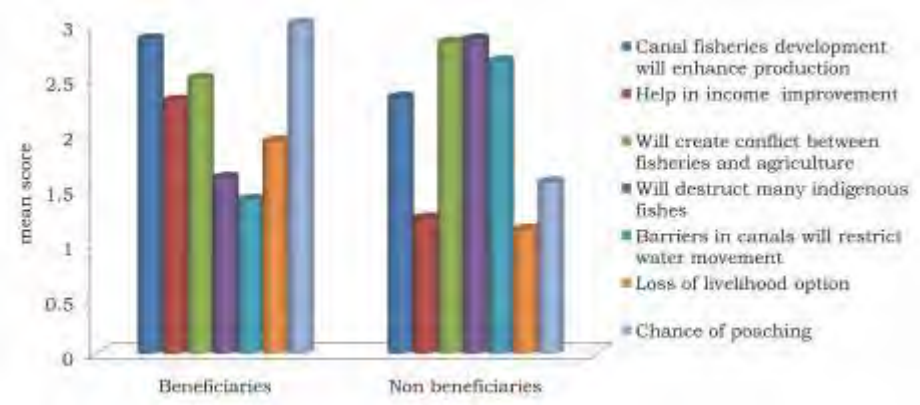
expressed their view that the chance of poaching is very high in canal fisheries.

ICAR-CIFRI conducted a PRA which identified that awareness and sensitization about canal fisheries may attract the local populace towards canal fisheries. People also perceive that the group approach may help to amplify community participation in canal fisheries development. Moreover, better linkages and improved coordination among research institutes, State departments, village Panchayats, SHGs, and fishers will support canal fisheries development in that area. More field demonstrations, training and capacity-building programmes and extension will help in the diffusion of the knowledge and practice of canal fisheries.

a. Kostala canal, Fraserganj, Sundarbans; b. Stocking of IMC fingerlings; c. fish harvest from the canal



Growth performance of stocked fishes in Kostala

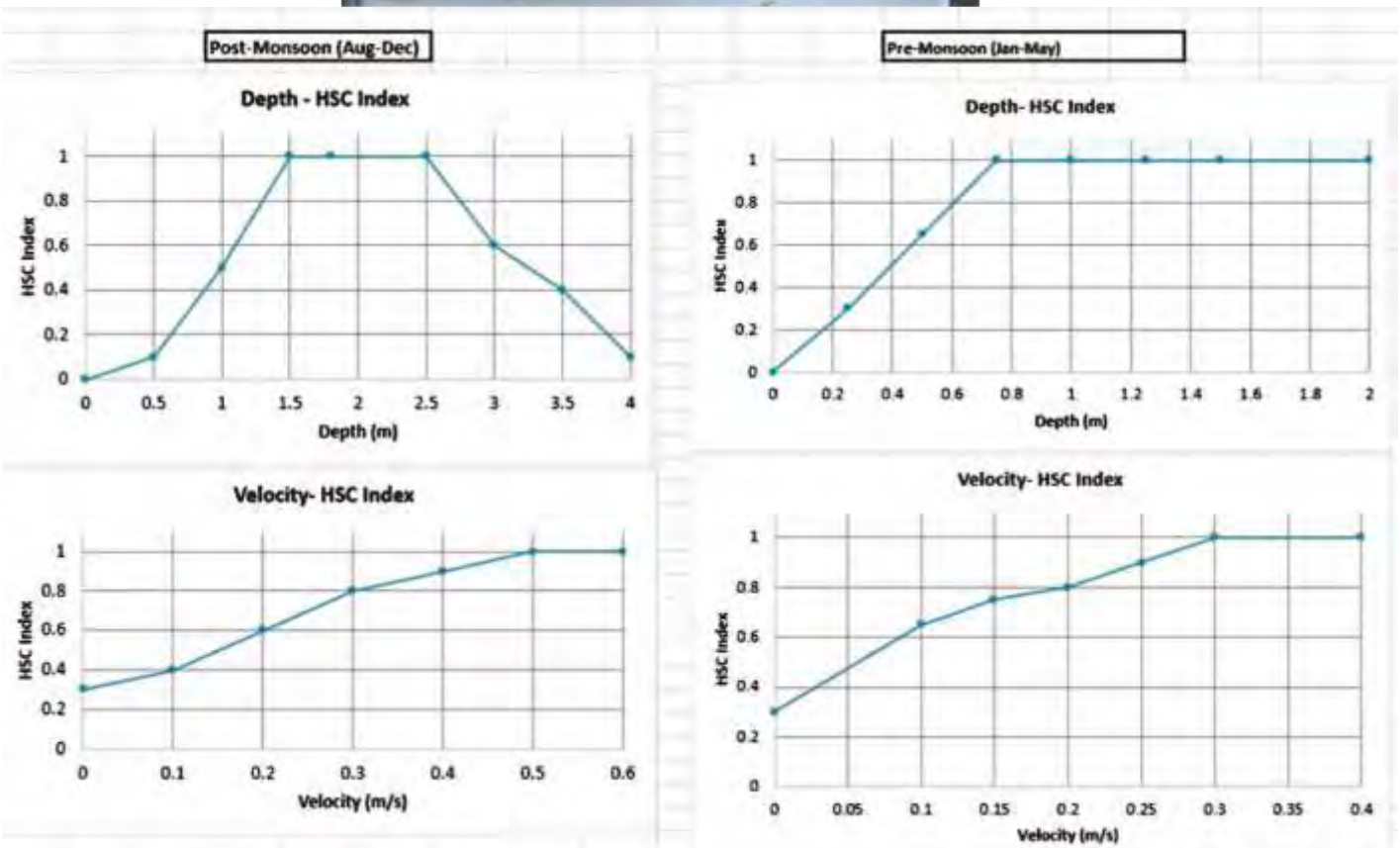


Distribution of the mean score of perception of the beneficiaries and non-beneficiaries on canal fisheries development

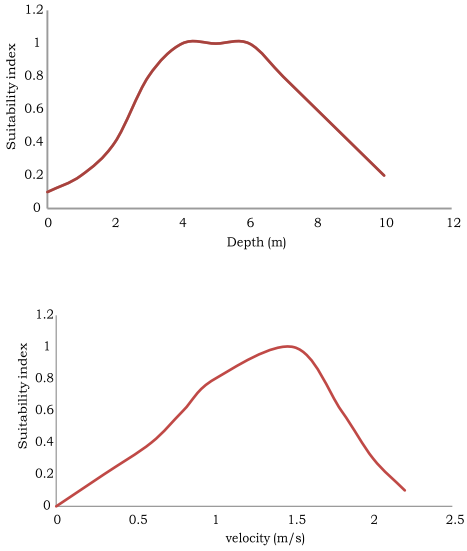
Project title: Investigation on environmental flows in river Kathajodi, Siang and Tamas, a tributary of river Ganga

Project code : REF/17-20/09
Duration : 2017-20
Scientific personnel : A.K. Sahoo (PI), B.K. Bhattacharjya (up to 30.09.2018), S. K. Das, D. N. Jha, Roshith C. M., R. K. Raman (up to 30.11.2019), S. K. Koushlesh, S. Sharma, S.C.S. Das, S. Borah
Associates : A. Sengupta, A. R. Chowdhury, D. Saha

Globally, the concept of environmental flows has become an indispensable component of river basin management for protecting the aquatic ecosystem including the habitat as well as the organisms including fish species. As a major case study, the river Kathajodi in the Mahanadi delta was considered. During the period a total of 96 fish species belonging to 60 genera and 36 families were recorded. About 53 % of the diversity is represented by seven families, viz., Cyprinidae (19 species), Clupeidae (7 species), Bagridae (6 species), Mugilidae (5 species), Engraulidae (4 species), Schilbeidae (4 species) and Ambassidae (4 species). The highest fish diversity (53 species) was recorded at Nuagarh (towards the estuarine mouth) due to the dominance of marine migrants. The diversity



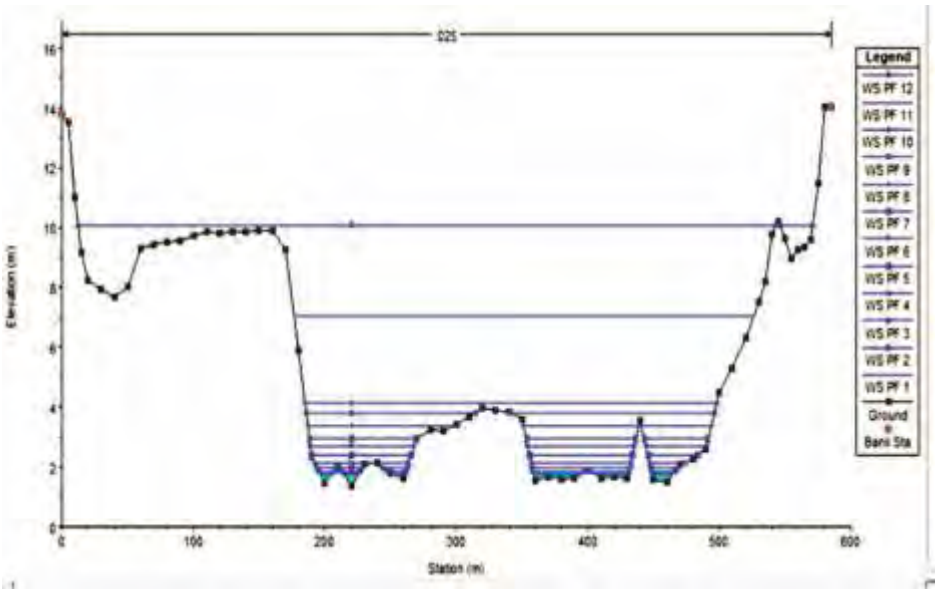
Cirrhinus reba and the HSC plotted for post-monsoon and pre-monsoon season



Tenualosa ilisha, and the HSC plot in terms of depth and velocity

recorded at Naraj and Galadhari were 36 and 38 species respectively. In all the stations, *Cirrhinus reba* majorly dominated in the catch and also contributes to the major important commercial fisheries. Habitat suitability curve (HSC) which is an important criterion for estimating e-flows based on the habitat requirements of the fish species was developed for two important fish species, *viz. C. reba* and *Tenualosa ilisha* in terms of depth and velocity. HSC curve for the *C. reba* was estimated for both pre-monsoon and post-monsoon. Similarly, in the estuarine zone, *Tenualosa ilisha* was found to be the most important migratory fish species. However, due to siltation and reduced water discharge, Hilsa presently has restricted to 5-10 km mouth of the estuary, particularly during monsoon. E-flows was estimated based on the habitat suitability curve (HSC). HSC was plotted in terms of their depth and velocity requirement for the hilsa.

Habitat analysis methods establish flow-habitat relationships that signify the quality and quantity of habitat available for different life stages of aquatic species under various flow conditions. Based on the HSC, the physical habitat simulation (PHABSIM) was used. A study of environmental flows for the selected stretch revealed that a minimum discharge of 750 - 800 cusecs during lean season, 2800 - 3000 cusecs during pre-monsoon, and 3850 - 4000 cusecs during post-monsoon would be ideal for *C. reba*. This study for the first time estimates the HSC of Hilsa and the out comes of the study would support in developing fisheries management plan through the concerned Departments including the water resources Departments, Government of India.



River cross-section used for HECRAS model used for *C. reba*

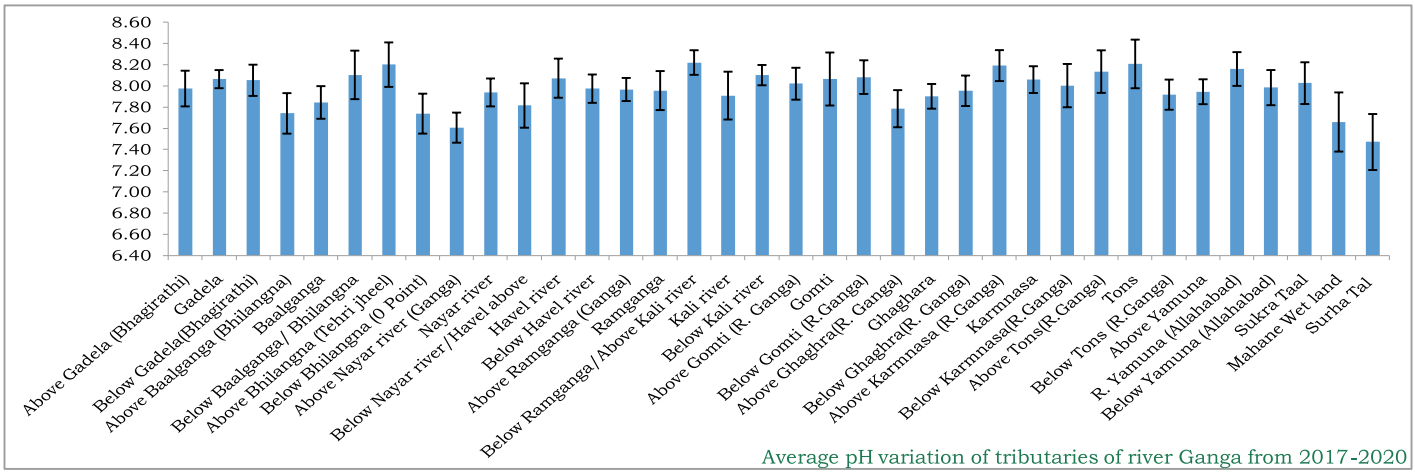
Project title : Impact of major tributaries and wetlands on biodiversity and ecological function of River Ganga

Project code : REF/17-20/10
Duration : 2017 - 2020
Scientific personnel : R.S. Shrivastava (PI up to 9.12.2019), D. N. Jha (PI from 10.12.2019) A. Alam (up to 30.09.2018), S.C.S. Das, J. Kumar (up to 30.09.2018), V. R Thakur, R. Das, M. Gupta (from 01.10.2018), V. Kumar (from 01.10.2018)
Associates: K. Srivastava, V. Kumar

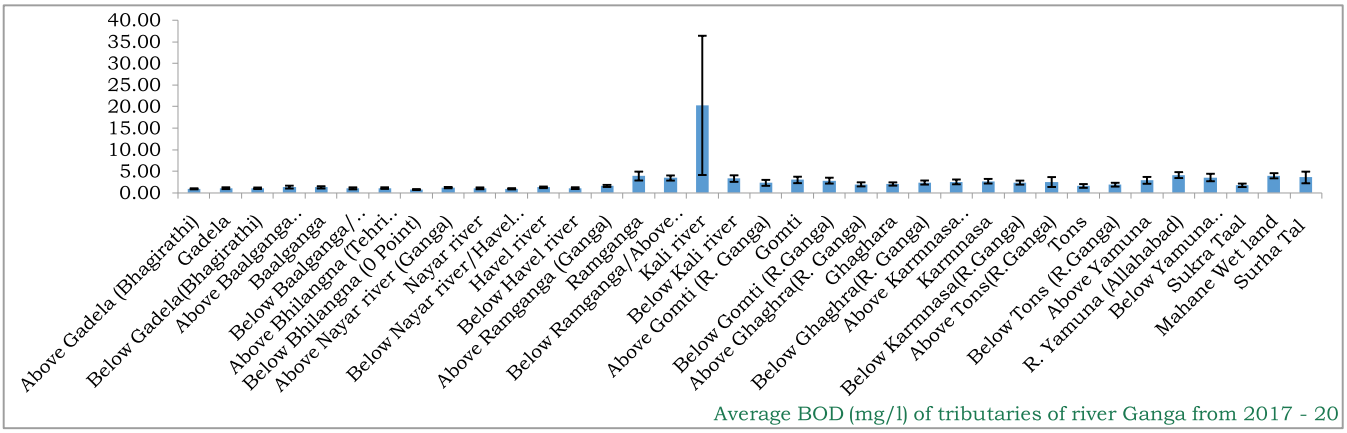
Twelve tributaries and three wetlands connected with the river Ganga along with the main channel had been selected for the study. The upper stretch of river Ganga is comprised of five tributaries, namely, Gadela, Bhilangna, Alaknanda, Nayar and Havel. Middle stretch is comprised of seven tributaries, namely, Ramganga, Kali, Gomti, Ghaghara, Karmnasha, Tons and Yamuna and three wetlands, viz., Sukar Taal, Mahane wetland and Surha Taal. Quarterly samplings (pre-monsoon in April, monsoon in July, post-monsoon in October, and winter in January) have been done to investigate the major water and sediment parameters.

Physico-chemical parameters of water

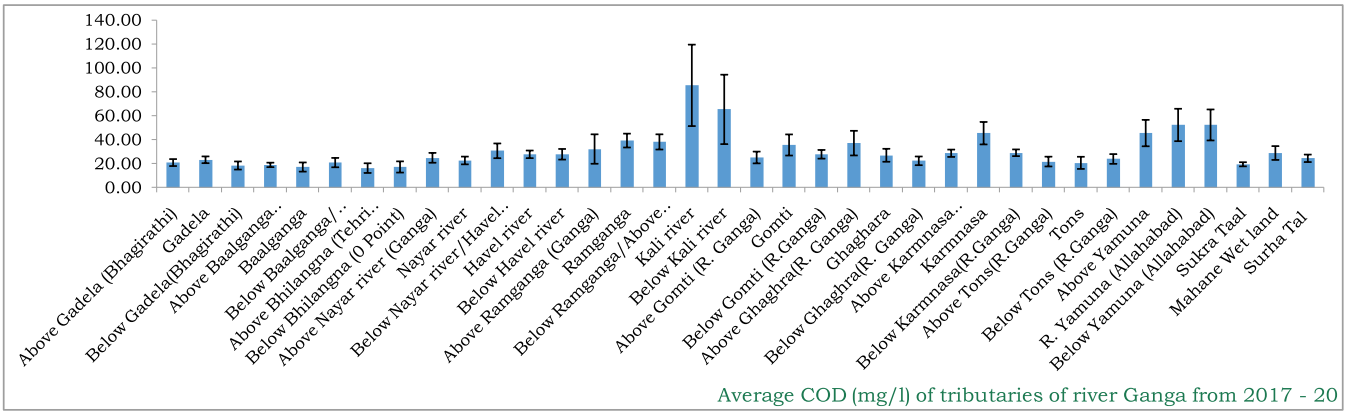
The average water temperature of all the sampling sites ranged between 14.47±0.96 ^{o}C and 28.77±1.93 ^{o}C with minimum average temperature recorded above Balganga and maximum at below Tons. Water flow of upper stretch was high except at Tehri jheel due to construction of dam, while flow of middle stretch was comparatively low. The highest velocity (2.36±0.89 m/sec) was recorded from above Balganga. Water of all the wetlands was almost stagnant. pH of all the sampling sites was neutral to alkaline. The average pH value ranged from 7.47±0.79 to 8.22±0.12. Slightly alkaline pH was recorded during the pre-monsoon as compared to monsoon and post-monsoon seasons. Tributaries of the upper stretch along with the main channel were observed transparent up to the bottom. Average DO of upper stretch was found comparatively higher than the lower stretch and ranged between 4.75-9.15 mg/l and found minimum in Surha taal and maximum above Gadela. Average maximum free CO_2 (8.46±3.68 mg/l) was recorded from the Surhatal and minimum (0.22±0.21 mg/l) was observed from Yamuna. Average total alkalinity ranged from 25.25-195.75 mg/l and found minimum below Bhilangna and maximum in Mahane wetland. The amount of chloride was maximum 76.60±10.96 mg/l in Yamuna while minimum (6.56±0.78 mg/l) from Balganga. Water flow rate was comparatively higher in sampling points of



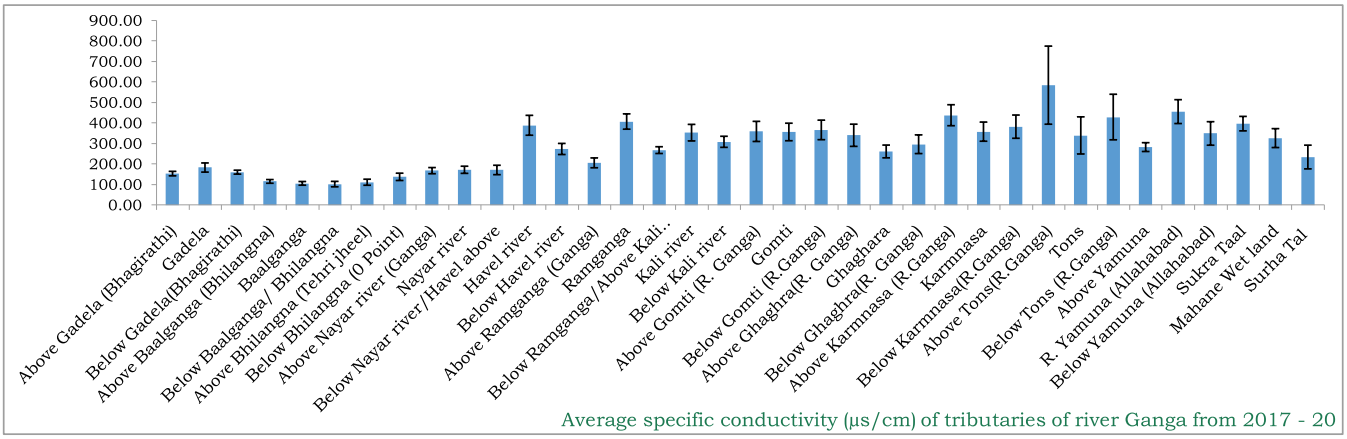
Average pH variation of tributaries of river Ganga from 2017-2020



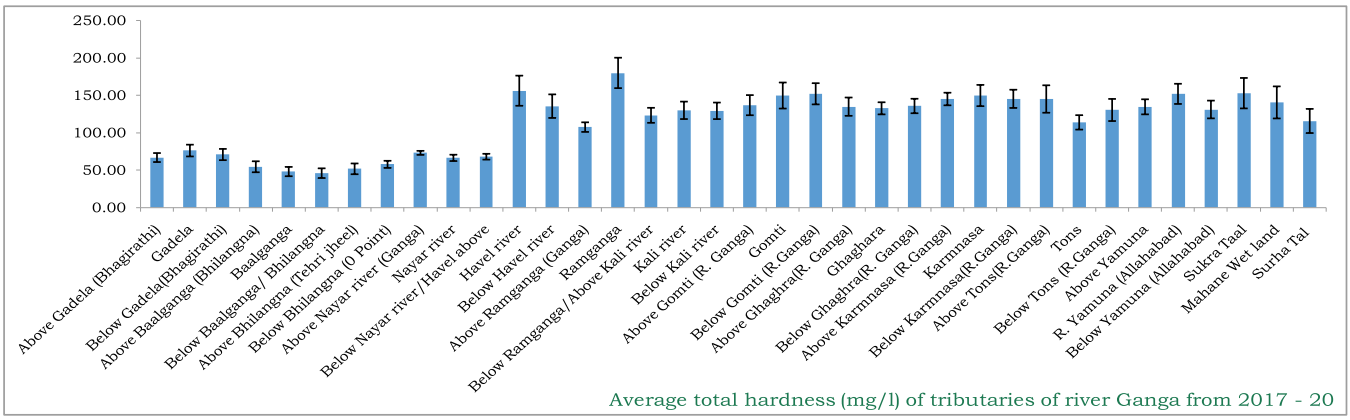
Average BOD (mg/l) of tributaries of river Ganga from 2017 - 20



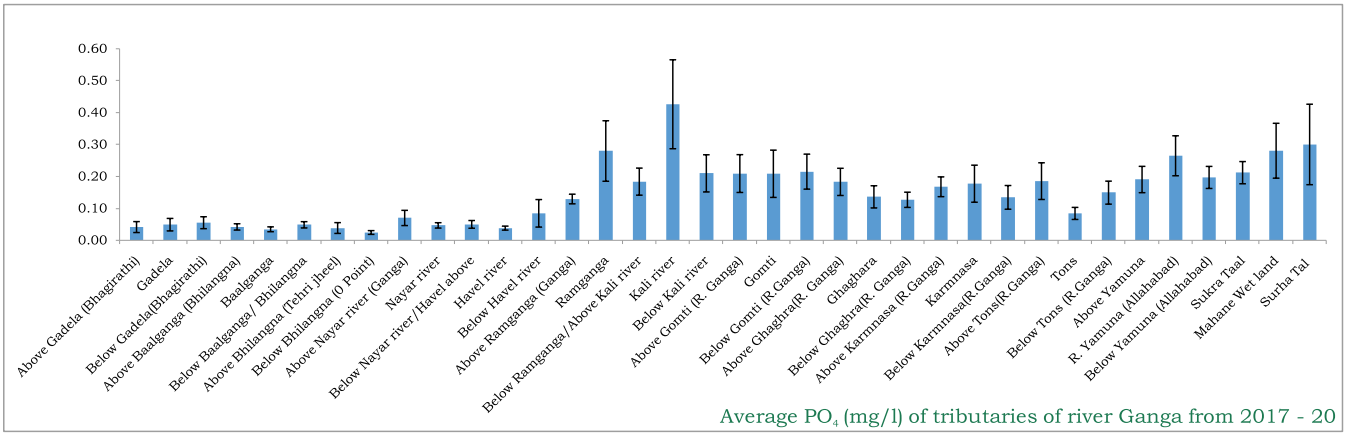
Average COD (mg/l) of tributaries of river Ganga from 2017 - 20



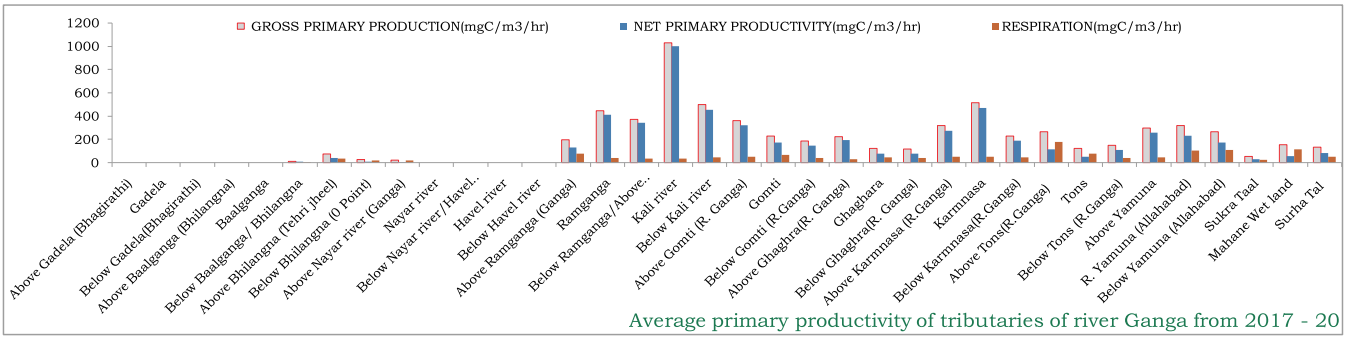
Average specific conductivity (µs/cm) of tributaries of river Ganga from 2017 - 20



Average total hardness (mg/l) of tributaries of river Ganga from 2017 - 20



Average PO_4 (mg/l) of tributaries of river Ganga from 2017 - 20



Average primary productivity of tributaries of river Ganga from 2017 - 20

upper stretch than lower stretch except above Bhilangna and below Bhilangna due to Tehri dam. Comparatively higher specific conductivity observed in lower stretch may be due to high accumulation of solids. Higher values of TDS observed in lower stretch were attributed to soil erosion in the nearby catchment and the massive contribution of suspended solids from domestic effluents or local sewage ingress. Comparatively higher levels of chloride and COD in the lower stretch of Ganga waters can be attributed to discharge of local effluents or domestic sewage disposal along the tributaries situated at the lower stretch of Ganga. BOD an d COD both were maximum at river Kali and low in upper stretch as compared to tributaries of the middle stretch of river Ganga. Primary productivity of Kali river was also observed maximum in all seasons.

Chlorophyll content

Chlorophyll-a content was maximum in Kali river followed by above Ramganga and Gomti. Chlorophyll content of the upper stretch was observed less as compared to the lower stretch.

Sediment quality of tributaries and wetlands

Entire stretches of river Ganga, tributaries along with three wetlands were dominated by sand followed by silt. Clay and silt contents were very less in the hilly stretch as compared to the middle stretch. Average values of other sediment quality parameters of the selected tributaries and wetlands are presented in table. The average pH of the entire stretch ranged between 7.8±0.1 and 8.4±0.2 with the highest value observed at Karmnasha and minimum value at Bhilangna. Maximum average specific conductivity (391±78.1 µs/cm) was observed at Havel and minimum (97.4±13.9 µs/cm) in Alaknanda. The average value of organic carbon of the entire stretch was 2.52% with a maximum (4.36±2.72 %) at Surha taal and minimum (0.22±0.07 %) in Kali river.

The value of available nitrogen ranged between 2.66±0.44 and 21.62±5.23 N/100g with minimum value in Bhilangna and maximum in Mahane wetland.

Macrobenthic organisms

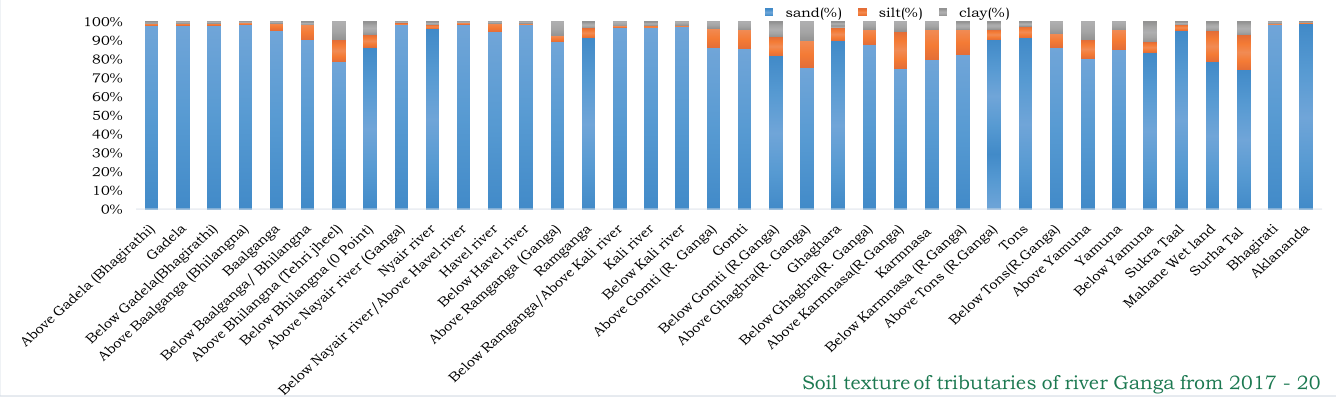
In January 2020 benthos varied from 30-230 N/m^2 with maximum abundance at Gomti. Important members were *Bellamya bengalensis, Brotia costula, Taribia lineata, Melanoides tuberculata, Gyraulus convexiusculus; Corbicula striatella, P. corrugata, P. favidens* and *Lamellidens corrianus*, etc. The Shannon Wiener index (H') varied from 0.3768 below Tons to 1.332 in Mahane; the value increased as both richness and evenness of the community increase. The Evenness index varied from 0.5335 in Gomti to 1 below Karmanasa. The Simpson diversity varied from 0. 2188 (below Tons) to 0.7041 at Chatnag. A high score close to 1 indicated higher diversity at Chatnag and Karmanasa.

Fish diversity

Fish diversity has been studied at different confluence points through experimental fishing with the help of multi-meshed cast and gill nets. A total of 75 fish species belonging to 9 Order, 21 families, and 49 genera

Salient sediment quality parameters at selected sampling sites

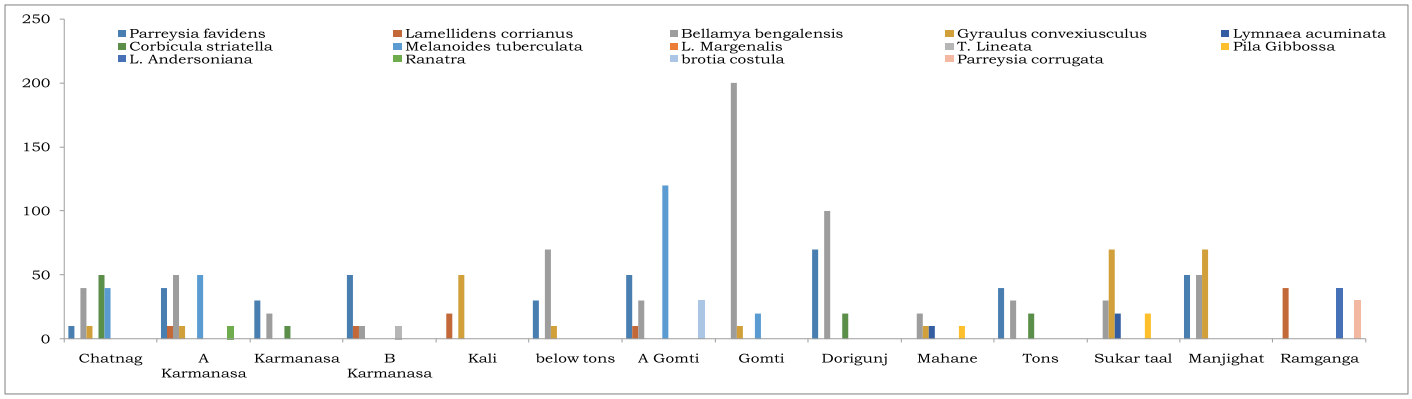
Sampling site	Average pH	Average Specific conductivity (µs/cm)	Free $CaCO_3$ (%)	Organic Carbon (%)	Average phosphorus (mgP/100g)	Average Nitrogen (mgN/100g)
Gadela	7.9±0.2	129.3±29.2	2.84±0.62	0.28±0.06	7.26±1.80	2.77±0.70
Bhilangna	7.8±0.1	104.9±13.8	4.35±1.75	0.27±0.08	4.61±0.99	2.66±0.44
Baalganga	8.0±0.1	136.4±25.2	1.92±0.51	0.53±0.26	3.99±1.07	3.46±2.04
Alaknanda	8.3±0.1	97.4±13.9	2.75±0.69	0.30±0.07	3.44±1.24	3.24±1.06
Nayar river	7.9±0.2	100.1±20.0	9.12±4.70	0.47±0.14	5.40±0.95	6.95±3.40
Havel river	8.1±0.1	204.3±47.1	11.86±4.47	0.31±0.06	3.29±0.71	7.54±2.79
Ramganga	8.1±0.2	257.2±63.6	8.56±2.87	0.32±0.08	8.81±1.37	10.20±2.29
Kali river	8.3±0.2	240.9±50.0	7.41±2.50	0.22±0.07	4.47±0.98	3.00±0.77
Gomti	8.2±0.1	391.9±78.1	7.47±2.37	0.51±0.11	4.25±1.10	14.33±3.55
Ghaghra	8.2±0.2	226.9±42.6	10.11±2.79	0.27±0.08	2.84±0.91	6.04±1.23
Karmnasa	8.4±0.2	372.6±60.2	11.06±3.15	0.49±0.08	6.06±1.21	18.23±4.05
Tons	8.2±0.2	215.2±28.0	7.79±3.01	0.41±0.07	3.71±0.83	8.36±2.81
Yamuna	8.4±0.1	395.5±96.9	7.54±2.38	0.34±0.10	4.33±1.49	8.06±1.40
Sukra Taal	8.0±0.1	324.6±64.5	5.38±1.46	0.74±0.14	7.25±2.47	7.11±2.48
Mahane wetland	7.8±0.3	292.4±55.8	2.45±0.69	0.82±0.21	9.05±2.77	21.62±5.23
Surha Taal	7.9±0.1	259.3±38.6	7.88±2.45	4.36±2.72	10.23±4.23	17.33±5.24



Soil texture of tributaries of river Ganga from 2017 - 20

Biodiversity indices at different sampling sites of tributaries and wetlands of river Ganga in January, 2020

Biodiversity indices	Chatnag	Above Karma nasa	Karma nasa	Below Karma nasa	Kali	below tons	Above Gomti	Gomti	Dorigunj	Mahane	Tons	Sukar taal	Manji ghat	Ram ganga
Taxa_S	4	5	2	3	2	2	4	3	2	4	2	4	2	3
Dominance_D	0.2959	0.3136	0.5556	0.3333	0.5918	0.7813	0.4515	0.7656	0.7222	0.28	0.52	0.3367	0.5139	0.3388
Simpson_1-D	0.7041	0.6864	0.4444	0.6667	0.4082	0.2188	0.5485	0.2344	0.2778	0.72	0.48	0.6633	0.4861	0.6612
Shannon_H	1.272	1.327	0.6365	1.099	0.5983	0.3768	1.028	0.4702	0.4506	1.332	0.673	1.233	0.6792	1.09
Evenness_e^H/S	0.8921	0.7539	0.9449	1	0.9095	0.7288	0.6989	0.5335	0.7846	0.9473	0.9801	0.8576	0.9861	0.9915
Brillouin	1.221	1.26	0.5739	0.9782	0.5661	0.3516	0.9908	0.451	0.4311	1.217	0.6297	1.182	0.6575	1.046
Menhinick	0.3381	0.4385	0.3651	0.5477	0.239	0.2236	0.2902	0.1978	0.1826	0.5657	0.2828	0.3381	0.1826	0.286
Margalef	0.6071	0.8218	0.294	0.588	0.2354	0.2282	0.5718	0.3678	0.2089	0.7669	0.2556	0.6071	0.2089	0.4255



Diversity of benthos at different study sites of tributaries & wetlands of River Ganga

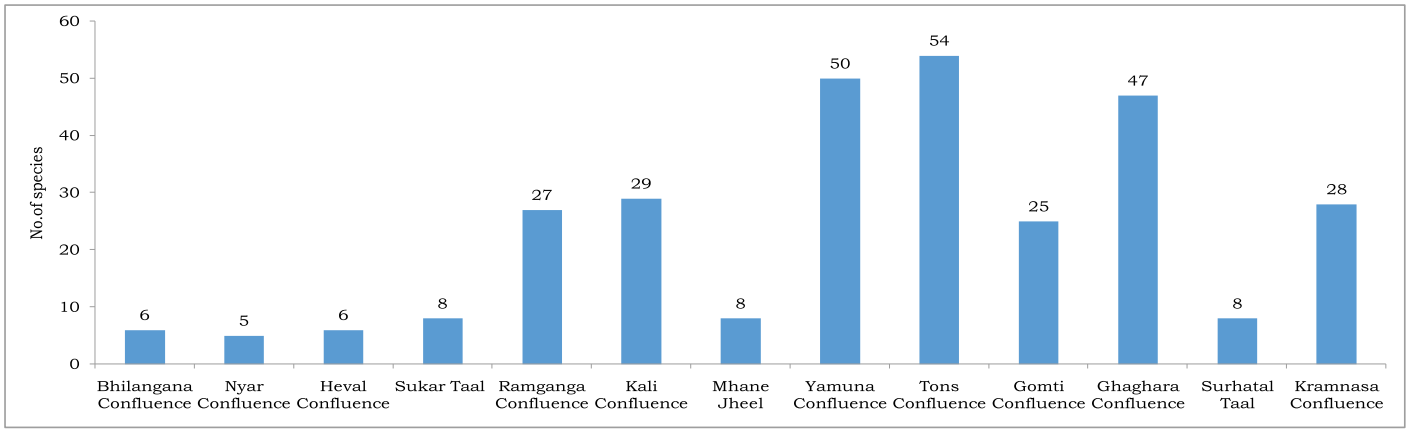
were documented from the different sampling sites. The study revealed higher species diversity with 54 species at Tons confluence, followed by 50 species at Yamuna confluence, 47 species at Ghaghara confluence, 29 species at kali confluence, 28 species at Karmanasa confluence, 27 species at Rāmgangā confluence, and 25 species at Gomati confluence. It is a fact that fish diversity remains high at the confluence point because of its fertile nature from high inflow of nutrients, food, etc.

Plankton diversity

River Gadela, Bhilangana, Balganga, Nayer, Havel and Alaknanda are tributaries of upper stretch. In these tributaries summer plankton population ranged from 315 u/l (below Gadela) to 3155 u/l (Bhagirathi), monsoon plankton from 50 u/l (Alaknanda) to 330 u/l (below Gadela) and winter plankton from 220 u/l (below Nayar) to 1073 u/l (river Nayar). Tributaries of middle stretch include Ramganga, Kali, Karmnasa, Yamuna, Tons and Gomti, In this stretch summer plankton ranged from 325 u/l (below Gomti) to 5660 u/l (Gomti), monsoon plankton ranged from 50 u/l (Yamuna) to 5205 u/l (above Kali/below Ramganga), winter plankton ranged from 176 u/l (Tons) to 1090 u/l (Karmnasa).

Plankton populations were dominated by Bacillariophyceae, followed by Chlorophyceae and Myxophyceae. Other groups like Euglenophyceae and Dinophyceae were observed rarely in the middle stretch. Zooplanktons were recorded in all the tributaries of the middle stretch only and were dominated by rotifers followed by crustacea and protozoa. Crustaceans ranged from 10 (below Gomti) to 120 u/l (Yamuna), while rotifers ranged between 10 u/l (above Kali) to 480 u/l (Gomti) in summer, 30 u/l (Ramganga, Kali) to 270 u/l (Karmnasa) in monsoon and 40 u/l (above Ramganga) to 360 u/l (Yamuna) in winters.

A total of 106 planktonic taxa (78 phytoplankton, 28 zooplankton) were recorded during 2017-2020. Among these, 27 belong to the Bacillariophyceae, 35 to Chlorophyceae, 11 to



Fish diversity at different confluence points

Myxophyceae, 2 to Dianophyceae, 3 to Euglenophyceae, 10 to Crustacea, 12 to Rotifera, and 6 to Protozoa. The plankton population was dominated by diatoms and green algae in all the tributaries and Ganga. Maximum diversity was recorded in the river Ganga, followed by Havel, Nair, Ramganga, Yamuna, Karmnasa, Kali and Tons. *Tabellaria, Synedra, Eunotia, Cymbella, Cyclotella* were dominant in the upper stretch while the middle stretch was dominated by *Melosira, Navicula, Nitzschia* (Bacillariophyceae), *Scenedesmus, Chlorella, Ankistrodesmus, Pediastrum* (Chlorophyceae), *Merismopedia, Phormidium* (Myxophyceae), *Brachionus, Asplanchna, Filinia* (Rotifera). In Mahane jheel plankton numbers were 1330 u/l, 410 u/l, and 920 u/l in summer, monsoon, and winter seasons respectively with *Gomphonema, Navicula* as the dominant taxa. In Suker taal planktons counts were 840 u/l, 135 u/l, and 746 u/l in summer, monsoon, and winter respectively; dominant taxa were *Synedra, Melosira, Cyclotella*. In Surha taal plankton populations were 445 u/l, 75 u/l, 823 u/l in summer, monsoon, and winter respectively, with dominance of *Cyclotella, Phormidium, Microspora.*

Periphyton

During the summer season periphytic population in these tributaries of Ganga river basin ranged from 770 u/cm^2 (below Havel) to 16440 u/cm^2 (Nayar river) and in winters it ranged from 1140 u/cm^2 (Tons) to 33868 u/cm^2 (Gadela). Total of 65 periphytic taxa belonging to various groups were recorded. Among them 28 were from Bacillariophyceae, 20 from Chlorophyceae, 9 from Myxophyceae, 3 from Euglenophyceae, 1 from Dianopphyceae, and 4 from Rotifera. Periphytons were dominated by diatoms in the whole stretch of Ganga river basin. Dominant periphytic taxa were *Navicula, Nitzschia, Cymbella, Synedra*, and *Gomphonema.*

Project title : Temporal assessment of estuarine fisheries resources for sustainable management

Project Code : REF/20-23/11
Duration : 2020-2023
Scientific personnel : S. Samanta (PI)

The estuarine ecosystems are among the most productive and bio-diverse habitats on earth and, many a times, covered with dense mangrove vegetation. Estuaries are important ecosystems as fishing as well as nursery grounds. The community structure of estuarine living resources is vulnerable to large changes form environmental and climatic perturbations, reduced river discharge, habitat degradation, over-fishing and pervasive coincidental killing of non-targeted species as by-catch which could adversely affect the long-term yield potential of the resources, unless handled by a comprehensive management plan. India has rich estuarine and other brackishwater resources along east and west coasts formed by the Ganga, Mahanadi, Godavari, Krishna, Cauvery, Narmada and Tapti rivers, and smaller coastal rivers along the west coast, mainly in Kerala, Karnataka and Goa. With this background, five sub-projects focusing on various Indian estuaries have been proposed to evaluate the estuarine fisheries resources for sustainable management.

Sub-project 1 : Temporal assessment of Hooghly-Matla estuarine fisheries resources for sustainable management

Scientific personnel : D. Bhakta (Subproject leader), R.K. Manna, S. M. Nair, S. Samanta

The Hooghly-Matla estuarine system on the east coast of India is the largest and most productive estuary in the country, covering about 8029 km^2 area. The Hooghly-Matla is a positive estuary in the mixo-haline range, where salinity ranges from 0.1 to >30 ppt. Various authors have documented the diversity of fish and shellfish species, plankton, benthos, and ecological parameters of the Indian estuarine systems but detailed information on zone-wise habitat pattern, suitable environmental requirements for commercially important fish species spawning and nursery raising, and fish catch structure are lacking. Studies of different biological parameters along with population parameters are prerequisites for sustainable management of any ecosystem. Studies are also necessary on estuarine fish assemblages in different habitats to establish how the composition of fish fauna and the species richness in the entire estuary changes with the season and with changing environmental conditions. The present study focuses on hydro-ecological changes in different estuarine zones, stock assessment of two commercially important fish species (*Polynemus paradiseus* and *Setipinna phasa*), and to develop predictive model for estuarine fish production for development of sustainable management measures of the Hooghly-Matla estuarine fisheries resources.

Sub-project 2 : Assessment of ecohydrological dynamics in relation to fish fauna and their recruitment towards development of sustainable management strategies in Rushikulya estuary

Scientific personnel : S. K. Das (Subproject leader), Roshith C. M., L. Kumar

Rushikulya estuary is known for its faunal diversity and a good spot of juvenile fishery. As this estuary is known for a nesting ground of some of World's most extant species of sea-turtles, its relationship with fishery may be of great interest. At the same time, demarcation of different salinity gradients is also important, which would enable us to characterize behaviour and distributions of different resources in the estuarine system. The present

study aims to characterize the hydro-ecological changes in different estuarine zones, assess the fish diversity, catch and population parameters, and develop a sustainable trophic model as a management tool of the Rushikulya estuary.

Sub-project 3 : Temporal assessment of Netravati-Gurupur estuarine fishery resources for sustainable management

Scientific personnel : M. Feroz Khan (Subproject leader), S. Sibina Mol

The productivity and sustainability of the estuaries depend on its habitat and environmental qualities. Over-exploitation of the resources, industrialization, domestic sewage and innumerable human activities have led to deterioration of these resources. The huge load of the nutrients, metals contaminants, oils and organic compounds significantly decrease the hydrobiological characteristics of the estuarine system. Thus, continuous monitoring of the physical, biological and chemical parameters is essential for a proper assessment, prevention and restoration of the water quality of the estuarine systems. Netravati–Gurupur estuary passes through the urbanized coastal city Mangalore. The rapid industrialization and unplanned urban growth along the bank of the estuary have resulted in the continuous increase in the flow of domestic and municipal sewage along with industrial effluents into the estuary. There are no bibliographic reports available on chemical contaminants, especially the heavy metals, in this estuary system. The project aims to characterize the hydro-ecological changes, ichthyofaunal diversity, fish catch and stock assessment of two commercially important fish species (*Sillago sihama* and *Nematalosa nasus*), and to develop static and dynamic food web model for the estuary.

Sub-project 4: Temporal assessment of the Mandovi-Zuari estuarine fishery resources for sustainable management

Scientific personnel : S. P. Kamble (Subproject leader), W. A. Meetei, Vaisakh G.

Mandovi-Zuari is an important estuarine system of Goa with a water spread of about 1200 ha. Studies conducted in the past by the CIFRI and available literature suggested that Mandovi-Zuari estuarine system have undergone changes in water quality, quantity, habitat and biodiversity threatening the sustainability of its tangible and intangible services to the mankind. Natural as well as human interferences resulting in habitat degradation and consequent impact on fisheries and biodiversity are prominent. Available literatures also suggest scattered study on habitat quality, biotic and abiotic factors of the ecosystem and fisheries. Management through holistic ecosystem-based approaches to achieve the goal of sustainable fisheries have not been targeted earlier. While fisheries scientists have strived to understand the population and catch dynamics of fish species, knowledge of their ecological/ habitat requirements and status of such habitats are seriously lacking. This project aims to generate information on hydro-ecological changes in different estuarine zones, and catch structures and population parameters of the Mandovi-Zuari estuarine system.

Sub-project 5 : Temporal assessment of Vembanad estuarine fisheries resources for sustainable management

Scientific personnel : T. T. Paul (Subproject leader), D. Sudheesan

Available literatures and previous studies conducted by ICAR-CIFRI referred Vembanad Lake as an essential habitat and Critically Vulnerable Area (CVA). The ecosystem faces multiple challenges with respect to hydrological, ecological and biological

regimes due to anthropogenic influences. A comprehensive study of the fishery of the estuary encompassing biotic and hydrological components for trophic modelling of the estuary is lacking. Also, scattered studies have pointed out the relevance of the estuary as breeding and spawning grounds of fishes, but scientific accounting and allocation of those grounds as conservation sites is lacking. Thus, there is a need for comprehensive assessment of the estuarine resource of Vembanad lake, its fishery resources, zone-wise habitat pattern and suitable environmental requirements, spawning and nursery raising and fish catch structure – which would help in promoting and initiating appropriate management measures including the conservation of estuarine aquatic resource of this globally renowned Ramsar Site.

Project title : Assessment of ecological impact of dams and barrages in selected rivers with special reference to fisheries

Project Code : REF/20-23/12
Duration : 2020-2023
Scientific personnel : A. K. Sahoo, S. K. Das, R. Baitha, M. Ramteke
Associates : A. Sengupta, D. Saha

The ecological impact assessment in rivers has gained higher attention with the construction of large dams, barrages and impoundments across the river, resulting in discontinuity in river flows and habitat. Most of the Himalayan rivers in India are regulated to harness hydropower with over 400 hydroelectric projects (HEPs) under different stages (planned, commissioned, under construction). In addition, cascade of dams in the river stretch is becoming a major concern due to cumulative impacts of large-scale physical changes leading to adverse impacts on the survival of fish fauna, their diversity, and distribution migration, recruitment, reproductive, and life history strategies. Realizing the importance of the river ecology towards conserving fish species, the project was conceptualized to study the current ecological asset in the selected river stretch including fish, plankton and benthic diversity, to assess the ecological impact in the selected river stretch due to dams, and to study the ecological impacts due to hydro-peaking. The output

Confluence point of river Rangit and Teesta

from the proposed objectives would not only serve as the baseline information but also support in developing management plans for aquatic biodiversity conservation. For this study, river Rangit was selected due to limited number of dams constructed along the river stretch.

River Rangit, the largest right bank tributary of Teesta, originates as Rangit Chu from Talung glacier at an elevation of 4080 m and joins Teesta river at West Bengal-Sikkim border. The basin area of Rangit river is 2134 km^2, of which 1621 km^2 lies in West Bengal and the remaining area falls in Sikkim state. Rathong Chu is the main tributary of Rangit river and six projects are planned on these river channels from Ting Ting to the confluence of Rangit and Teesta rivers. Of these, three projects are commissioned (Rangit III, Jorethang and Ting Ting), and one is under construction. The river habitat is majorly dominated by the boulders, rocks, gravels with sandy bottom with a water velocity of 0.5 m/s during the pre-monsoon season. Experimental fishing at the confluence site of river Rangit identified presence of fish species such as *Schizothorax richardsonii, Neolissochilus hexagonolepis, Bangana dero, Barilius vagra* and *Opsarius barna*. Among these, *S. richardsonii*, and *N. hexagonolepis* migrate upstream to the river Rangit.

Project title : Estimation of fish landings and catch structure in the rivers Mahanadi, Krishna, Barak and Kosi

Project Code : REF/20-23/13
Duration : 2020-2023
Scientific personnel : C.M. Roshith (PI), A. Pandit, C. Jana, L. Kumar, R. Baitha, C. Johnson, Vaisakh G.

Riverine fisheries substantially contribute in meeting the challenges faced by individuals, society and the environment in a changing global landscape. But there is overall scarcity of comprehensive information regarding the riverine capture fisheries production at local, national and global levels. This is due to the inherent difficulty in collecting data from these geographically vast and highly dispersed fisheries. Consequently, the fisheries of riverine ecosystems are often overlooked, underestimated and given low priority in planning and policy discussions which make it difficult to generate political will to protect these valuable resources along with the people that depend on them.

Indian rivers are facing serious threats to their biodiversity and ecological integrity from anthropogenic stressors such as construction of dams, abstraction of water (for irrigation and power generation), destructive fishing practices and pollution due to the discharge of sewage and industrial wastes. Many riverine fish species have become endangered due to habitat degradation from the combined effects of these anthropogenic stressors along with global phenomenon of climate change. However, the essential biological data needed for the proper management of many of these threatened riverine fishes are either insufficient or absent. Information on the riverine fish landings and catch structure are imperative in securing the future of these valuable resources as it aids in better incorporation of riverine fisheries in decision making process, identification of critical habitats/hotspots and improved valuation of riverine fisheries to accurately recognize the full breadth of provided services. The present study is directed to generate information on fish landings and catch structure along the selected riverine stretches, assess indigenous and economically important fisheries, and socio-economic status of fishermen of four Indian rivers representing different eco-climatic zones, viz., Mahanadi, Krishna, Barak and Kosi.

Project title : Exploration of fish diversity and identification of priority habitat in protected and less-explored inland water bodies

Project code : REF/20-23/14
Duration : 2020-2023
Scientific personnel : R. K. Manna (PI), S. Kumari, A. K. Das, A. M. Sajina, D. Bhakta, A. Roy, P. Debroy, K. Kumari, S. M. Nair, B. K. Bhattacharjya, N. S. Singh, S. Bora, A. Alam, J. Kumar, D. N. Jha, S. Borah, V.L. Ramya, P. K. Jesna

waters are available, literatures on the distribution of fish and other biotic communities in declared protected habitat are limited. It is essential to fill the knowledge gaps on the biodiversity of protected areas as the impacts of these undisturbed areas largely remain unknown.

Sub-Project 1 : Aquatic biodiversity assessment and priority fish havitat identification in protected and less explored inland water bodies in (Bhitarkanika NP, Jaldapara NP, Panna NP, major waterfalls regions of Chotta Nagpur plateau

Sub-Project 2 : Assessment of fish diversity and identification of priority habitat in protected and less explored wetlands and reservoirs of different eco-regions

The project aims to develop biological inventory of fish and shell fish in selected protected water bodies, and to identify priority habitat of fish in the protected water bodies based on ecological biological parameters.

List of selected protected areas for fish diversity assessment study

Identified protected Area	State
Nagi Dam Wildlife Sanctuary	Bihar
Nakti Dam Wildlife Sanctuary	
KusheswarAsthan WLS	
Kulik (Raiganj) Bird Sanctuary	West Bengal
Jaldapara National Park , 1941	
Nugu WLS	Karnataka
Cauvery WLS	Karnataka and Tamil Nadu
Kaziranga National Park	Assam
Orang National Park	
Parvati Arga Bird Sanctuary, RS	Uttar Pradesh
Dudhwa Tiger Reserve	
Panna National Park	Madhya Pradesh
Bhitarkanika National Park , 1998	Odisha

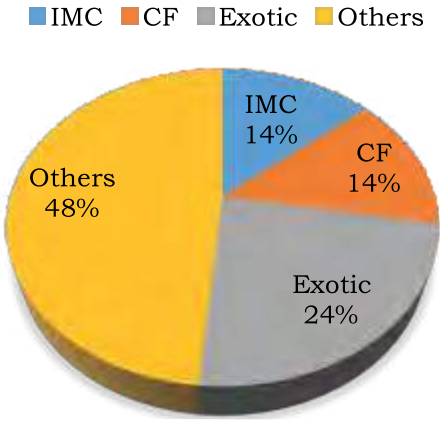
Baseline information from selected protected inland water bodies

Protected area of inland water bodies have been identified through literature survey. Even though extensive studies on freshwater fishes in different types of Indian open

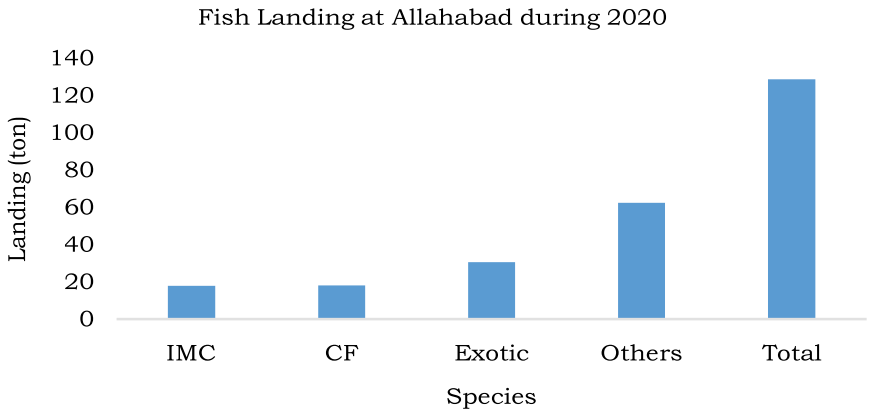
Project title : Eco-variability and impact study of river Yamuna on river Ganga with special emphasis on fisheries

Project Code : REF/20-23/15
Duration : 2020 - 2023
Scientific personnel : D. N. Jha (PI), A. Alam, J. Kumar, V. R. Thakur, M. Gupta
Associates: S. Srivastava, K. Srivastava, V. Kumar

Fish landing from Allahabad stretch of the river Ganga was estimated to be 128.7 t during 2020 with about 23.67 % share of exotic fishes. In total fish catch, miscellaneous group of fish dominated (48.53%), followed by exotics, catfish (14.01%), and Indian major carps (13.79%). Among the exotic fish, common carp dominated over tilapia while among IMC, Mrigal contributed more than rohu,



Share of species in total catch at Prayagraj during 2020



Fish landing at Prayagraj during 2020

catla and calbasu. There is about a 4.91% decrease in average fish landing in respect to the previous year which could be attributed to a marginal decrease in fishing

Project title : Assessment of environmental variability, nutrient fluxes and biotic community interactions of a few mangrove stands of Indian mangrove eco-region

Project Code : REF/20-23/16
Duration : 2020 - 2023
Scientific personnel : S. Dam Roy (PI), H. Chowdhury, C. M. Rosith, L. Kumar, T. N. Chanu

An initiative has been taken for the development of a museum having a herbarium on mangroves of Sundarbans as well as fish biodiversity of Sundarbans at Kolkata research Station of ICAR-CIFRI. In the Herbarium the following true mangroves and mangrove-associates were preserved to make a reference library. The fin and shell fishes were also placed as reference collection of the museum.

Fish and herbarium collection at Kolkata Centre

Mangroves of Sundarbans

Species	Local Name
True mangroves	
Sonneratia griffthi	Ova
Sonneratia caseolaris	Chat keora
Sonneratia apetala	Kerora
Exoecaria agollocha	Geon
Avicennia alba	Kal ban
Avicennia marina	Payra ban
Avicennia officinallis	Jat bana
Ceriops tagal	Mot garan
Ceriops decandra	Jhumpti garan
Rhizophora mucronata	Garjan
Rhizophora apiculata	Garjan
Kandelia candel	Goria
Heritieria fomes	Sundari
Bruguiera gymnorhiza	Kankra
Bruguiera sexangula	Bakul kankra
Bruguiera cylindrical	Bakul kankra
Lumnitzera racemosa	Gripal
Xylocarpus mekongensis	Pasur
Xylocarpus granatum	Dhudul
Mangrove associates	
Aegiceras corniculatam	Kotshi
Aegialitis rotundifolia	Tora
Acanthus valubilis	Lata horggsa
Porteresia coarctata	Dhani
Scyphiphora hydrophyllacea	Tagari ban
Tamarix gallica	Nona Jhee
Manilkara hexandara	Bilithi Bakul
Brownlowia lanceolata	Lata Sundari
Clerodendrum inerme	Pron jue

Fishes of Sunderbans mangrove eco-region

Scientific name	Local name
Polynemus paradiseus	Topssa
Etroplus suratensis	Pyra chadha
Osteogeneiosus militaris	Tengra
Megalopsis cordyla	
Uranoscopus coganatus	
Pisodonophis boro	Eel
Escualosa thoracata	
Sillaginopsis domina	Bull
Protonibea diacanthus	
Mastacembalus armatus	
Glossogobius guirius	Bele
Datnioides polota	
Sardinella gibbosa	
Coila Species	Amodi
Therapon jarbua	Katkoi
Belopthalmus bodartii	
Scomberomerus guttatus	
Sillago sihama	Bela
Pterosis russeli	
Setipinna phasa	Ram phasa
Setipinna taty	Lal phasa
Liza tade	Bhangura
Liza parsia	Parsa
Trichiurius savala	Rupabati
Lates calcarifer	Bhetki
Pama pama	Bhola
Sillaginopsis panijus	Tul Bula
Scatophagus argus	Payra tali
Eleutheronema tetradactyla	Gurjali
Cynoglossus arel	Bhowsh pata
Procupine fish	Sajaru fish
Tenulosa hilsa	Hilsa
Macrospinosa cuja	Kuj Bhetki
Thenus orientalis	Sand lobster
Scylla serrata	Mud crab
Charybdis cruciata	Mangrove crab
Carcinoscorpus rotundicauda	Horse shoe crab

Project title : Resource assessment and refinement of fisheries management plans through co-management in floodplain wetland of different eco-regions

Project code: RWF/17-20/05
Duration: 2017 - 2020
Scientific personnel: B. K. Bhattacharjya (PI), U. K. Sarkar, M. A. Hassan, A. K. Das, Md. Aftabuddin, R. S. Shrivastava (up to 9.12.2019), A. K. Bera, S. K. Sahu, D. N. Jha (up to 30.09.18), A. Alam (up to 30.09.18), D. K. Meena, P. Mishal, Lianthuamluaia, P. Maji, P. Deb Roy, P. Gogoi (since 01.04.2018), S. Yengkokpam, A.K. Yadav, P. Das, S.C.S. Das (up to 30.9.2018), S. Borah, N. Sharma, N.S. Singh, Vikas Kumar (since 01.10.2018), V.R. Thakur, J. Kumar and M. Gupta (since 01.10.2018)
Associates: B. C. Ray, A. Kakati, V. Kumar, S. Srivastva, K. Srivastava, S. Saha, S. Das, B.K. Naskar and Y. Ali

The project aims at fisheries assessment of the wetlands in different parts of the country and improvement in their management techniques for sustainable fish production enhancement. During this period, selected wetlands from the State of Assam, Arunachal Pradesh, Madhya Pradesh, and West Bengal were assessed.

West Bengal

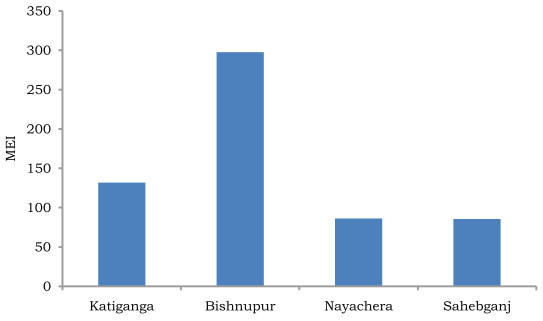
The environmental variables and biotic community interactions were assessed in four wetlands, namely, Nayachara and Sahebganj in Teesta-Torsa basin, and Katiganga and Bishnupur in Bhagirathi-Hooghly stretch. The study was carried out in monsoon (July–October), post-monsoon (November – February) and pre- monsoon (March – June) seasons.

Environmental variables

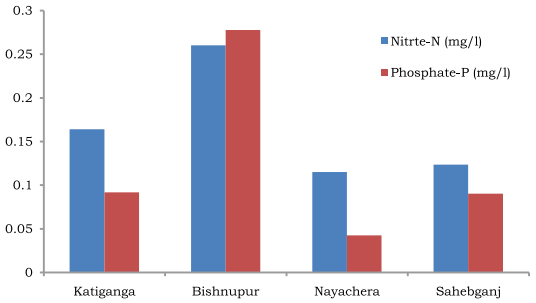
Water variables (DO, pH, total alkalinity, and nutrients viz. nitrate–N, phosphate–P) indicated the productive nature of all the four wetlands. Morpho-Edaphic Index (MEI) ranged from 85–297 with the highest value in Bishnupur wetland of Murshidabad. The phosphate–P and nitrate–N concentrations were also highest in Bishnupur wetland as compared to the other three wetlands, indicating higher trophic state of the Bishnupur wetland.

Fish yield estimation of floodplain wetlands of West Bengal

The culture-based fisheries (CBF) are being practiced in floodplain wetlands at varying levels. The fish yield data from the 21 selected wetlands in West Bengal revealed an average yield of 1,083 kg/ha/yr. The fish yield ranged from 97–4,745 kg/ha/yr among the wetlands with the highest yield achieved in sewage-fed Chaltia wetland, Murshidabad. The average fish yield was higher in closed wetlands (1,165 kg/ha/yr) as compared to open/seasonally open wetlands (864 kg/ha/yr). As a whole, the wetlands in the lower Ganga basin showed higher fish yield



MEI of the four wetlands of West Bengal



Nutrient parameters of the four wetlands of West Bengal

Fish yield pattern in selected wetlands of West Bengal

than those in the Teesta-Torsa basin.

Variability in sediment enzyme

Seasonal variations of sediment enzymes in the four wetlands indicated the highest phosphatases and glucosidase activities in Katiganga and Nayachhara, respectively. Sewage fed Bishnupur wetland had higher dehydrogenase and less glucosidase enzyme activities than the other three non-polluted wetlands. The phosphatase activities (acid phosphatase and alkaline phosphatase) were higher in Nayachara and Sahebganj than in Bishnupur and Katiganga wetlands. Distinct seasonal variations of enzyme activities were observed with the highest levels (except acid phosphatases) during winter in all the wetlands. Lowest activities were seen during monsoon for alkaline phosphatase, dehydrogenase, and β glucosidase. Non-polluted wetlands (Katiganga, Nayachara, and Sahebganj) showed distinct sectoral variations during summer. Hence, sediment enzyme activities are correlated with the abiotic variables of sediment (moisture, soluble reactive phosphorus with acid and alkaline phosphatases; pH and organic matter with β glucosidase) in a different manner. Sediment enzyme activities can be used as one of the biological and microbiological proxies for ecosystem health assessment.

Plankton community dynamics

Assessment of plankton assemblage revealed that the phytoplankton species richness was higher in the wetlands of Teesta-Torsa basin as compared to Ganga basin; and these were represented majorly by Cyanophyceae and Chlorophyceae respectively. In total, 128 species of phytoplankton were recorded (118 species under 94 genera in Sahebganj wetland; 103 species under 86 genera for Nayachara); among these, 94 species were common to both the wetlands. Among zooplanktons, crustacean nauplius (34%) showed prominence followed by rotifera (29%) in Sahebganj, while in Nayachara wetland rotifera alone contributed 43% followed by crustacean nauplius (25%). Cumulative dominance (k-dominance) curve portrayed that the phytoplankton abundance was unambiguously more diverse in macrophyte free areas as compared to partially covered and macrophyte infested areas. Diatoms (34%) belonging to bacillariophyceae were the most dominant algae class within the macrophyte bed, whereas Cyanophyceae (27.15%) and Chlorophyceae (19.54%) in the macrophyte free zones.

Community assemblage of phytoplankton in the Ganga basin revealed that Chlorophyceae showed prominence, comprising 62.17% and 51.24% in Bishnupur and Katiganga, respectively. Concurrently, 36, and 25 zooplankton species were recorded. Among zooplankton, rotifera accounted significantly in both the wetland. Rotifera species *Brachionus caudatus* invariably dominated during winter and monsoon in Katiganga beel. Plankton density was maximum in post-monsoon season in both the wetlands. The calculated value of Shannon diversity (3.50) and Margalef species

richness index (4.30) indicated moderately-rich plankton diversity in both the wetlands.

Uttar Pradesh

Loni wetland, a seasonally open system of 129 ha, is situated at the Rawa district of Bundelkhand region, Uttar Pradesh. The water currents from the two seasonal rivers (Phutahna and Barha) get directed towards the central regions of the wetland. The physico- chemical parameters of the water showed a sound water quality regime. Sediment of the wetland was slightly alkaline (pH: 7.67). Average sand, silt, and clay contents were 77 %, 22 %, and 1 %, respectively. The wetland depicted rich nutrients with 25.39 mgN, and 14.21 mg available P/100 gm sediment. The specific conductivity was minimum (102 µS/cm) during winter as compared to other seasons. The magnitude of DO was maximum (10 mg/l) in the winter season.

Plankton and chlorophyll contents

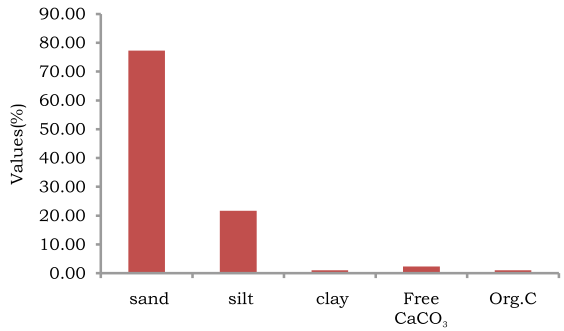
A total of 30 species of phytoplankton were recorded in Loni wetland belonging to Bacillariophyta, Charophyta, Chlorophyta, Cryptophyta, Euglenophyta, Miozoa, and Ochrophyta. By and large, Bacillariophyta accounted maximum (50%) followed by Chlorophyta (26%) and Charophyta (10%). The

Loni wetland, Uttar Pradesh

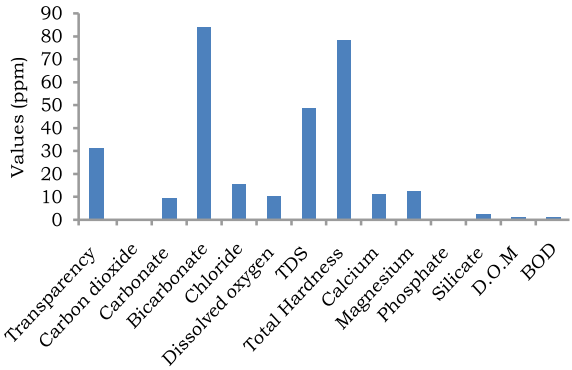
average density was 5.5 x 10^5/µl. The average value of chlorophyll-a was 5.91 mg/m^3. Chlorophyll-a showed mesotrophic state in the Loni wetland.

Macrobenthic fauna and fish diversity

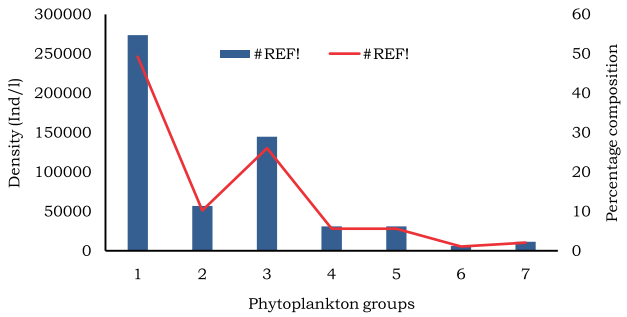
A total of eight macrobenthic fauna comprising of 4 insect and 4 gastropods were recorded in the Loni wetland. *Bellamya bengalensis* was abundant at all the sampling sites. The macrobenthic population density ranged from 30–160 nos./m^2. A total of 32 fish species, belonging to 24 genera, seven orders, and 13 families were recorded. Order Cypriniformes (47%)



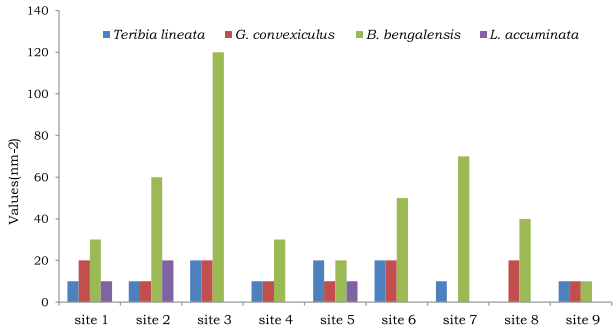
Sediment quality parameters of Loni wetland in winter



Water quality parameters of Loni wetland in winter



Density and percentage composition of phytoplankton groups in Loni wetland



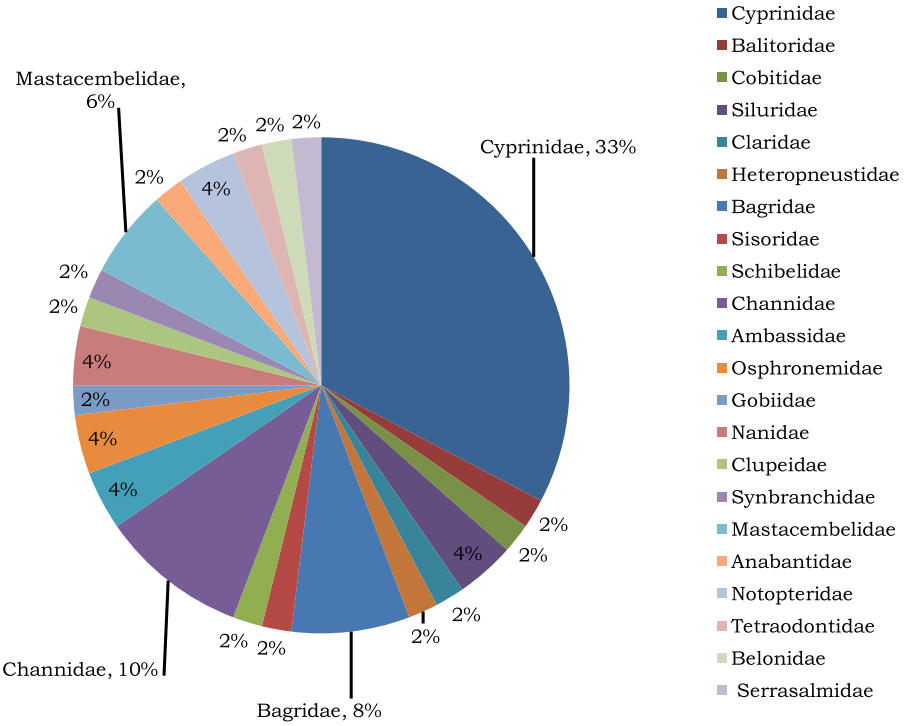
Abundance of benthos in Loni wetland

contributed significantly followed by Perciformes (25%), Siluriformes (13%), Clupeiformes (6%), Beloniformes (3%), Mastacembeleformes (3%) and Osteoglossiformes (3%). Twenty-eight species were categorized under Least Concern (LC), three species (*Chitala chitala, Wallago attu*, and *Ompok bimaculatus*) under Near Threatened (NT), and one under Not Evaluated (NE) IUCN category of conservation status.

Arunachal Pradesh

Fisheries of Borbeel

Borbeel is an open beel located at Namsai district, Arunachal Pradesh, and is connected to the River Dihing. There is no scientific record of fish diversity of the beel. In the present study, a total of 52 fish species were recorded belonging to 22 families and 8 orders across the seasons. Order Cypriniformes (19 species) contributed the highest number of species followed by Perciformes (12 species), Siluriformes (10 species), and others. The family Cyprinidae (17 species) accounted maximum number of species followed by Channidae (5 species), Bagridae (4 species), Mastacembelidae (3 species), Siluridae (2 species), Ambassidae (2 species) Osphronemidae (2 species), Nanidae (2 species), Notopteridae (2 species) and remaining 13 families had one species each. Four exotic fishes (*Cyrpinus carpio, Ctenopharyngodon idella, Hypophthalmicthys molitrix,* and *Piaractus brachypomus*) were also recorded, where Pacu was the accidental entry from cage aquaculture carried out by the Fisheries Department in the beel.



Family wise composition of fish in Borbeel, Arunachal Pradesh

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

Project code : RWF/17-20/06
Duration : 2017 - 2020
Scientific personnel : U. K. Sarkar (PI), M. A. Hassan, A. K. Das, S. K. Sahu, A. K. Bera, Lianthuamluaia, P. Mishal, Suman Kumari, G. Karnatak, T. Tayung, P. Majhi, P. Debroy, P. Panikkar, M. Karthikeyan, A. Saha, Ramya V. L., Jesna P. K., Sibinamol S., R. Palaniswamy, T. T. Paul, A. Alam, J. Kumar, Sandhya K. M. (Upto 13.07.2018) and D. Karunakaran (upto 30.06.2018)
Associates : S. Das, B.K. Naskar, Y. Ali, S. Manoharan, U. Unnithan

Macrophyte-associated fauna and benthos

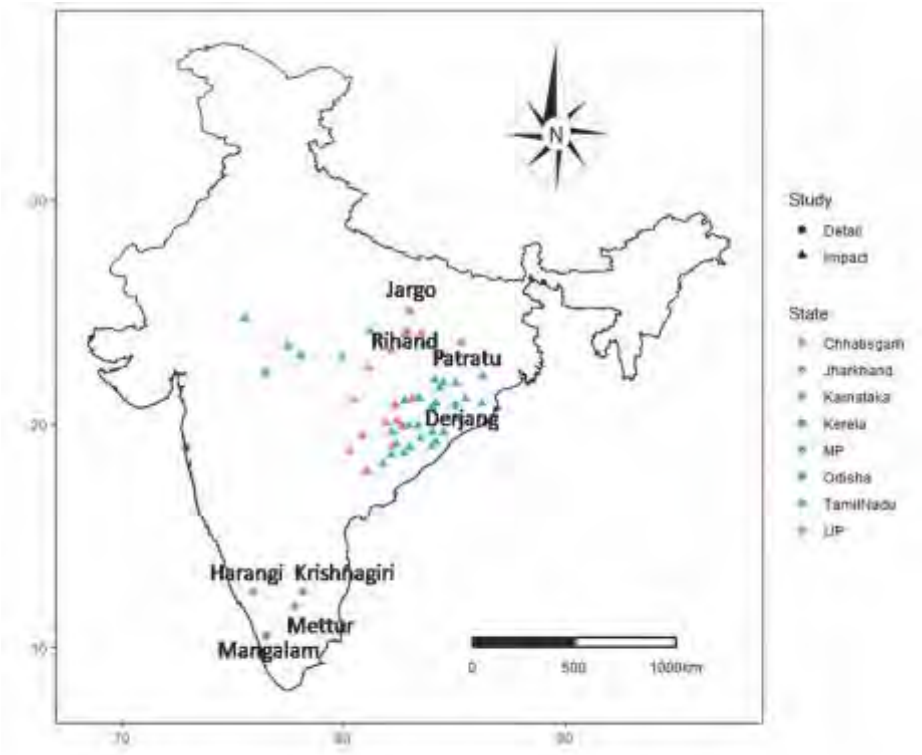
Seasonal investigation on macrophytes-associated fauna (MAF) and benthos population of Borbeel revealed the highest numerical abundance of MAF during winter (58 nos./m^2), followed by pre-monsoon (37 nos./m^2) and monsoon (29 nos./m^2) seasons. A similar trend was observed for benthos with total abundance ranging from 15 to 27 nos./m^2. Maximum diversity of both MAF and benthos were also recorded in winter and minimum in monsoon season. The MAF consisted of small fishes (7 species), insects (6 species), mollusks (2 species), and crab (1 species). The benthic fauna was dominated by mollusks.

Detailed analysis of data on eight tropical reservoirs of Jharkhand, Odisha, Uttar Pradesh, Karnataka, Tamil Nadu, and Kerala was carried out for assessing the temporal and spatial pattern of fisheries, biotic and abiotic components for refinement of management strategies and development of region-specific fisheries management guidelines.

Ecological assessment

Studies on habitat parameters indicated water quality to have a profound impact on fish, phytoplankton, and benthos abundance. Overall assessment indicated Derjang reservoir of Odisha as more productive than Patratu reservoir of Jharkhand among the small category in eastern India. Among the peninsular reservoirs, Krishnagiri was most productive owing to high organic load making it an ultra-eutrophic reservoir. The physico-chemical parameters of Jargo reservoir, Uttar Pradesh reflected medium productive nature. Physico-chemical prediction maps were prepared for the Derjang reservoir using interpolation.

The water area variations of 13 reservoirs of southern and eastern states were delineated and collected from Indian Remote Sensing imageries (lISS III and WIFS). There were five large reservoirs, five medium reservoirs and three small reservoirs. In this study, the open-source imageries from different websites like www.earthexplorer.usgs.gov and delineated water area of bhuvan geo portal (www.bhuvan.nrsc.gov.in) were used.



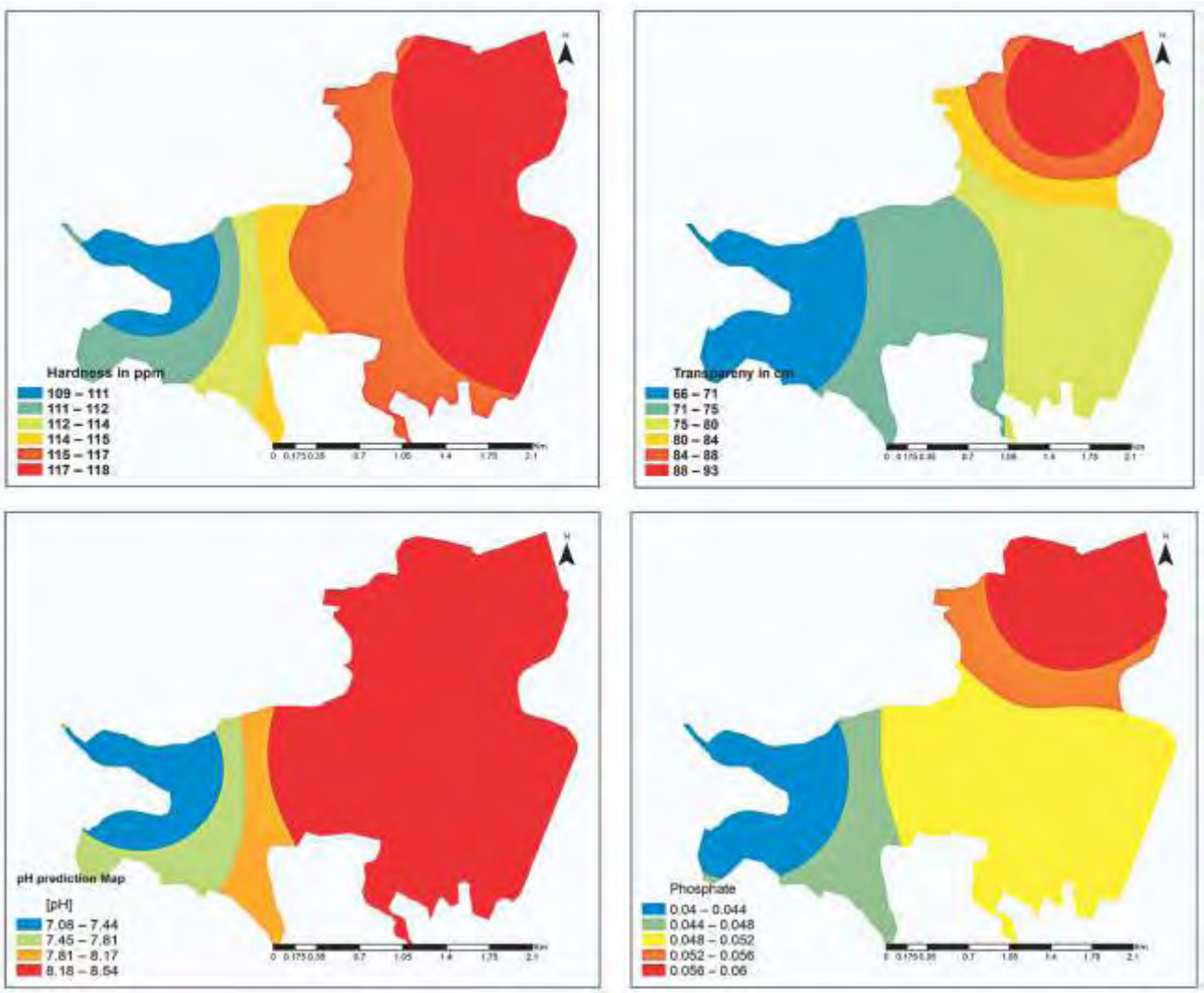
Map showing the study area

Phosphorus and nitrogen fractionation from a hyper-eutrophic reservoir

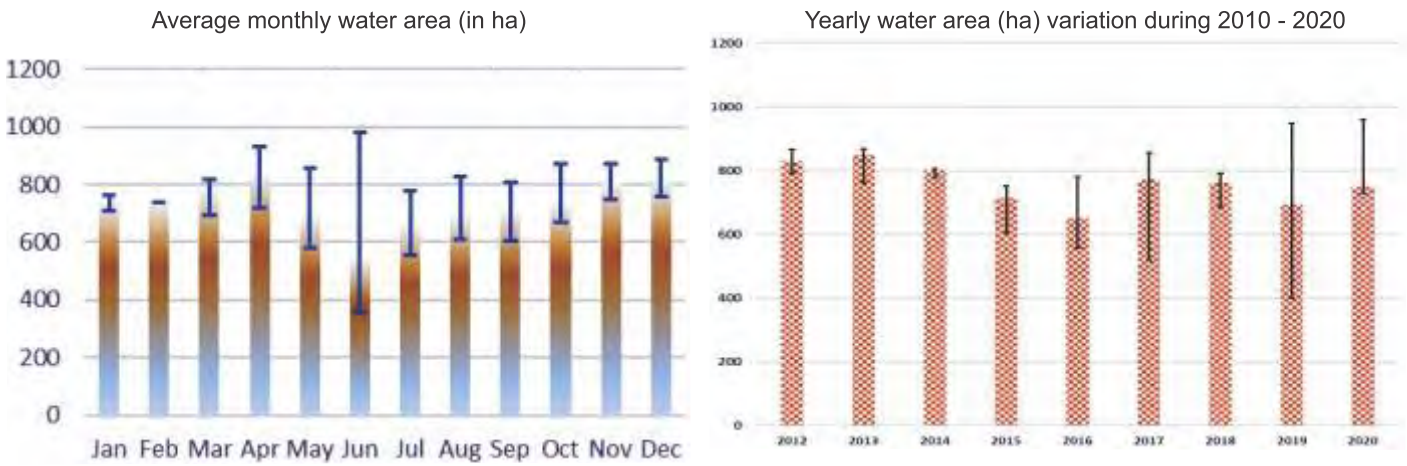
To determine the availability and sources of sediment P and N and eutrophication status, spatio-temporal variation of different P & N fractionations of sediment of hyper-eutrophic Krishnagiri reservoir, Tamil Nadu was investigated. Sediment total P (TP) content ranged from 4.62 g/kg to 5.64 g/kg. The main phosphorus form was the inorganic P (IP) which constituted 73.4-87.7% of TP. Among the different P fractions, viz., calcium bound (Ca-P), iron bound (Fe-P), aluminum bound (Al-P), exchangeable (Ex-P), and Organic-P (Org-P), Ca-P was the major dominating faction in both IP and TP. Overall the trend was as follows Ca-P>Fe-P>Al-P>Org-P>Ex-P. The dominant sources of P pollution in Krishnagiri reservoir are due to both external P influx and internal P sources from cage-aquaculture activities. Nitrogen speciation indicated that ammonium and nitrate-N in the sediment were significantly high. Inorganic nitrogen (nitrate + nitrite + ammonium) concentrations represented the major component of total nitrogen. All nitrogen forms showed an increasing gradient from lacustrine to riverine zone. The results suggest that highly contaminated sediments are significant sources of nutrients to the overlying water. The observed variations in sediment P & N fractionations would be useful in the implementation of effective management practices in controlling pollution due to nutrients in eutrophic reservoir.

Fish diversity and catch composition

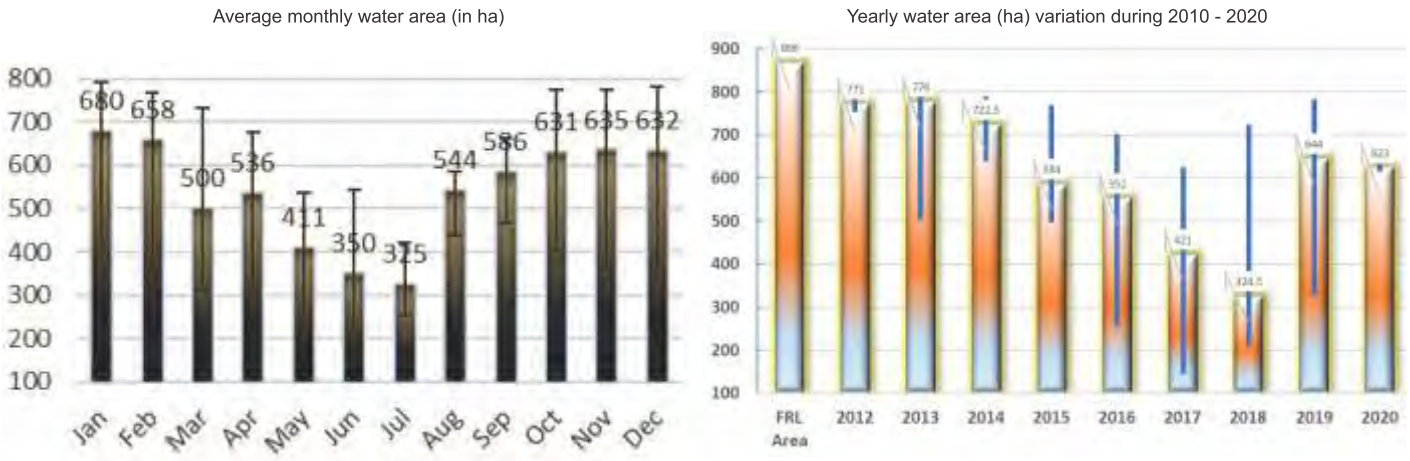
Twenty-nine fish species were recorded from Derjang while 42 species from Patratu reservoir. Fish species richness was highest in Rihand followed by Mettur and Patratu. More than 80% of the fish production was due to stock enhancement through stocking of Indian Major Carps (IMC) in Derjang while it was more than 50% in Patratu indicating a positive impact of fingerling stocking on fish yield. A total of 44 fish species belonging to 32 genera, 14 families, and 6 orders were documented from the Rihand reservoir out of which 4 were exotics. Rihand reservoir was dominated by *Labeo catla* for a long time, but time series data on fish catch (2008-2018) indicated that the catch of *L. calbasu* and *L. rohita* in long term have dominated over catla. Among the studied peninsular reservoirs, Mettur (42 species) had the highest richness of fish taxa. In the Krishnagiri reservoir, more than 95% of fish catch was dominated by *Oreochromis niloticus*. Carps dominated the catch in Mangalam reservoir.



Interpolation of different water physico-chemical parameters in Derjang reservoir



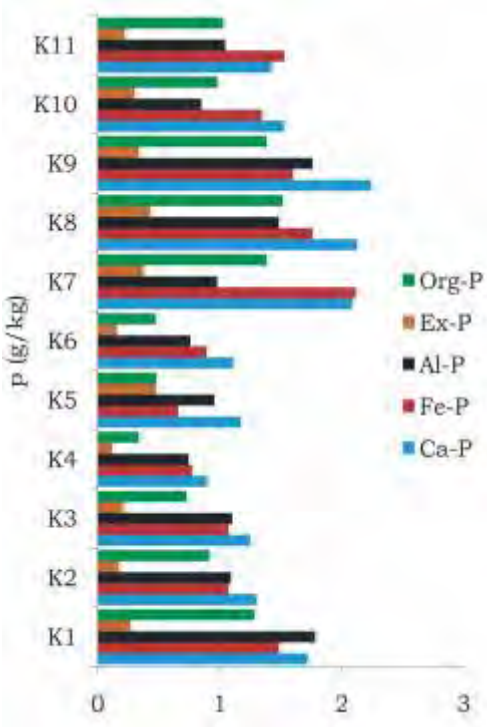
Water area variations of Patratu reservoir in last eight years (based on Remote sensing image)



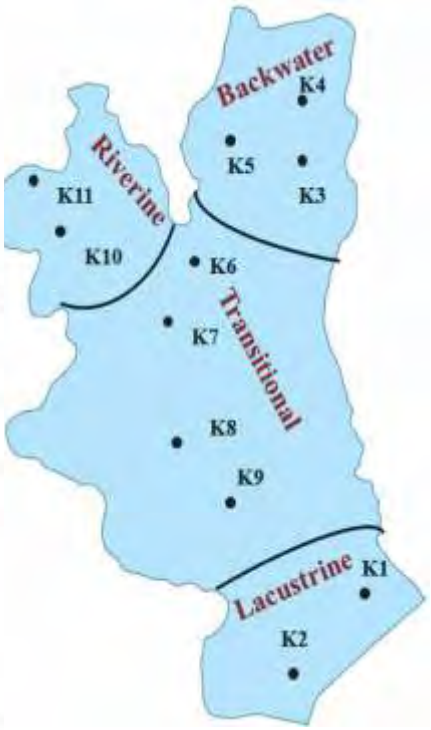
Water area variations of Derjang reservoir in last eight years (based on Remote sensing image)

Ecosystem health assessment

The ecosystem health of Mettur (Stanley), Nagarjuna Sagar, and Krishnagiri reservoirs were assessed based on 11 metrics classified under four broad categories, viz., fish assemblage, plankton, invasiveness, and production potential. Spatial data on diversity and abundance of fish, plankton, exotic fishes and productivity were collected to estimate the reference scores for each metric. The water quality of the reservoirs was also assessed based on BOD, turbidity, DO, PO_4, NO_3, Chl-a, and pH. Mettur reservoir scored B for the ecosystem health based on biotic indices (70%) as well as water quality (63%). The present fish yield from the reservoir is 84.88 kg/ha/yr against a production potential of 162 kg/ha/yr. In Nagarjuna Sagar reservoir, during the 1970s, fish catch was dominated by catfishes like *Pangasius pangasius*, *Mystus aor*, *M. seenghala* and *Silonia childreni* which had shifted to Indian Major Carps (IMCs) in the 1990s after the formation of the Srisailam reservoir at the head of Nagarjunasagar reservoir, which act as a recruitment centre of IMCs. The reservoir scored 'A' (84%) for ecosystem health based on the multimetric index and 'B' for water quality, which indicates several indicators

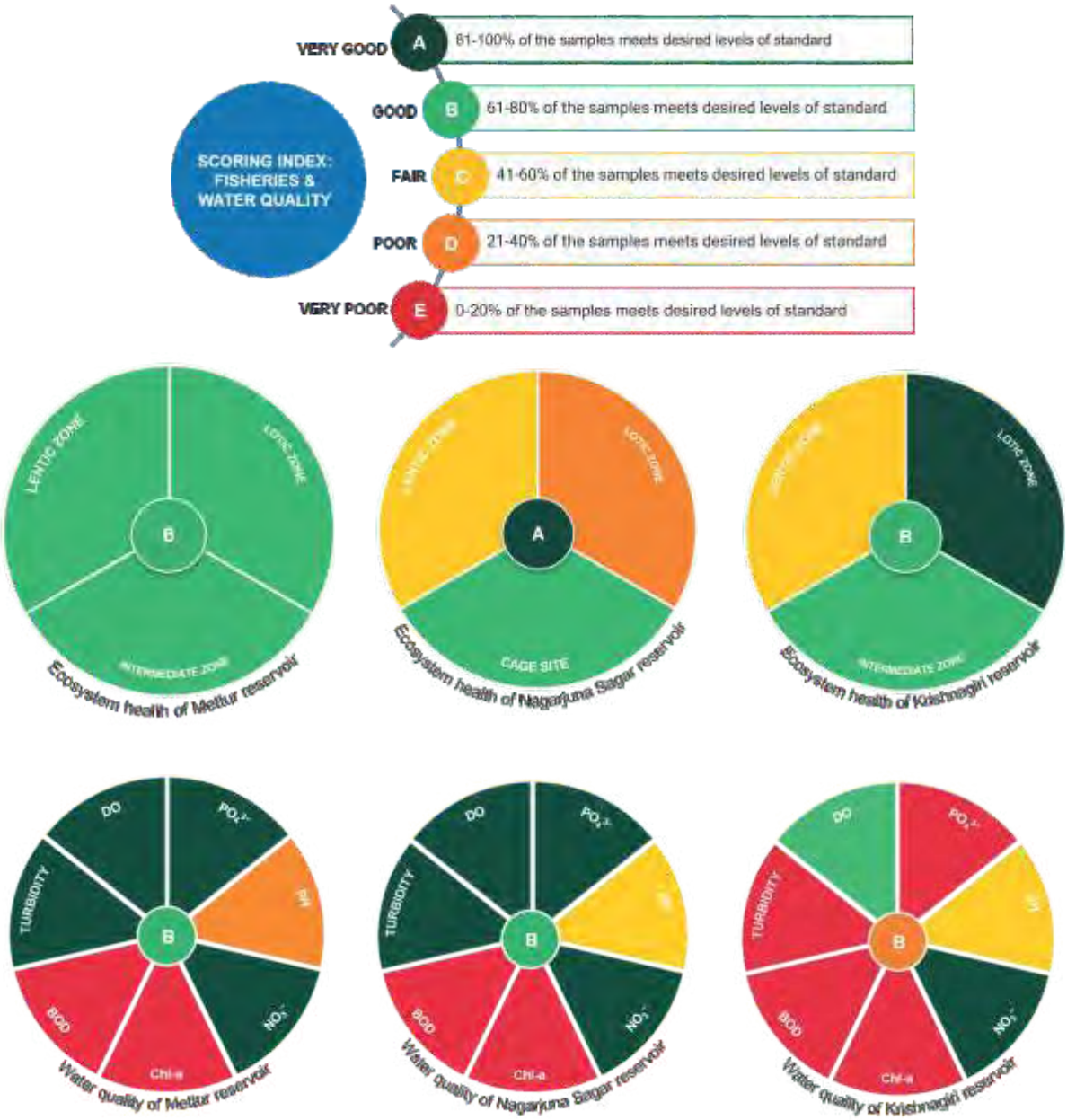


Sediment P fractionation



Sampling points at Krishnagiri reservoir

Sediment phosphorus fractionation in Krishnagiri reservoir



Ecosystem health index of selected reservoirs

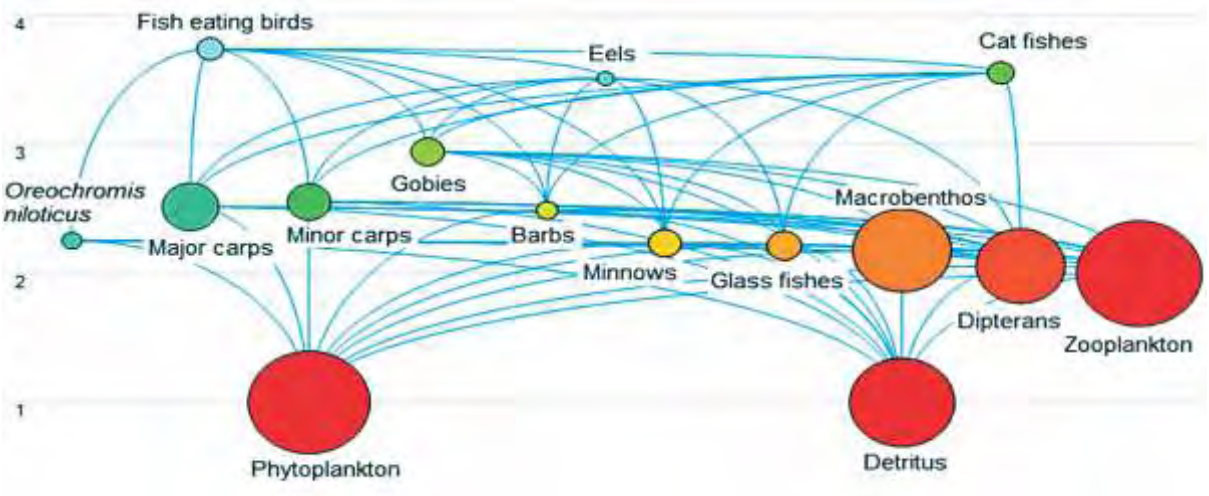
compliances with the desirable limits. DO, turbidity, PO_4, and No_3 scored 'A' while pH scored 'C'. BOD and Chl-a were under 'E' category. The primary productivity of the reservoir is estimated at 83.59 $mgC/m^3/hr$ and the fish production potential is 59.77 kg/ha. Krishnagiri reservoir scored 'D' for ecosystem health based on water quality indicating the need for immediate action for employment of integrated management plans to restore the aquatic ecosystem. Based on the biotic parameters, the reservoir scored 'B' (75%) with the lowest score in the lentic zone (58%). The reservoir has a production potential of 430 kg/ha/yr and the present yield from the reservoir is 318 kg/ha/yr.

Ecological modelling

The Ecopath model developed for Mettur reservoir indicated the dominance of low-level trophic organisms. The predation pressure was highest for minnows (*Parambassis ranga* and *Chanda nama*) and lowest for the most dominant fish group *O. niloticus* and the major carps. The trophic levels of the reservoir varied between 3.23 and 1.0, with the largest values corresponding to aquatic birds, and the carnivorous fishes (catfishes, freshwater eels) acting as top predators upon system resources at lower trophic levels. The mixed trophic impact routine showed that the freshwater eel *Mastacembelus armatus* has a strong negative impact on minor carps whereas the catfishes (*Mystus* spp.) have a negative impact on the Major carps, *Glossogobius giuris*, and the barbs. The Gobids has a strong negative impact on the minnows and glass fishes. The reservoir has a detritus-based food chain, where almost all the biomass is concentrated in the first two trophic levels (the producer's level and the herbivore/detritivore level), with rather low transfer efficiencies. The total system throughput was 25,639.7 t/km^2/yr. The total Biomass/total system throughput was 0.004. The primary production/biomass ratio was 101.3. The ratio of primary production to respiration was 7.84. All the attributes of ecosystem maturity and stability explicitly indicate that the ecosystem is in the developmental phase. This indicates that the reservoir ecosystem is still immature and not resilient to perturbations.

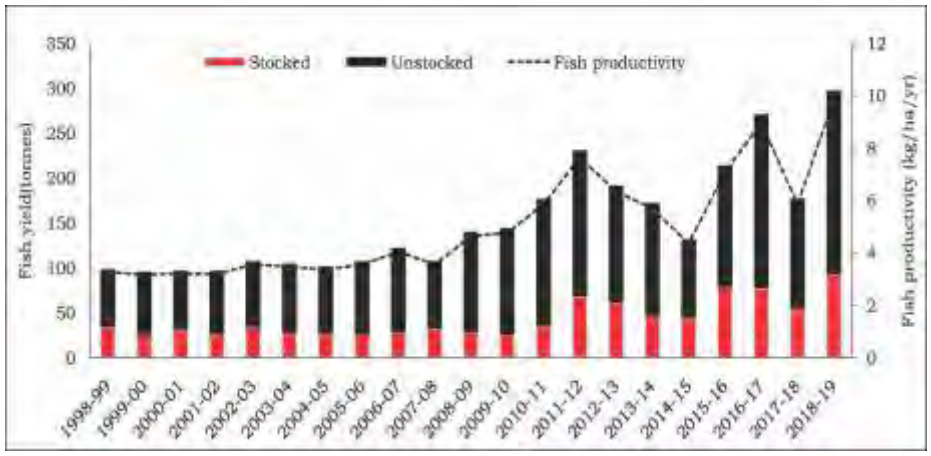
Impact of fish seed stocking

The estimated fish yield of the studied reservoirs varied from 6 to 328 kg/ha/yr which is quite less than the potential fish yield of the respective reservoir indicating huge scope for fisheries enhancement. The impact of fingerling stocking on fish yield was studied in 58 small reservoirs of Odisha, 24 small reservoirs of Chhattisgarh, 6 large reservoirs of Madhya Pradesh, and Rihand reservoir of UP. In Odisha, fish yield increased significantly ($p < 0.05$, t-test) from 204 kg/ha/year in 2012-13 to 323 kg/ha/yr in 2013-14. In Chhattisgarh, fish yield increased significantly ($p<0.05$) from 80.43 to 374.46 kg/ha/yr as a result of supplementary stocking. The catch of the IMC has steadily increased significantly from 39.9 (1998-99) to 135.7 tonnes (2018-19) in Rihand.



Trophic model of Mettur reservoir, Tamil Nadu

The analysis of catch of stocked major carps (1998-2019) showed that their yield varied between 24.66 t (1999-2000) to 92.51 t (2018-19) with a mean of 44.09 ± 4.67 t. The fish productivity of this reservoir ranged from 2.49 (2006-07) to 9.86 (2018-19) with a mean of 4.94 kg/ha/yr. The regression analysis showed that the relationship between fish catch and stocking density was insignificant at a 5% level of significance in the Rihand reservoir. Significant increase ($p<0.05$, t-test) in fish yield from 12.3 kg/ha/yr in 2004-05 to 50.3 kg/ha/yr in 2016-17 was observed in 6 large reservoirs of MP due to fingerling stocking.



Trend of fish production (t) and productivity (kg/ha/yr) in the Rihand reservoir during the period 1998-2019

Demonstration of *e-Matsya*

e-Matsya is an innovative data acquisition system to collect fish catch data from reservoirs and other inland water bodies. The demonstration of *e-Matsya* was given to the Department of Fisheries in Karnataka and Kerala. Besides, demonstration of e-Matsya was also given to the Odisha World Fish Project representatives and the officers of Odisha Fisheries Department through video conferencing.

Project title : Assessment and validation of potential fishing zones in medium and large reservoirs using hydroacoustics

Project code : RWF/17-20/07
Duration : 2017 - 2020
Scientific personnel : M. Feroz Khan (PI), Sibina Mol, S.

Acoustic survey

The hydroacoustics surveys were conducted in Krishnaraja Sagar reservoir in Mandya District of Karnataka using a split-beam echosounder (Simrad using a frequency of 1200 kHz), and a data-processing software package Sonar 5. Measures of Target Strength (TS) of fishes were used for scaling echo integration data to absolute abundance estimates and for interpreting the observed echoes. Simrad EK60 and EY500 split-beam scientific echosounder operating at a frequency of 120 kHz with circular (ES 120_7C, nominal beam angles 7 × 7°, beaming vertically) transducer was used. The whole system was calibrated by copper calibration sphere of 23 mm in diameter and TS estimated to –40.8 dB at reservoir.

A zig-zag trajectory was used as a sampling design where the width of the reservoir allowed. Acoustic surveys were divided into transects. Each transect was cleared of noise (bubbles, debris, bottom structures etc.) by setting an appropriate threshold and manual deletion, so only fish echoes remained for further analyses. For most surveys,

the TS thresholds were set at –65 dB for horizontal beaming and –70 dB for vertical beaming. Raw acoustic data were analyzed with EP500 and Sonar5 post-processing software. The bottom exclusion zone is selected to remove data within the near-bottom dead zone.

The major achievements in the project are:

- A portable assembly suited for operation in coracles was developed and the prototype has been successfully tested in Krishnarajasagar reservoir recording fish abundance without using outboard motor.
- A new assembly has been developed for converting the Transducer to Sonar and Echosounder as per the requirements.
- The Potential Fishing Zones (PFZ) in the reservoirs have been marked for the fishermen to have fast access to areas having fish abundance. The atlas of potential fishing zones made using these surveys is useful for all stakeholders.
- The map of reservoirs would be used for building spatial models of potential fishing zones using EwE software.

Hydroacoustics survey in Krishnaraja Sagar reservoir

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

Project code : RWF/17-20/08
Duration : 2017 - 2020
Scientific personnel : Preetha Panikkar (PI), M. Feroz Khan, Jesna P. K.
Associate : M. E. Vijaykumar

Feeding trial in cages using BSF meal based pelleted feed

Black Solider fly, *Hermetia illucens* (Stratiomydae : Diptera) is an insect that is amenable for mass production, can feed and multiply upon decaying organic material and widely used in biodegradation of wastes. The life cycle of the BSF is completed in 23-25 days depending upon the substrate in which it is grown and the prevailing weather conditions. A cost-effective protein rich and palatable insect meal-based fish feed was developed incorporating the Black soldier fly (BSF), (*Hermetia illucens*) prepupae meal. The BSF prepupae with 32.53% crude protein grown on organic waste were used for the feed formulation. The possibility of occurrence of heavy metal in the feed was analysed as the BSF was reared on vegetable waste and the analysis showed that arsenic, cadmium, chromium, lead, nickel and mercury were well within the safe limits. This could be a viable alternative substitute to the

Life cycle of Black Soldier Fly (*Hermetia illucens*)

BSF pre-pupae and BSF meal based pelleted feed

high cost fish meal used in the fish feed formulations. Pre-pupae was used as it is easier to harvest this stage due to the insensitivity to light compared to the larval stage.

A feeding trial was conducted in cages (3.5 x 2.5 x1.5 m^3) for 45 days. *Pangasianodon hypophthalmus* stocked at 20 nos/m^3 was fed with Black soldier fly (*Hermetia illucens*) incorporated feed at the rate of 5% of fish body weight. The stocking size was 20 ± 1.0 g and the average wet weight gain was about 62.0 g. The Feed conversion efficiency (FCE) was 0.71. The Feed conversion ratio (FCR) was 1.4 which is better as compared to the FCR obtained in the tank culture experiments using Pangasius. The results show that BSF can be an effective alternate protein source for fish feed formulations.The utilization of this detritivorous insect would enable environment friendly and sustainable way of waste reduction as well as to reduce the feed cost in aquaculture industry.

Project title: Diversification of enclosure culture in reservoirs and wetlands

Project code : RWF/17-20/09
Duration : 2017-2021
Scientific personnel : B. K. Das (PI), U. K. Sarkar, M. A. Hassan, A. K. Das, A. K. Sahoo, D. Debnath, P. Das, S. Yengkokpam, T. T. Paul, D. Das, G. Karnatak, S. Kumari, P. Mishal, H. S. Swain, Jesna. P. K, T. Tayung, M. H. Ramteke, V. Thakur (up to 30.09.18), Monica Gupta (01.04.28 to 30.09.18), J. Kumar (since 01.10.18), Vikas Kumar (since 01.10.18), S. P. Kamble

Periphyton based cage culture of *Systomus sarana*

An experiment was undertaken to study the effects of different substrates (split bamboos, sugarcane bagasse, and mosquito nets) on the growth and survival of *S. sarana* in floating cages in Salia reservoir, Odisha. All the three substrates were hung parallel to the vertical side nets of cages. *S. sarana* of an average size 100.26±0.29 g was stocked in the cages @10 nos./m^3. In all the treatments, fishes were fed with commercial floating feed twice a day @ 4% of fish body weight. After a culture period of 60 days, it was observed that bamboo substrate produced quantitatively higher periphyton per unit area, in comparison to sugarcane and mosquito net. Since the bamboo substrate is more stable than sugarcane bagasse and has organic carbon as compared to the mosquito net it can be considered as a better substrate to grow periphyton.

Optimization of stocking density of Amur carp (*Cyprinius carpio*) fingerlings in cages

Cage culture experiments were conducted to optimize the stocking density of Amur carp (*Cyprinius carpio haematopterus*) fingerlings for table fish production in cages.

Haul of *Puntius sarana*

Bamboo substrate based *Puntius sarana* culture in cage

Sugarcane substrate based *Puntius sarana* culture in cage

Cyprinius carpio (Amur carp) trail in cages at Maithon reservoir

Haul of *Cyprinus carpio* (Amur carp) in cages at Maithon reservoir

Over wintering fingerling production of *H. fossilis*

Sixteen units of cages (individual cage dimension : 5m x 5m x 2m each) installed in Samaguri beel were stocked with Amur carp fingerlings (avg. length 8.44±0.13 cm; avg. weight 9.23±0.44 g) at five different stocking densities, viz. 5, 10, 15, 20 and 25 fingerlings/m^3 in triplicates. Fish were fed CIFRI CAGE GROW floating feed containing 32% CP @ 5% body weight twice-a-day. Water quality parameters were estimated before stocking and were favourable for fish production.

Amur carp was evaluated as a candidate species for diversification in cage culture at Maithon reservoir, Jharkhand, with special reference to its performance at low-temperature regime. The fishes (3.85±0.23cm, 2.65±0.10g) were stocked in cages at stocking densities of 10 & 20 nos./m^3 in duplicate in GI cages (5m x 5m x 3m). The fishes are being fed with CIFRI CAGEGROW feed @ 3-5% of body weight twice a day. The growth of the fishes is being recorded on monthly basis. The average size attained by fishes during 150 days of culture is 63.21±1.21g and 58.36±0.91g at stocking densities of 10 nos./m^3 and 20 nos./m^3 respectively. No significant differences ($p>0.05$) have been observed in water and sediment qualities at the cage site as compared to reference sites.

Over-wintering of Singi from early fry to fingerling in circular tanks for cage grow material

H. fossilis (avg. wt. 0.71±0.12g) were stocked in two stocking densities, viz., 1 no./l (T1), and 2 nos./l (T2) in circular tanks (5000 litre capacity) in duplicates. The fishes were fed with floating feed (0.8 mm; 40% CP and 6% CL) @ 8% of the bodyweight 4 times (9:00, 12.00, 15.00 and 18:00 hrs) a day for 45 days. Hideouts were provided in the tanks to control cannibalism. The fish achieved an average weight of 2.97±0.22 and 2.45±0.20g in T1 and T2 respectively in 45 days. The live weight gain (%) achieved were 318% and 245% respectively for T1 and T2 indicating density-dependent growth pattern. The experiment is in progress.

Growth performance and survival of *Labeo rohita* in floating bamboo cages with different stocking density in Timbi reservoir, Gujarat

Grow out culture of *Labeo rohita* was conducted in floating net cages (2m x 1.5m x 1m) in Timbi reservoir, Vadodara, Gujarat. *Labeo rohita* fingerlings (13.79 ± 0.14 cm; 19.99 ± 0.52 g) were stocked in three stocking densities, viz. 10 nos./m^3 (T1), 20 nos./m^3 (T2) and 30 nos./m^3 (T3). Fishes were fed twice a day with commercial floating feed @ 8 % of the total biomass. The physico-chemical parameters of water of the study site were observed in permissible ranges for rearing of carps. After 90 days of rearing, significantly ($P<0.05$) higher growth performance with better FCR was observed in T1 while the highest biomass was found in T3. No significant differences in growth parameters were observed between T2 and T3. Stocking density did not exhibit a significant effect on the survival of rohu ($P>0.05$), however survival was maximum in T1.

Project title: Understanding spatio-temporal variations of reservoir ecosystems and developing improved fisheries management strategies for different eco-regions: A new perspective

Project code : RWF/20-23/10
Duration : 2020 - 2023
Scientific personnel : U. K. Sarkar (PI), M. A. Hassan, A. K. Das, M. Naskar, S. K. Sahu, A. M.Sajina, L. Lianthuamluaia, P. Mishal, S. Kumari, G. Karnatak, S. K. Koushlesh, H. S. Swain, C. Johnson, T. Tayung, P. Panikkar, M. F. Khan, M. Karthikeyan, A. Saha, V. L. Ramya, P. K. Jesna, S. Sibinamol, D. Sudheesan, T. T. Paul, D. Debnath, S. Yengkokpam, A. K. Yadav, S.C.S Das, S. Borah, A. Alam, J. Kumar, W. A. Meetei, G. Vaisakh
Associates : S. Das, B.K. Naskar, Y. Ali, V. Kumar, S. Manoharan, R. K. Sah, J. K. Solanki, A. Kakati

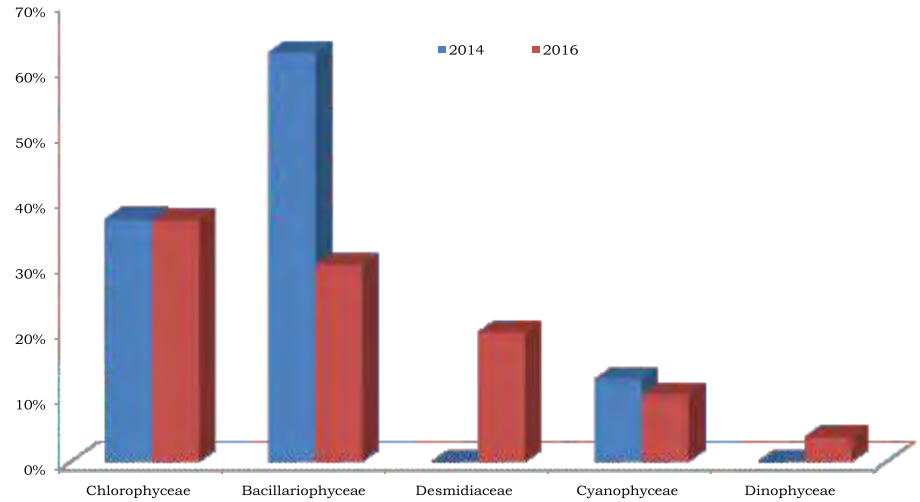
This reservoir research programme is functioning through 5 subprojects: (i) Understanding spatio-temporal variations of large reservoir ecosystems (Hirakud, Panam & Idukki) and developing improved fisheries management strategies, (ii) Development of ecosystem-based fisheries management strategies for medium reservoirs (Kodar, Upper Manair, Poondi & Seruli B) in different eco-regions, (iii) Refinement of culture-based fisheries for small reservoirs (Gayatri, Beko, Upper Khaguria & Sunei) in different eco-regions, (iv) Tropho-dynamic modeling of reservoirs for ecosystem-based fisheries management, and (v) Assessment of time scale changes in reservoir ecology and fisheries and developing an updated database.

Status and fish productivity of the reservoirs of Uttar Pradesh

The total area under the reservoirs in Uttar Pradesh is approximately 1,49,035 ha which are spread across 17 districts. Rihand (52,000 ha), Matatila (10,368 ha), Rajghat (22,400 ha), Saradasagar (6900 ha), and Brahmanand Sagar are the five large reservoirs with a cumulative area of 82,747 ha. The medium reservoirs have a total area of 49,371 ha and the small reservoirs have 16,917 ha. The reservoirs are stocked with the seed of major carps in July and August every year. The fish production from the small, medium, and large reservoirs range between 52-139 kg/ha/yr (Gularia, Bachra, Pahuj), 10-51.3 kg/ha/yr (Jargo reservoir), and 2.49-9.48 kg/ha/yr (Rihand reservoir) against the potential production of 500, 100 and 50 kg/ha/yr, respectively. Low stocking density, very small size at stocking, the low conversion efficiency of the photosynthetic energy to fish, and the dominance of catfishes were the major causes for the low fish productivity in reservoirs. The stocking density of >2000 (small), 1000 (medium), and 500 (large) fingerlings per ha per yr, stocking of fingerlings (> 100 mm TL), in-situ breeding and rearing in cages and pens, adoption of culture-based fisheries in small reservoirs, cage culture technology in medium and large reservoirs and identification and protection of the breeding ground of the Gangetic carps are some of the suggested measures for the enhancement of fish productivity in reservoirs.

Productivity and fisheries status of Idukki reservoir, Kerala

Idukki reservoir, the only large reservoir of Kerala is formed by building three dams, viz. Idukki, Cheruthoni, and Kulamavu dams, across the River Periyar. It is spread across a catchment area of 649.3 km^2 with an FRL of 702.3 m. Indices such as shoreline development index (1.2) and volume development index (2.3) indicated low productivity of Idukki reservoir which further suggests high potential for fish production enhancement



Plankton diversity of Idukki reservoir

strategies. Very low Morpho-Edaphic Index (MEI) indicated the oligotrophic status of the reservoir. A review of literature on Idukki reservoir also indicated oligotrophic status of the reservoir in 2014 which shifted to mesotrophic in 2016 as evident from the plankton diversity estimates. A bibliographic estimate of catch statistics of Idukki reservoir indicated that exotics (*C. carpio* and *Oreochromis* sp.) dominated the catch to the tune of 80.67% followed by indigenous fishes. The predominance of exotics in the reservoir can have huge biosecurity concerns since the reservoir is situated in the Western Ghats biosphere.

Status of fisheries of Hirakud reservoir

Hirakud Dam built on Mahanadi River is the longest dam in India with a 4.8 km main dam and a total length of 25.8 km with dam and dykes taken together. It is situated in Sambalpur, Jharsuguda, and Bargarh districts of Odisha on river Mahanadi. It has a water spread area of 74,592 ha, catchment area of 83,395 km^2 and shoreline of 643.60 km. The reservoir serves the irrigation needs of 2,64,038 ha of land and is a major resource for fish production. About 5000 fisher families are dependent on this reservoir for their livelihood. The fishing right of the reservoir was conferred on the state fisheries department in as early as 1960 and leasing right was entrusted with the fishery department by the revenue department for commercial exploitation.

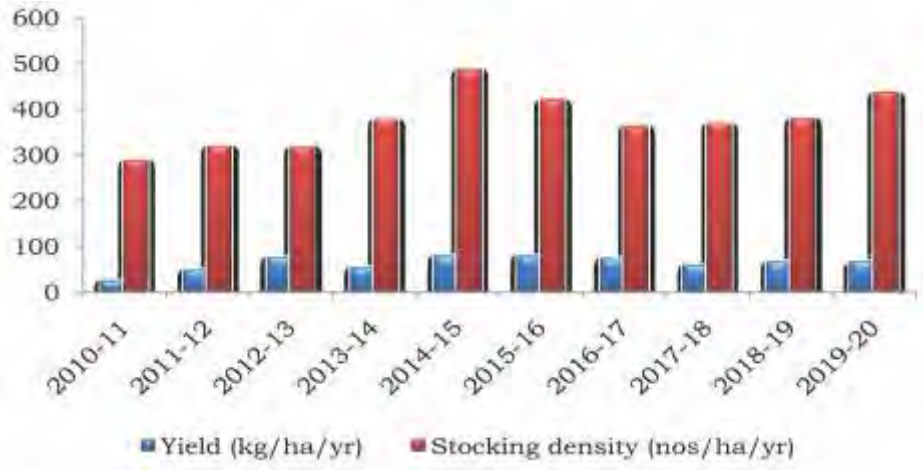
Hirakud reservoir harbours a rich ichthyofaunal diversity along with abundance representing its parent river, the Mahanadi. The diversity of fishes in the reservoir is mainly comprised of carps, catfishes, murrels, featherbacks, and prawns. The commercial fish catch of the reservoir since inception (1959 to 2015) indicates an upward trend during its initial 10 years, marginal shortfall afterward and highest catch recorded in 1980-81(15.6 kg/ha). There has been a sharp fall in catch in the succeeding two decades. The fish catch of the reservoir again dropped to 4.5 kg/ha/yr in the '90s and the trend continued. The average yield of Hirakud reservoir was at its peak during the late '70s when it was recorded to be 11 kg/ha/yr which gradually reduced to 3.1 kg/ha/yr in 2000-2001.

Analysis of literature showed that the fish catch comprises mainly of catfishes *Eutropichthys vacha, Wallago attu, Sperata seenghala, S. aor, Rita chrysea, Silonia silondia* accounting to 40-50% followed by carps viz. *Labeo fimbriatus, Labeo calbasu, Labeo rohita, Cirrhinus mrigala, Labeo catla*, etc. comprising 15-20% and rest are miscellaneous fishes like *Gudusia chapra, Osteobrama cotio, Salmostoma bacaila* and *Ailia coilia*. The data collected from Odisha state fisheries department indicates the dominance of *S. seenghala, S.aor* and *W. attu* among the predatory fishes.

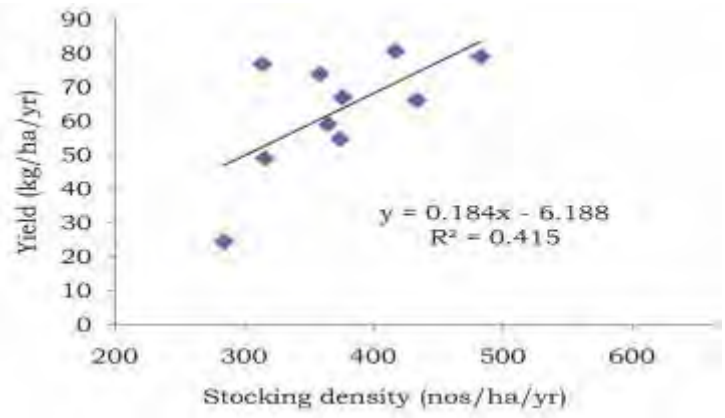
Impact of stocking in Tamil Nadu reservoirs

Tamil Nadu state has a total water spread area of 3.7 lakh ha inland resources suitable for fish culture or enhancement. The inland fishery resources of Tamil

Nadu have a fish production potential of 4.5 lakh MT with an actual yield of only 0.87 lakh MT. The fisher population is about 1.83 lakh, out of which 59,000 are registered under 270 fishermen cooperative societies and are actively involved in fishing. The fish stocking and yield data of 54 reservoirs during 2011-2020 collected from the Fisheries Department of Tamil Nadu were analyzed. Major fish species stocked in the reservoirs were *Labeo catla, L. rohita, Cirrhinus mrigala* and *C. carpio*. The relationship of stocking density to yield was assessed by regression analysis and the relationship is y = 0.1841x - 6.1888 (R^2 = 0.415). The correlation between stocking density and yield was assessed by Pearson correlation coefficient. The stocking density had a strong positive correlation with fish yield (r=0.65).



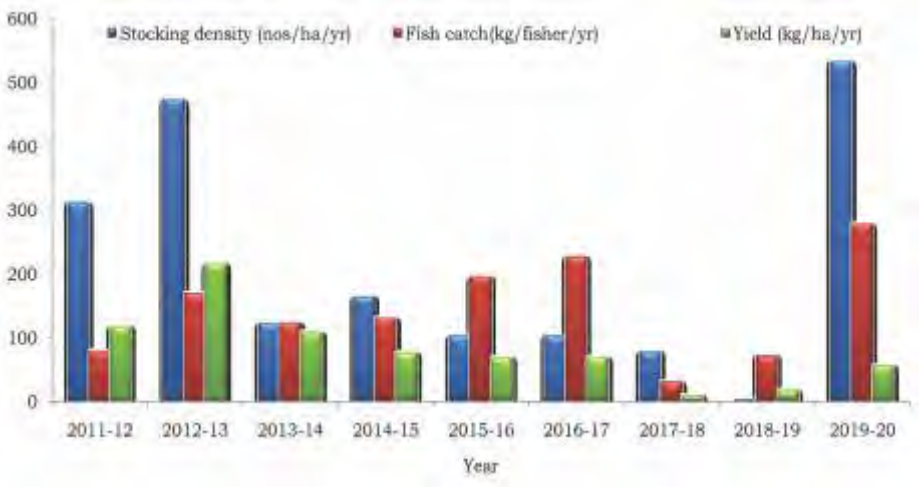
Stocking density and fish yield in Tamil Nadu reservoirs during 2010-20



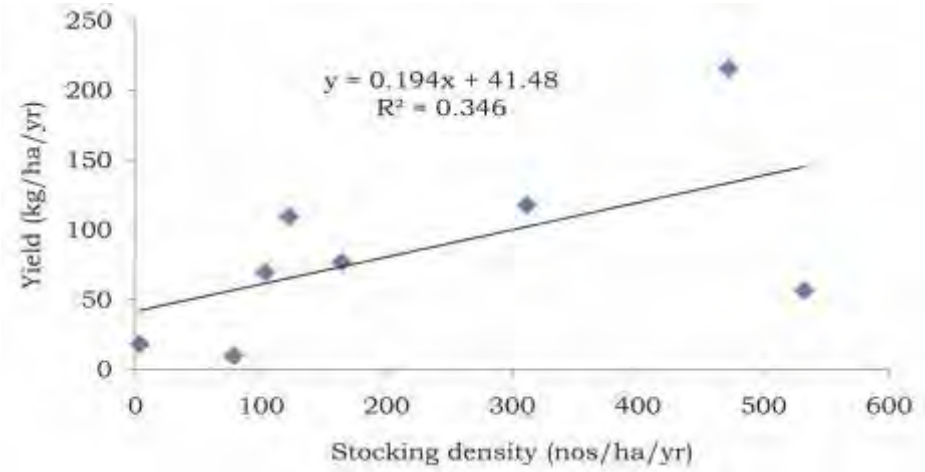
Relationship between stocking density and fish yield in Tamil Nadu reservoirs

Poondi reservoir

Poondi reservoir (13°11′6″ N, 79°51′36″ E) is one of the major reservoirs across the Kosathalaiyar river in Thiruvallur Distirct of Tamil Nadu. The reservoir constructed during 1944 for the purpose of irrigation is also a major source of water for Chennai city, which is about 60 km away from the reservoir. The total water spread area is 3,458 ha and the area at the full reservoir level is about 1729 ha. The Fishery Cooperative Society



Stocking density and fish yield in Poondi reservoir during 2011-20



Relationship between stocking density and fish yield in Poondi reservoir

issues license to its members for fishing. There are 9 societies with 770 members in and around Poondi reservoir. Presently there are 809 licenses issued for a fee of Rs. 100/month. The seed stocking rate was 8.40 lakh during 2019-20 and the exploitation target was fixed at 8.4 tonnes for stocked and 130 tonnes for unstocked fishes. Fish stocking, yield, and fisher's details of Poondi reservoir during 2011-2020 were collected from the state fisheries department. Major fish species stocked in the reservoir were *L.catla, L. rohita, C. mrigala* and *C. carpio*. The relationship of stocking density to yield was assessed by regression analysis and the relationship is y = 0.1948x + 41.48 (R^2 = 0.3467). The Pearson correlation analysis showed that stocking density has a strong positive correlation with fish yield (r=0.59).

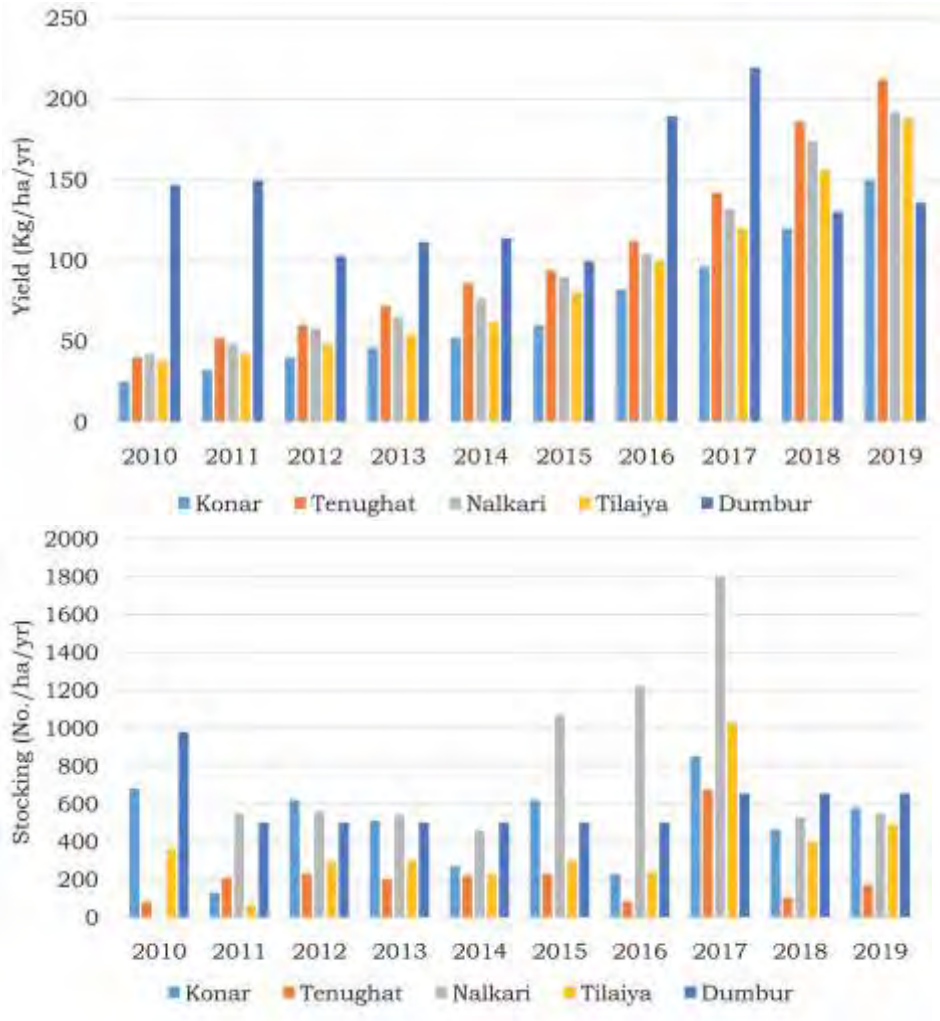
Impact of stocking in Jharkhand and Tripura reservoirs

Adoption of culture-based fisheries regime has been found prevalent in many ecoregions of India yielding improved fish production and livelihood. The Department of Fisheries Jharkhand and Tripura adopted culture-based fisheries developed by ICAR-CIFRI to increase fish production from reservoirs in a co-management regime. The impact of stocking of fingerlings of IMCs on fish yield has been assessed from four reservoirs of Jharkhand (Konar, Tenughat, Nalkari, and Tilaiya) and one in Tripura (Dumbur). Stocking density was found to be less than 1000 number of fish fingerling/ha/yr except in Tilaiya and Nalkari reservoirs. The fish yield has increased maximum in Konar (6 fold) and minimum in Dumbur (2 fold). Fish yield and stocking density of Jharkhand & Tripura reservoirs during 2010-19.

Ecosim model of Karapuzha reservoir

The ecosystem dynamics and ecological interactions among various organisms in Karapuzha reservoir in the Wayanad District of Kerala were studied through Ecopath modeling. The model revealed that fishing and predator-prey interaction form the main drivers of this ecosystem. For the first time in a reservoir ecosystem in India, Ecopath with Ecosim was used to predict temporal shifts caused by fishing impacts. The mean trophic level of the catch was 2.53 which remained constant throughout the time series.

The Ecopath model constructed for the reservoir was simulated using Ecosim. The dynamic model showed a slight increase in catches for eels, minnows, and crustaceans with an increase of fishing effort. Such findings indicate that the biomass levels for these species are currently too low to afford higher fishing pressure. At the beginning of the time series, the fishing mortalities of *Oreochromis mossambicus, Clarias gariepinus* and *Channa* spp. were high. The simulated graphs show that, between 2016 and 2045, the biomass for *C. gariepinus, Mastacembelus armatus* and the minor carps were higher under decreased effort scenarios. However, for the other fish groups, the biomass increased with increased fishing efforts. The highly



Fish yield and stocking density of Jharkhand & Tripura reservoirs during 2010-19

invasive *C. gariepinus* shows a high level of exploitation when the fishing effort is doubled. Further increasing the fishing effort by 50% will lead to a drastic decline of *C. gariepinus* and the fish may ultimately disappear from the reservoir by 2040. Major carps are overexploited and regular stocking is required to revive the fishery. Their presence does not negatively impact any other fish groups. Minor carps are overexploited and a 10% reduction in fishing effort will help in reviving this fishery. Eels are underexploited and there is much scope for the expansion of eel fishery in this reservoir whereas snakeheads are overexploited.

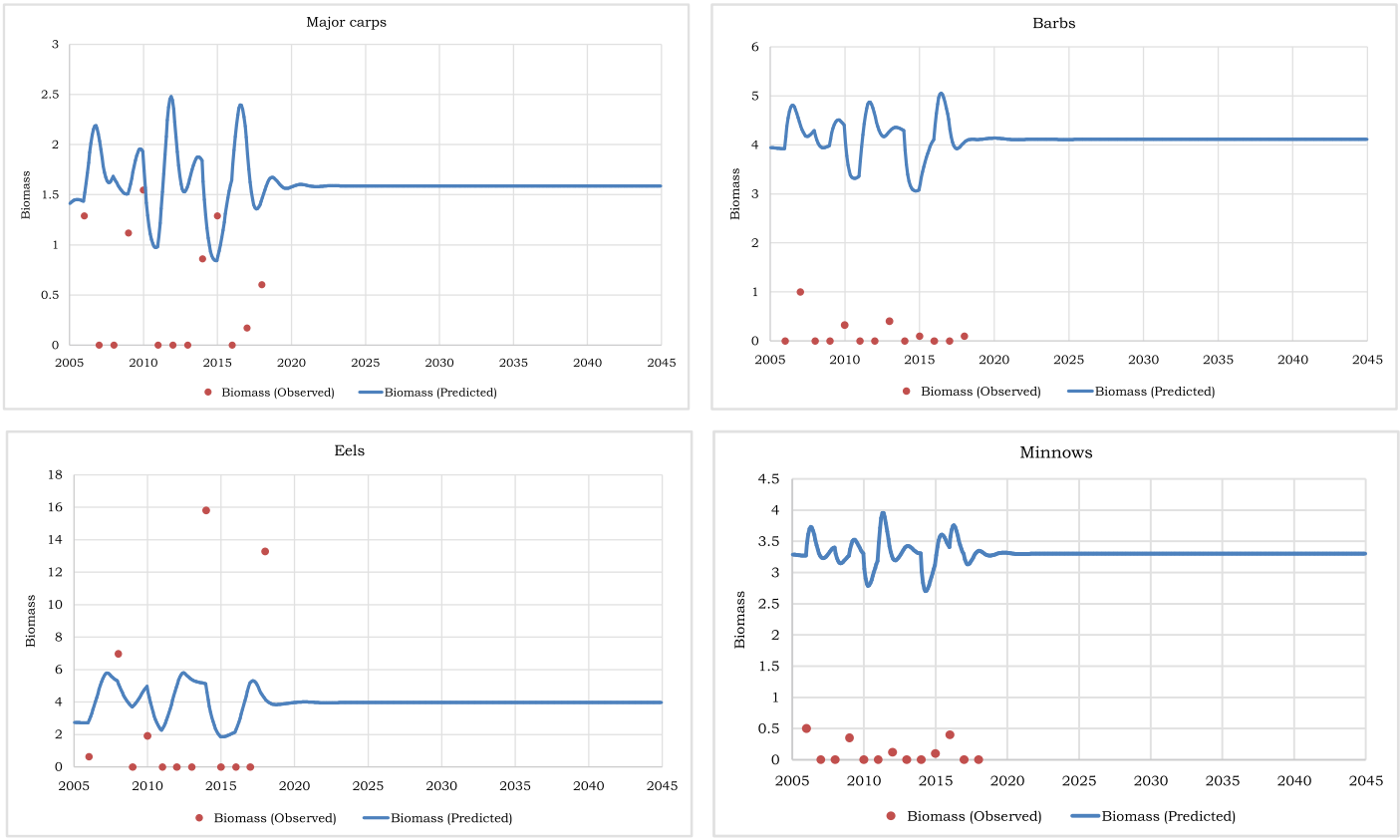
Ecosystem summary indices of different reservoir ecosystems: Tools for developing management protocols

Food web structure is a vital component in understanding the ecosystem function and is useful in developing management protocols. The health of an ecosystem can be measured using Odum's attributes of system maturity and ecologists around the world are investigating this aspect. A healthy ecosystem is not easily vulnerable to disturbances, both anthropogenic and natural. A comparative analysis of different time periods for the same system can help managers to assess the health status of the system. A comparative statement of the ecosystem summary indices for the different inland ecosystems modeled in India is given in Table.

The TPP/TR, which is an indicator of the 'maturity' of the system is almost close to one for Wyra, followed by Karapuzha indicating better resilience of these reservoirs against perturbations (both natural and anthropogenic). High values were obtained for Mettur and Krishnagiri reservoirs which show that these reservoirs are in a developmental phase. The high overhead values for Wyra and Karapuzha reservoirs further show that these ecosystems have sufficient energy reserves and are stable indicating better 'health' compared to other ecosystems.

Strategic plan for increasing fish production from reservoirs under PMMSY

Pradhan Mantri Matsya Sampada Yojana (PMSSY) is a



Time series of observed total catch and predicted total catch (tonnes/km^2/yr) for Karapuzha reservoir

scheme to bring about Blue Revolution through sustainable and responsible development of the fisheries sector in India through addressing critical gaps in fish production and productivity. There is a greater scope to increase fish production from Indian reservoirs in a sustainable manner and can contribute significantly to the ambitious fish production target under the scheme. The three-pronged strategies for fisheries development are CBF in small and medium reservoirs, stock enhancement in large reservoirs, and table fish production through enclosure culture (cages) in medium and large reservoirs. There are also issues of institutional arrangements and governance and poor socio-economic status of fishers. The value chain to be strengthened for effective marketing and enhanced income. A long-term focused vision and strategic action plan is the pre-requisite to address the yield gap and to enhance fish yield in a sustainable manner. The proposed plan aimed at enhanced fish production from these huge untapped resources keeping the ecological integrity. The fish yield from Indian reservoirs has enhanced through fingerling stocking and adoption of improved management practices and the average productivity increased to 34, 98, and 190 kg/ha/yr from large, medium, and small reservoirs respectively. The production potential has been re-casted to a level of 100, 200, and 500 kg/ha/yr from large, medium, and small reservoirs, respectively. The increase in fish productivity is about one-third of the present production potential and there exists scope for developing effective and sustainable strategies for further enhancing the fish yield.

In addition to the cages functional at present, an additional 20,000 cages have been earmarked to be

System summary statistics for the reservoir ecosystems modeled

Reservoir	Area (ha)	TPP/ TR	TPP/ TB	TB/ TST	CI	OI	FCI	MPL	Ascendancy	Overhead
Wyra	1074	1.367	16.24	0.011	0.246	0.191	NA	3.42	24.75	75.25
Kelavarapalli	430	7.78	76.07	0.006	0.296	0.156	3.04	2.31	35.92	64.08
Hemavathy	9162	5.33	72.58	0.005	0.264	0.112	NA	3.75	38.2	61.8
Manchanbele	365	3.433	15.863	0.024	0.326	0.212	3.79	2.671	37.21	62.79
Ravishankar Sagar	9540	7.5	12.26	0.012	NA	NA	NA	NA	NA	NA
Karapuzha	331.2	0.018	0.265	0.116	8.844	2.969	24.5	75.5	24.5	75.5
Mettur	14690	0.004	0.321	0.141	7.565	2.526	37.80	62.07	37.8	62.2

TPP: Total Primary Production, TR: Total respiration, TB: Total Biomass, TST: Total System Throughput, CI: Connectance Index, OI: System Omnivory Index, FCI: Finn's Cycling Index, MPL: Finn's Mean Path Length, NA: Not available

incorporated and installed under PMMSY by different states in their larger water bodies. Looking towards greater interests of the multi-stakeholders and saving the water bodies from being eutrophied due to intense cage culture activities, ICAR-CIFRI in consultation with NFDB, Hyderabad has come to a common consensus and agreement that only 0.1% of the total area under large water bodies will be taken into consideration for cage culture. Accordingly, 2,000 ha will be available to be covered under cage culture. There will be 400 cages accommodated in a 1 ha area at a size group of 6x4 or 5x5 m^2 and thus, a total of 8.6 lakhs cages could be installed in Indian freshwater bodies. There is a greater scope to increase fish production from small and medium reservoirs in a sustainable manner and can contribute significantly to the fish production target under the scheme. The realization of the full potential of reservoirs can yield 6.3 lakh tonnes through implementation of CBF/stock enhancement and 25.8 lakh tonnes through cage culture.

Time series analysis of reservoir ecology and fisheries

The available secondary data on ecology influencing fish abundance were collected for 121 reservoirs from all over India. The average value of the productivity indicators including conductivity, nitrate, and phosphate clearly indicated that most of the reservoirs were rich in nutrients to support good fisheries in the reservoirs. Critical parameters including pH and DO were in the favorable range for fish production. Secchi depth or transparency also clearly indicated the reservoirs were highly productive for fish production. The collected data will be useful for the formulation of management strategies for the sustainable enhancement of fish production in the reservoirs.

Projected fish yield through stocking enhancement

Reservoir category	Present fish yield (kg/ha/yr)	Potential yield (kg/ha/yr)	Yield gap (kg/ha/yr)	Targeted yield under PMMSY
Small	190	500	310	343
Medium	98	200	102	147
Large	34	100	66	50

Average water quality parameters of reservoirs

Parameters	Values
Transparency (m)	1.17
pH	7.84
Conductivity (µS/cm)	245.92
Nitrate (mg/l)	0.65
Phosphate (mg/l)	0.32
Dissolved oxygen (mg/l)	7.65
GPP (mg/cm^3/hr)	281.34
NPP (mg/cm^3/hr)	156.59
Avg. fish yield (kg/ha/yr)	98.49

Project title : Eco-orientation approach for fisheries enhancement of floodplain wetlands in diverse eco-regions of India

Project code : RWF/20-23/11
Duration : 2020-2023
Scientific personnel : A. K. Das (PI), U. K. Sarkar, A. Sinha, A. Alam, D. Debnath, D. K. Meena, A. K. Bera, Md. Aftabuddin, Liantuamluaia, P. Gogoi, G. Chandra, R. Baitha, M. Gupta, V. Thakur, J. Kumar, S. Borah, S. Yongkokpam, S.C.S. Das, P. Das, A. K. Yadav

The project has the following subprojects :

Sub-project 1 : Eco-orientation approach for fisheries enhancement of floodplain wetlands in NE States of India

Sub-project 2 : Eco-orientation approach for fisheries enhancement of floodplain wetlands in West Bengal

Sub-project 3 : Eco-orientation approach for fisheries enhancement of floodplain wetlands in Bihar

Sub-project 4 : Eco-orientation approach for fisheries enhancement in floodplain wetlands in UP/MP

India is endowed with a vast expanse of open inland waters in the form of rivers, canals, estuaries, lagoons, reservoirs and lakes. Extensive areas under floodplain wetlands in the form of mauns, beels, dah, chaurs, jheels, pats are available in eastern Uttar Pradesh, Madhya Pradesh, northern Bihar, West Bengal, Assam, Tripura, Manipur, Arunachal Pradesh and Meghalaya. India has around 0.564 million ha of floodplain wetland resources. These are shallow nutrient rich water bodies formed due to the change in river course and are integral parts of river complex. These water bodies are extremely rich in nutrients and have immense potential energy resource, which can be tapped for getting maximum energy return as fish through the adoption of culture-based fisheries and integrated approach.

The fish production potential of the wetlands ranges from 1500 to 2000 kg/ha, but the actual realization of fish yield is much less (~ 400kg/ha) leaving a big gap to bridge. Focused research interventions and implementation of knowledge-based management practices is required to bridge the gap between present production and potential. Culture based fisheries are generally practised for management of wetlands India. However, the distributions of wetlands are quite uneven in different eco-regions of India and applying a single management strategy may not be suitable for different eco-regions. A multidisciplinary farming approach is more advantageous to a farmer than the mono-cropping system to utilize the available resources in possession and for gainful employment of the weaker section of the society through the encouragement of integrated approach. In most perennially open and large wetlands, natural fish stocks are harvested with little human intervention on habitat variables and fish stocks. At present, many of the closed floodplains are managed through culture-based fisheries (CBF). To harness the actual potential of floodplain wetlands of India, the existing technology needs to be validated and refined for different eco-region of India.

Stock enhancement is being carried out in many closed and seasonally open wetlands in different parts of India. But few attempts were made to assess the impact of stocking on fish yield. Teh project aims to assess time-scale changes in fish yield and catch composition in relation to fisheries management, generate information on bio-diversity and habitat characteristics in relation to eco-health, assess impact of management regimes on socio-economic and livelihood of wetland fishers, and to develop guidelines/advisories for sustainable management of floodplain wetlands of India.

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

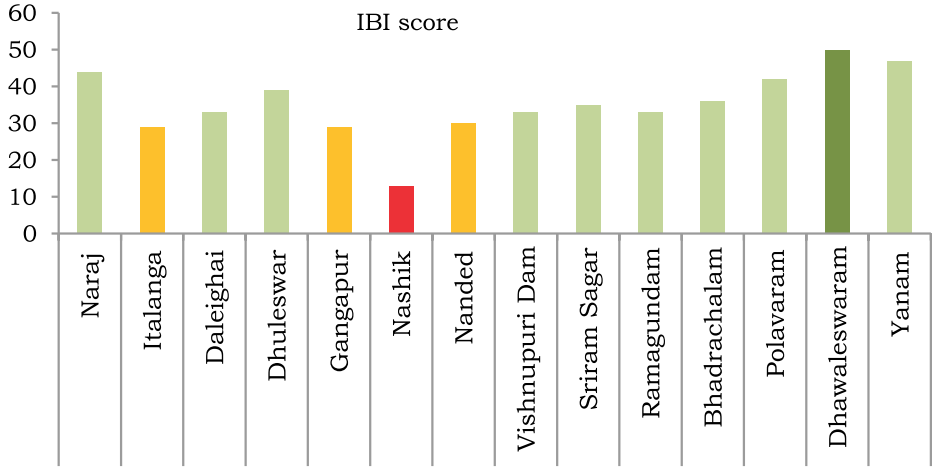
Project code : FREM/17-20/11
Duration : 2017 - 2020
Scientific personnel : S. Samanta (PI), S.K. Nag, M. Naskar, Sajina A.M., Vikas Kumar
Associates : S. Bhowmick, K. Saha, S.K. Paul, S. Bandyopadhyay, A. Ghosh

Ecological health of riverKathajodi-Devi and Godavari

River Kathajodi is the main southern distributary of Mahanadi, branching off at Cuttack, Odisha. The lower part of the river acquires the name Devi as it flows further east; it bifurcates several times during its course before joining the Bay of Bengal. River Godavari is the second-longest river in the Indian subcontinent, with a total length of 1465 km, and is called 'Dakshin Ganga' or Ganges of the South. The river traverses through Maharashtra, Telangana, Andhra Pradesh, and Yanam before it drains to the Bay of Bengal.

The most significant ecological stressor identified for the two rivers was the river fragmentation and impaired flow. Pollution was the second most significant stressor in this river system. River Kathajodi-Devi faces severe threat due to direct inflow of Cuttack city sewage of 100 mld capacity. Domestic pollution through intensive use of water for bathing, washing clothes and utensils, defecation, dumping wastes, etc. along with pollution from industrial sources contributed to the degradation of the river ecosystems. There are several industries along the bank of the river and agricultural runoff, urbanization, and developmental activities have also contributed to the anthropogenic impacts on the river ecosystem.

The IBI scores reflect the ecological health of the rivers. The poor score indicates impairment like deteriorated stretches having less flow with stagnant water, receiving the discharge of sewage and untreated industrial effluents etc., whilst the river stretch with good flow indicates high score. The fish-based index of biotic integrity (IBI) showed that most of the stretches Kathajodi-Devi river were in moderately impaired condition except at Italnga, where the sewage from Cuttack city has accumulated causing severe (>50%) impairment of ecological health. In Godavari, three sites in Maharashtra were severely impaired with Nashik exhibiting a very poor IBI score. The rest of the river stretches were moderately impaired except Dhawaleswaram which showed slight impairment and



The IBI scores of freshwater stretch of River Kathajodi and River Godavari

Fishers operating cast net just downstream of Naraj Barrage in River Kathajodi

an acceptable IBI score. No stretch remained in pristine or unimpaired condition in both the river systems.

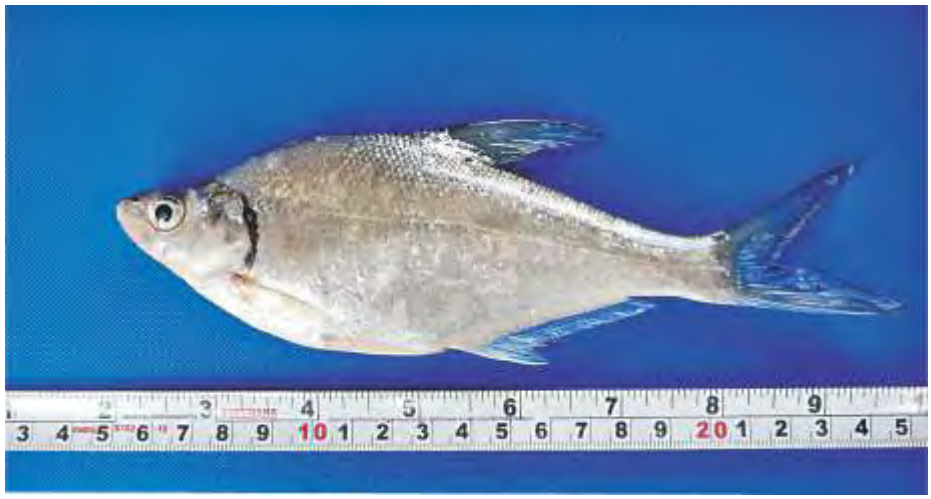
Following recommendations have been formulated for improving the river health of Kathajodi-Devi and Godavari river systems, based on the observations and inference from the study:

- The enhanced level of pollution in both the rivers, especially in Kathajodi is due to the rampant disposal of sewage. The discharges from many industries enter the rivers directly. There is an urgent need to establish sewage treatment plants and ensure these plants function properly and release only permissible treated sewage to the rivers.
- The failure to enact and apply laws prohibiting the discharge of industrial and human wastes into the river has made the systems dangerously polluted day-by-day, causing serious health hazards. There is a strong need to strengthen the enforcement of environmental laws and legislations for conserving rivers.
- Obstructed river flow is also a major ecological stressor in both rivers due to a greater extent of river fragmentation. At least the minimum required environmental flow of water must be ensured after a river gets diverted by various projects for irrigation, hydropower, industrial use, etc.
- The rivers are germplasm reserves of native fish fauna. Immediate measures are to be taken to conserve the declining fish diversity. Despite all ecological stresses, these river systems still support rich fish diversity. Also, these rivers have very

Idol immersion leading to pollution in river Godavari at Ramagundam

relevant ecological roles, such as the mouth of the Devi River serves as a nesting ground for olive ridley sea turtles. It is of paramount importance to keep these rivers healthy to perform their ecological functions.

- Further fragmentation of these river systems by more dams and barrages should be avoided.



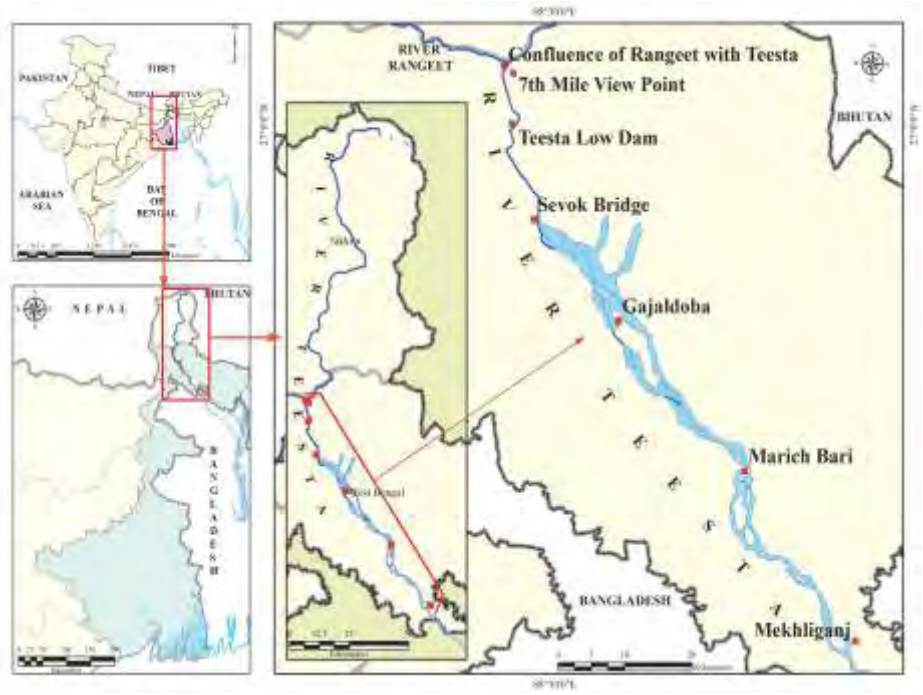
Osteobrama vigorsii from River Godavari

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

Project code : FREM/ER/17-20/12
Duration : 2017 – 2020
Scientific personnel : S. K. Nag (PI), S. Das Sarkar, Md. Aftabuddin, K. Kumari, R. K. Raman (up to 30.11.2019)
Associates : K. Saha, S. Bandyopadhyay, S. K. Paul (up to 30-9-2019), A. Ghosh

The widespread use of chemicals in agriculture, dairy, public health, industry, and our daily life has resulted in their presence in the environment, specifically in aquatic ecosystems. Inland waters are, therefore, highly impacted due to pollution from anthropogenic sources. Under the present project, aquatic systems like rivers and wetland were monitored for the presence of targeted emerging contaminants, the toxicological effect of the contaminants on aquatic biota including fish, and the associated risks to the consumers due to the presence of the contaminants in fish.

River Teesta, a transboundary river originating in the eastern Himalayas and flowing through the Indian states of Sikkim and West Bengal before entering Bangladesh, was studied to find the status of contamination in the river ecosystem with pesticide multi-residues through multiple seasonal samplings of water, sediments, and biota from different locations stretching from confluence point of Rangeet river with Teesta at Teesta bazaar near Kalimpong to Mekhliganj in Coochbehar District of West Bengal. It was observed that organochlorines (OC) and synthetic pyrethroids (SP) were detected in 25% and 19% of water samples respectively but organophosphates (OP) were detected in only 3% of water samples. The OC and OP residues in water were below the USEPA National Recommended Water Quality Criteria value. In sediments, OC (36%) and OP (33%) residues were present to a higher extent than the SPs (8%). A similar trend was also observed in fish. The residue concentrations in fish were much lower than the tolerance level in most of the cases. The human health risk assessment studies revealed that estimated daily intakes



Sampling stations on River Teesta

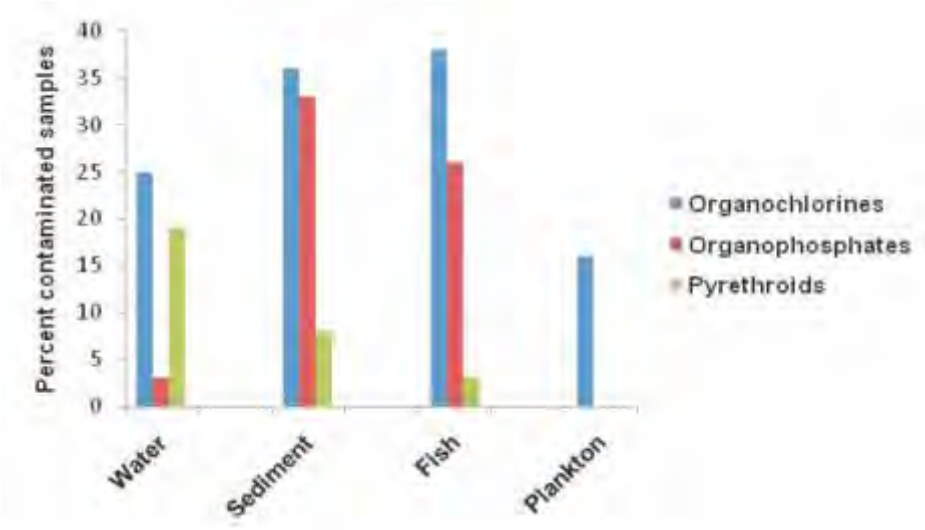
(EDI) through consumption of contaminated fish were much lower than the acceptable daily intakes (ADI) of detected pesticides in fish. In planktons, only OCs were recorded. The investigation revealed that though pesticide residues were detected to some extent in biotic and abiotic components of the environment, the river ecosystem was not under serious stress from pesticide residues.

Effects of emerging contaminants on microalgae

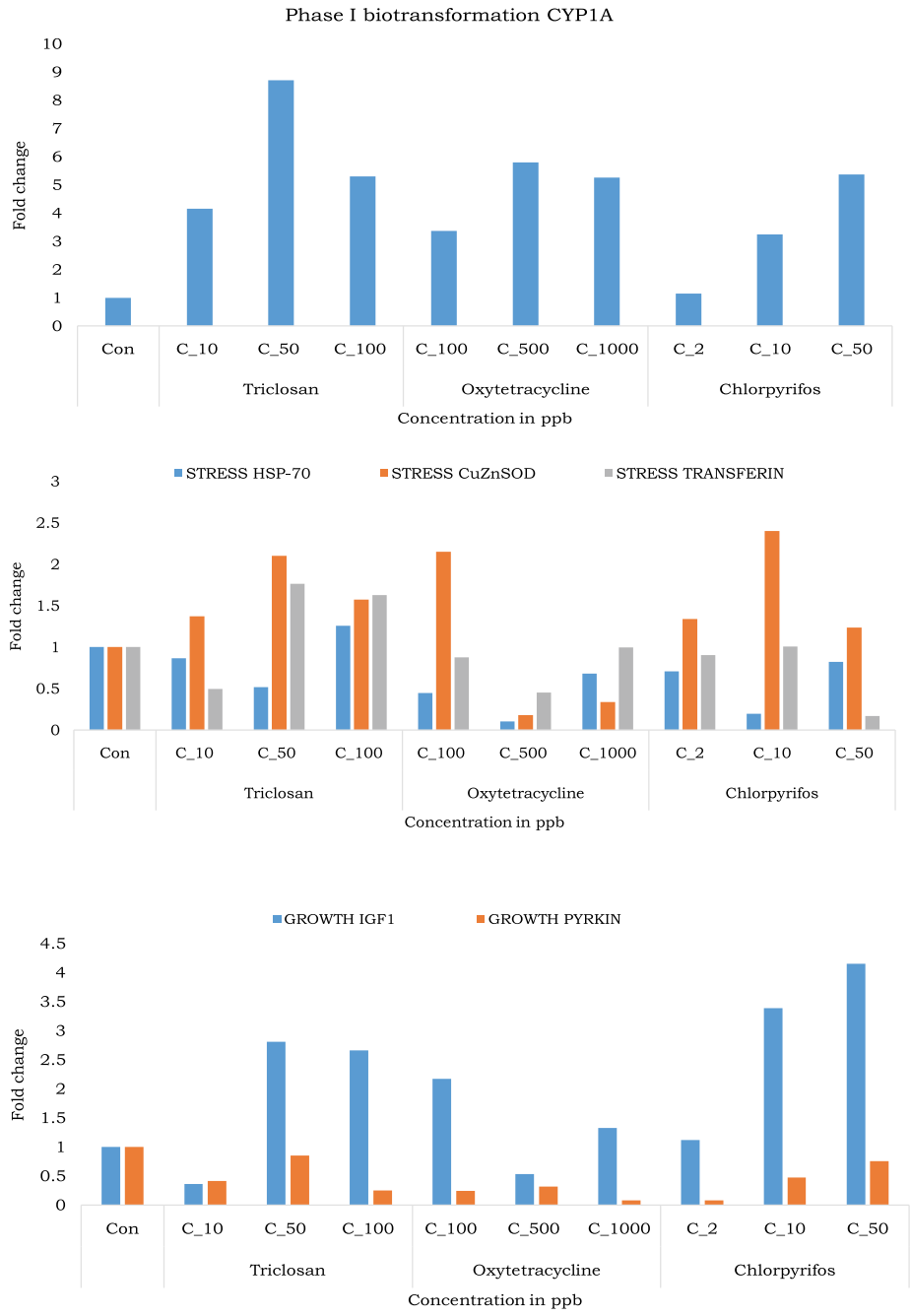
The toxicological implication of triclosan (TCS) exposed to test microalga was experimented with in wet lab conditions. Decrease in cell density, cell malformities in *Nitzschia* spp., *Chlorella* sp., *Navicula radiosa, Selenastrum* sp. were observed in TCS-treated algae. The toxicity effect of TCS has been reflected in a gradual decline in algal genus richness leading to a shift in natural food web structure. Hence, the compound is indicated as a biomarker for evaluating the environmental distribution of trace contaminants on microalgae which occupies the base of trophic strata. EC_{50} of TCS in microalgae (non-axenic culture) was estimated to be 1.0 µg/ml at 48 h.

Effect of selected toxicants on gene expression in fish

Effect of triclosan (TCS, 10-100 g/l), oxytetracycline (OTC, 100-1000 g/l) and chlorpyrifos (2-50 g/l) on phase I biotransformation (CYP1A1), reproduction (vitellogenin), growth (IGF1, pyruvate kinase) and stress (HSP, CuZnSOD, transferrin) genes of *Labeo catla* was assessed by static non-renewal acute toxicity test. The five genes, viz. β-actin EF1α, GAPDH, TBP and RAG1 were selected as internal controls for target gene validation. The bestkeeper analysis found EF1α as the



Extent of contamination of Teesta river samples with pesticide residues



Upregulation and downregulation of phase-I biotransformation gene: CYP1A, stress, and growth

most stable housekeeping gene and was used further for target gene normalization. The efficiency was evaluated by cDNA standard. There was up-regulation and down-regulation of phase I biotransformation genes, stress, growth, immune genes of *L. catla* upon exposure to TCS, OTC and chlorpyrifos.

Effect of selected toxicants on gene expressions of zebra fish (*Danio rerio*)

Acute non-renewal toxicity (96 h) study was conducted with TCS and triclocarban (TCC) in zebrafish to evaluate the sublethal toxicity of these emerging contaminants on reproductive performance. Initially, a series of range-finding test have been conducted using 100 µg/l to 200 µg/l TCC and 0.2 mg/l to 1.4 mg/l TCS and then definitive tests were conducted using 100, 120, 140, 160, 180 µg/l TCC and 0.3, 0.5, 0.7, 0.9, 1.0, 1.1, 1.2, 1.3 mg/l TCS. The 96 h median toxicity of triclocarban was 0.145 mg/l while for triclosan the value was 0.864 mg/l. The finding suggests triclocarban as more toxic than triclosan in zebrafish. After finding LC_{50} values, three doses (1/2, 1/10 and 1/100 of LC50) were selected to evaluate sublethal toxicity of TCS and TCC on reproductive performance and transcriptomic study was conducted for comparative evaluation of various genes involved in reproduction.

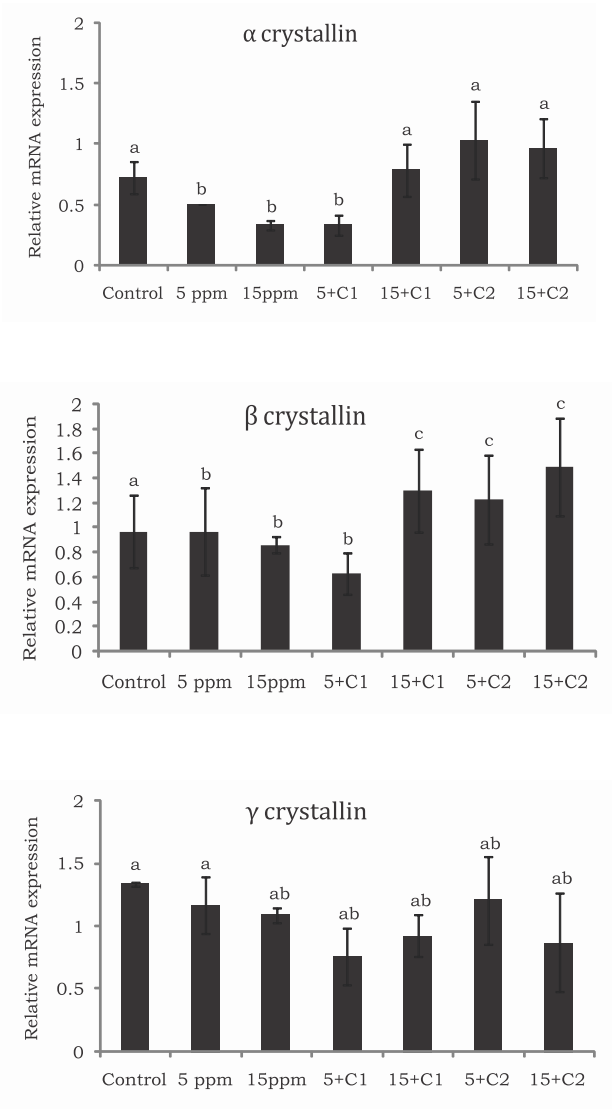
Project title : EIA and mitigation of arsenicosis as a serious environmental challenge with special reference to fish and fishery resources

Project code : FREM/17-20/13
Duration : 2017 - 2020
Scientific personnel : B. P. Mohanty (PI), S. Samanta, S.K. Manna, S.K. Sahu, A.K Bera, P. Maurye, S. Das, Sarkar, P.K. Parida, P. majhi, N. Sarma, P.R. Behera, R.K. Raman (up to 30.11.2019), G. Chnadra, Santhanakumar, V.
Associates : S. Bhowmick, K. Saha, S.K.S.S. Hameed, S. banerjee, S.K. Paul, Sk. Rabiul

The mobilization and transformation of carcinogenic arsenic in every compartment of the environment renders a greater geogenic concern. Curcumin, the main natural polyphenol and a potent bioactive compound present in the rhizomes of the plant *Curcuma* spp., is an effective agent to restrict arsenic-induced oxidative tissue damage both in vitro and in vivo. A number of studies have shown the therapeutic efficacy of curcumin against various diseases including Alzheimer's disease, cancer, diabetes, chronic asthma, inflammatory disease, liver injury, and thermal stress.

Protective effect of curcumin on the eye lens against arsenic toxicity

To investigate the impact of arsenic on the lens crystallin and fatty acid profiles and to evaluate the impact of curcumin in arsenic toxicity gene expression profiles of alpha, beta, and gamma crystallins and GC-fingerprinting of fatty acids of lens lipids were carried out in fish fed with curcumin supplemented feed and exposed to arsenic. Expressions of α and β-crystallin genes were down-regulated in arsenic-exposed groups (fed normal feed); however, insignificant alterations were observed in the groups fed curcumin-supplemented diet. Similarly, the fatty acid fingerprint of the arsenic-exposed group exhibited a reduction in saturated fatty acid and DHA content in fish lens. However, the fatty acid profile of arsenic-exposed groups remained unchanged in the curcumin supplemented group. Interestingly, the concentration of one non-fatty acid, antioxidant compound decreased in response to arsenic-exposure which got restored to normal level in curcumin supplemented groups.



Expression patterns of α, β, and γ crystallins

Project title : Fish health management and antimicrobial resistance in inland open waters

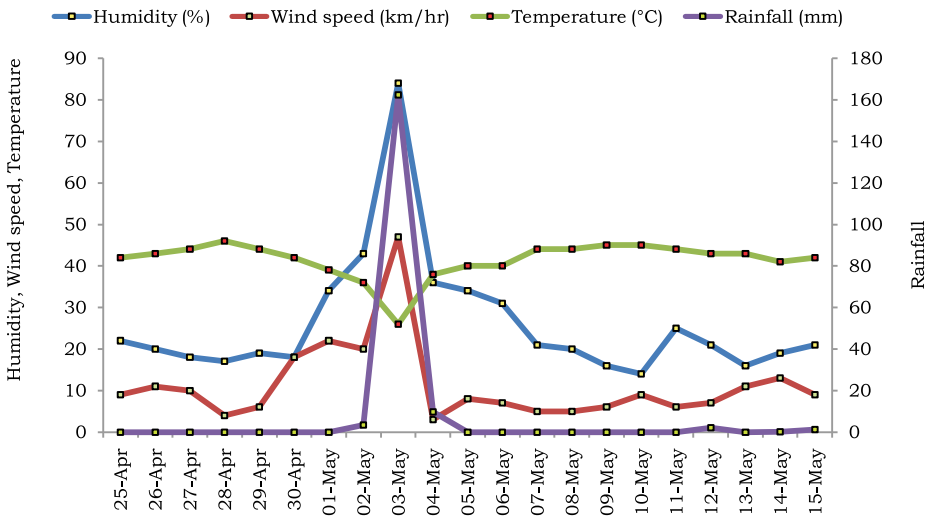
Project code : FREM/17-20/14
Duration : 2017-2021
Scientific personnel : B. K. Das (PI), B. P. Mohanty, S. K. Manna, B. K. Behera, R. K. Manna, H. Chowdhry, A. K. Bera, A. K. Sahoo, D. J. Sarkar, T. Abdulla, R. Baitha, V. Kumar, D. K. Meena, H. S. Swain, D. Das, M. Shaya Devi, Soma Das Sarkar, Sathana Kumar V.
Associates : S. Bhowmick, R. C. Mandy

Mass mortality of fish in a reservoir triggered by cyclone mediated environmental stress

Fish mortality was investigated in a reservoir system located 140 km away from the east coast of India where the super cyclone Fani - a category 4 storm - hit on 3 May 2019. The cyclone moved inland in Angul, Odhisa and developed into a tropical depression with an average wind speed of 47.0 km/hr, variable rainfall events with humidity ranging from 76.0% to 99.5% and pressure 978.0 to 1005.5 mbar. A total of 175.5 mm rainfall was recorded at Angul within a span of 57 hrs during 2-4 May 2019. During the field investigation, the plankton crash was also noticed with the dominating population of *Microcystis* sp.

Following the cyclonic depression and heavy rain, increased turbidity (3.41 NTU) at the water surface as compared to the sub-surface layer was observed which might have caused floating mats of dead algal bloom in Derjang reservoir, Odhisa. Higher TDS (207.3 mg/l), and conductivity were also observed at the surface water. Higher chloride content (>50 mg/l) indicated the impact of runoff on the reservoir. The water temperature was also stabilized (35.2°C) with corresponding air temperature as observed during the sampling in comparison with significantly lower air temperature of 26.0 °C on the day of cyclonic storm and rainfall (3 May 2019). In soil, significantly higher organic carbon (2.5±0.9 %) and specific conductivity (949±472 µS/cm) have been observed.

From the moribund fish few bacteria were isolated. Intraperitoneal injection of the bacterial isolates in fish elicited a wide range of ailments and signs resembling the clinical disease seen during field investigation. The clinical signs were mostly noted in the form of septicaemia, anorexia, lethargy, abdominal swelling, erratic swimming, surfacing and haemorrhagic spots at the base of the fins, and latero-ventral side of the body. Challenge study revealed that *K. pneumoniae* isolates (Accession No. MN593016, MN593017, MN593018, and MN593020) were pathogenic for different fish species with



Weather parameters of pre and post-cyclone (Fani) period at Angul, Odhisa

Water quality parameters of the Derjang reservoir during fish disease outbreak

Water parameter	Mean (range)	
Air temperature (°C)	38.0	-
Water temperature (°C)	35.2 (34.8-35.4)	31.4 (31.0-31.8)
Turbidity (NTU)	3.41 (3.12-3.56)	2.77 (2.64-2.92)
TDS (mg/l)	207.3 (205.0- 209.0)	205.66 (204.0-207.0)
pH	9.4 (9.2-9.5)	-
Conductivity (µS/cm)	379.9 (372.4-385.5)	357.1(351.4-363.2)
Salinity (PPT)	0.15 (0.14-0.16)	0.15(0.14-0.16)
Chlorophyll (µg/l)	1.5 (1.4-1.6)	2.98 (2.93-3.06)
Phycocyanin (µg/l)	0.51 (0.48-0.53)	0.83 (0.79- 0.86)
Dissolved Oxygen (mg/l)	8.18 (7.98-8.24)	7.41 (7.32-7.52)
FreeCO_2 (mg/l)	Nil	-
Total Alkalinity (mg/l)	109.3 (108-110)	-
Total hardness (mg/l)	110.0 (108-112)	-
Ca^{++} (mg/l)	31.6 (25.7-35.3)	-
Mg^{++} (mg/l)	7.4 (5.3-11.1)	-
Chloride (mg/l)	66.0 (56-72)	-
Nitrate-N (mg/l)	0.09 (0.051- 0,120)	-
Phosphate-P (mg/l)	0.10 (0.098- 0,100)	-
Silicate-Si (mg/l)	21.7 (19.9- 22.4)	-

Soil physico-chemical parameters of the Derjang reservoir during the disease outbreak

Soil parameter	Mean value
pH	7.8±0.3
Sp. Conductivity (µS/cm)	949±472
Organic carbon (%)	2.5±0.9
$CaCO_3$ (%)	1.87±1.5
Av. Phosphate (mg/100g)	22.5±14.7

LD50 ranging from $8.1x10^6$ c.f.u/fish in *S. sarana* to $2.2x10^8$ c.f.u./fish in *L. rohita*. *A. hydrophila* (MN593014) and *A. baumannii* (MN585784) were found pathogenic with LD50 of $1.2x10^7$ and $2.7x10^7$ c.f.u/fish in *L. rohita* and *L. catla*, respectively. Cumulative mortality pattern for the pathogenic bacteria in respective fish species showed varied intensity of virulence of the bacteria which also depends on the fish species affected.

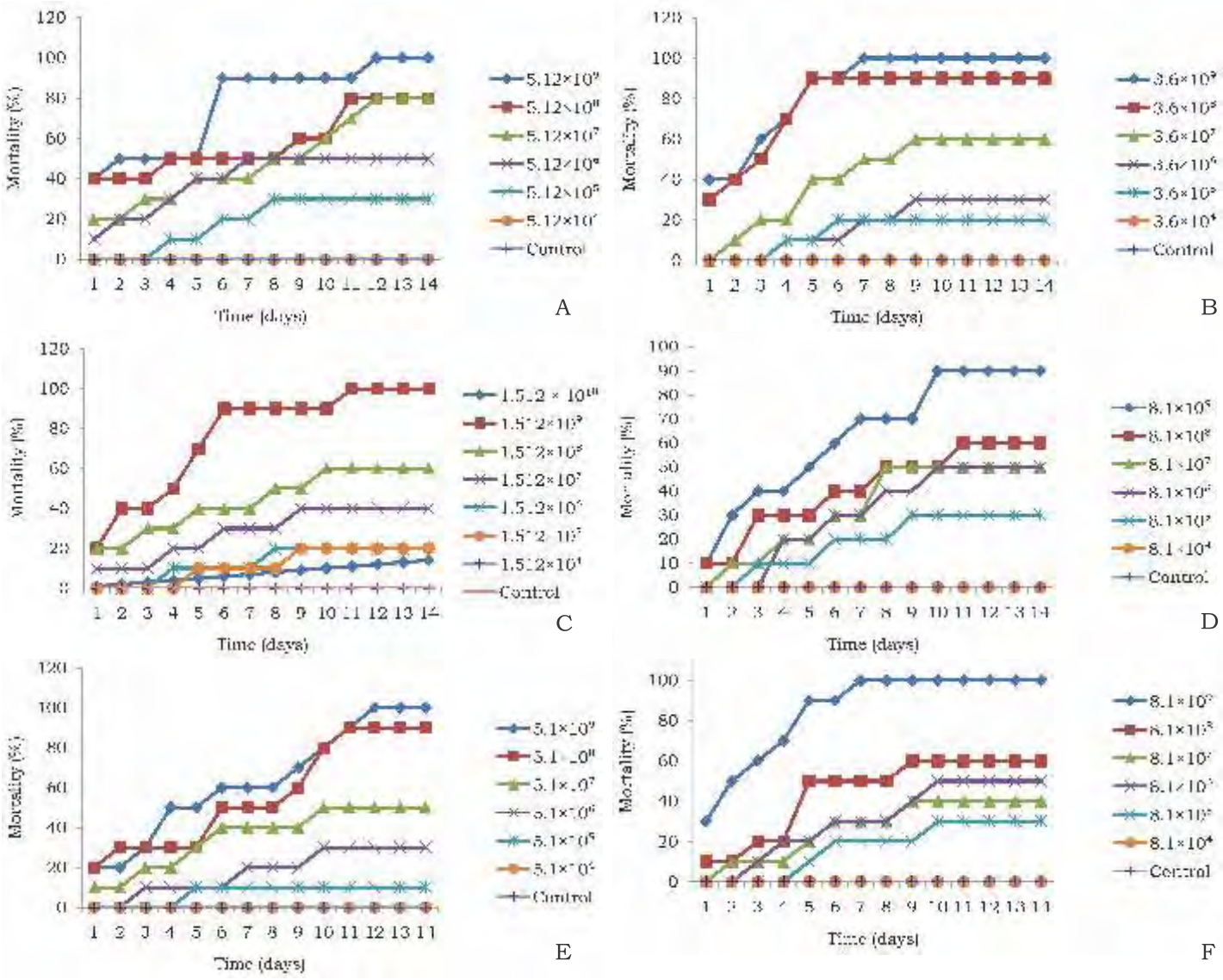
Incidence of different bacterial diseases in wetlands

Routine investigations on fish diseases were conducted in East Kolkata wetland and Moyna wetland. During the period under report, clinical disease with mortality was recorded in *L. rohita* from East Kolkata wetland. On bacteriological investigation, *Aeromonas jandaei* and *A. veronii* were isolated from the diseased fishes. In Moyna wetland mortality from septicaemia was noticed in *L. rohita, Oreochromis niloticus*, and rohu-catla hybrid in different occasions. Applying microbiological methods *A. veronii, A. jandaei, A. veronii, A. caviae, Klebsiella pneumonia, Plesiomonas shigelloides*, and *Edwardsiella tarda* were isolated from the moribund diseased fishes.

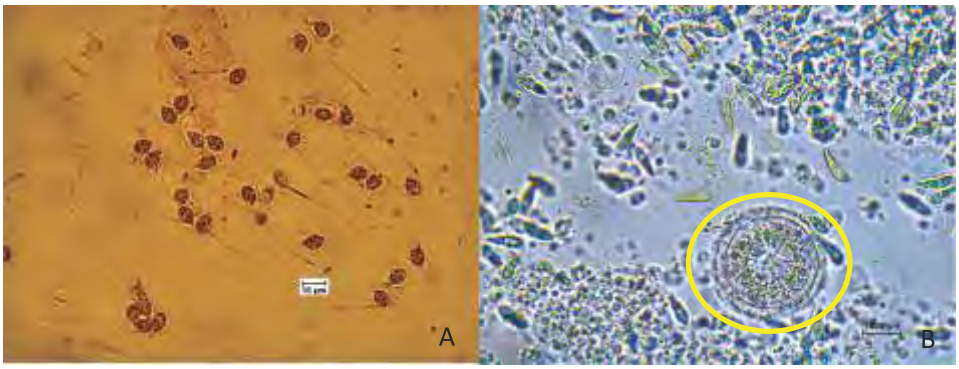
Bacterial gill disease was investigated in *Labeo rohita, L. catla* and *Oreochromis niloticus* with gill discoloration, tail rot, skin ulcer, resembling the typical sign of bacterial gill disease from East Kolkata wetlands, India. The results revealed *Chryseobacterium gleum* as the responsible pathogen. The bacteria isolates were identified using bacterial colony morphology, biochemical test, whole-cell protein profiling, 16S rRNA gene amplification, and nucleotide sequence analysis.

Multiple parasitic infestations in Indian major carps

An investigation was made to identify parasitic diseases in the freshwater culture area of Moyna and Uluberia. Live fishes (*Labeo catla, Labeo rohita* and *Cirrhinus mrigala*) were randomly sampled with a cast net for isolation and identification of parasites. The investigation revealed that *L. rohita* and *C. mrigala* were infested with *Thelohanellus* spp. identified mostly from gills and caudal fins of *L. rohita* and *C. mrigala*; *Trichodina* was identified from gill scrappings of *L. rohita* at Moyna. The parasitic infection was found to be low to moderate with no observed fish morbidity and mortality. While the gills of *L. catla* was heavily infected with gill myxozoans, *Myxobolus* spp. along with the isolated



Day-wise cumulative mortality pattern of fishes intraperitoneally challenged with various doses of bacteria. A- *Klebsiella pneumoniae* in *Systomus sarana*, B- *Aeromonas hydrophila* in *Labeo rohita*, C- *Klebsiella pneumoniae* in *Labeo rohita*, D- *Klebsiella pneumoniae* in *Cirrhinus mrigala*, E- *Acinetobacter baumannii* in *Labeo catla*, F- *Klebsiella pneumoniae* in *Ompok bimaculatus*



A) Wet mount of gills using lugol's iodine showing *Myxobolus* spp., and B) wet mount of gills showing *Trichodina* sp.

appearance of a protozoan parasite Trichodina at Uluberia.

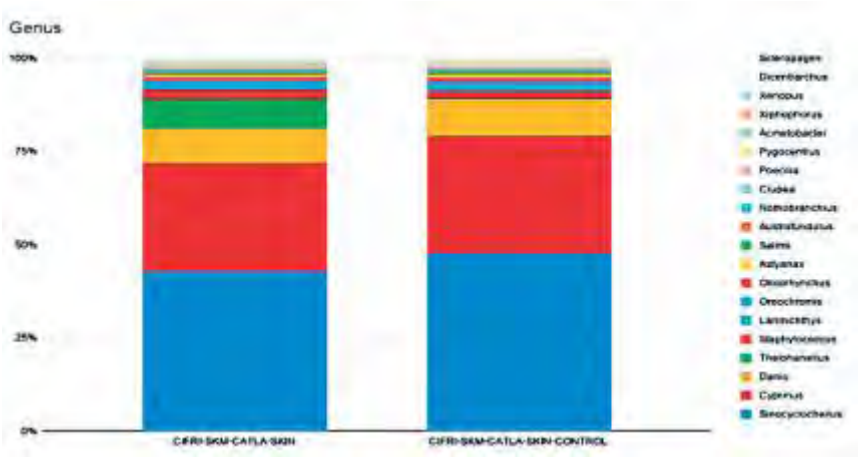
Molecular diagnosis of *Thelohanellus kitawei* infection in *Labeo catla* with proliferative skin and gill lesions

Mass mortality of *L. catla* fry with proliferative skin and gill

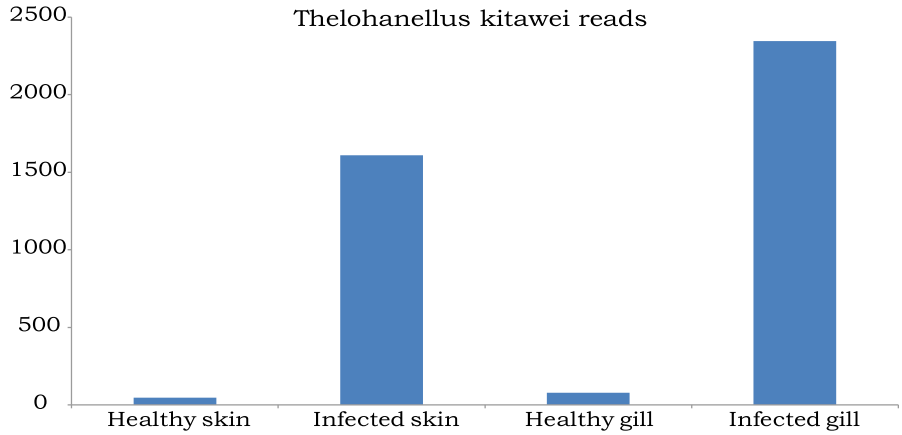
Diseased *L. catla* fingerling

lesions was investigated through classical microbiological, parasitological, and histopathological methods as well as metagenomic sequencing to examine whether some novel pathogen was involved in the disease.

The skin and gill lesions were sequenced by de novo whole metagenome sequencing method in Illumina platform. The study revealed that bacterial diversity and read counts were not significantly different in infected and healthy skin/gill tissues. No intracellular pathogen like virus, chlamydia and rickettsia were also detected in the sequences indicating that microbes were not responsible for the disease.



Bacterial diversity at genus levels in skin with muscle samples of diseased and healthy fish



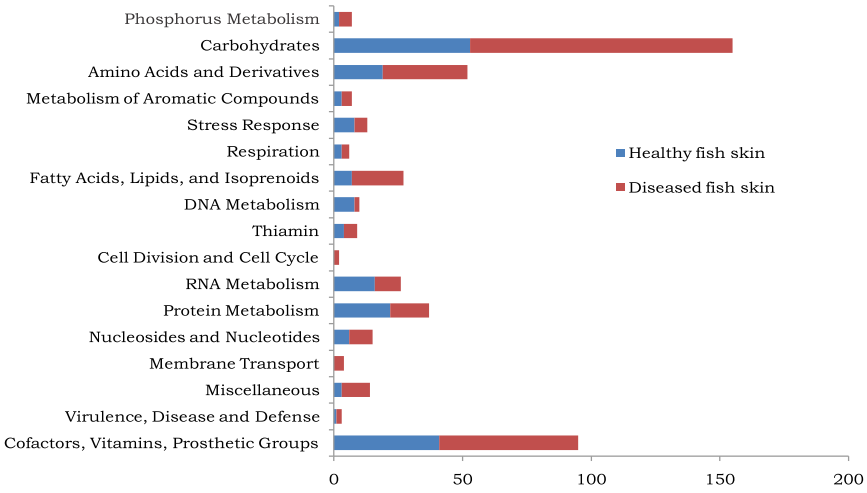
Number of *T. kitawei* reads in skin samples of diseased and healthy fish

However, there was a many-fold increase in the number of reads of the parasite *Thelohanellus kitawei* in both the skin and gill tissues of infected fish confirming that the disease was caused by the parasite. Wet mounts of the scrapping of skin lesions also revealed the presence of huge numbers of *Thelohanellus* (Myxosporea: Myxobolidae). This, along with parasitological study established the parasite as the causative agent of the typical disease condition in *L. catla* fry. This is possibly the first report of severe mass mortality of carp caused by the parasite in freshwater systems.

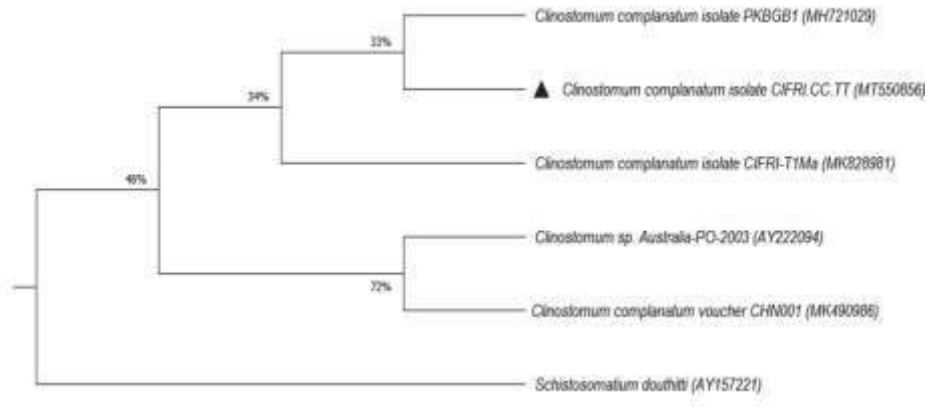
SEED analysis revealed no major local tissue-level changes in biochemical functions but a general stress-mediated increase in carbohydrate, amino acid, and fatty acid metabolisms in infected fishes, as compared to the healthy control.

Identification of progenetic *Clinostomum complanatum* in ornamental fish

During the routine investigation of ornamental fish *Trichopodus trichopterus* was detected with metacercarial stage of trematode infection in fish body cavity. Based on microscopic examination, the trematode was identified as *Clinostomum complanatum*. Molecular detection through amplification of 18S rRNA and



SEED analysis of skin samples of diseased and healthy fish



The phylogenetic tree of *Clinostomum complanatum* based on 18S rRNA sequences

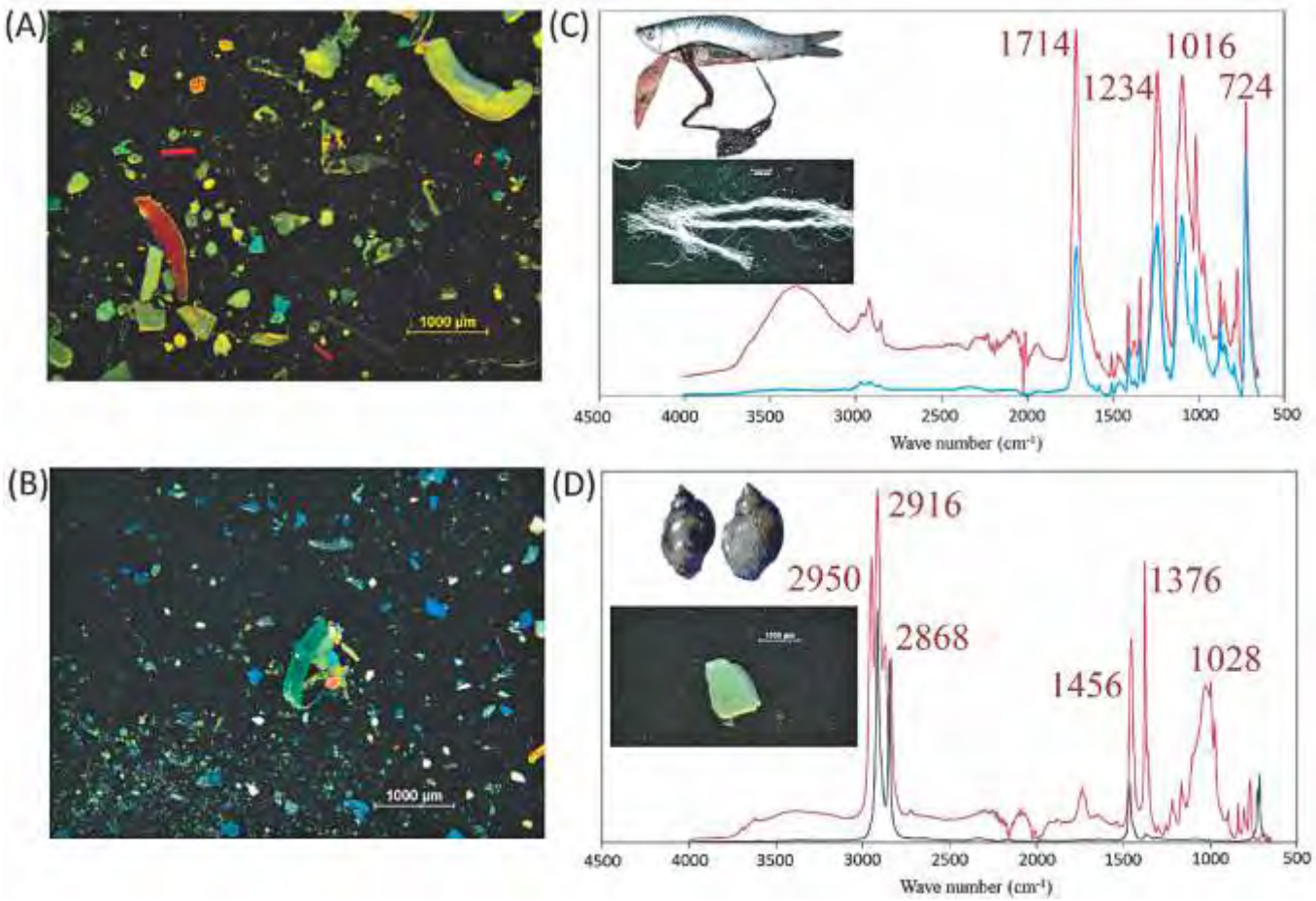
cytochrome coxidase I gene revealed 650 bp and 436 bp amplicons respectively. Sequencing of the amplicons confirmed the parasite identity. Phylogenetic tree and pairwise genetic distance were constructed using sequences of 18S rRNA. Evolutionary analyses were conducted in MEGA X. Based on pairwise genetic distance analysis our isolate (*C. complanatum* MT550856 CIFRI.CC.TT) was found to be very close (0.003) to *Clinostomum complanatum* MH721029 and *Clinostomum* sp. Ay222094.

Occurrence of microplastics as heavy metal vector in East Kolkata wetlands

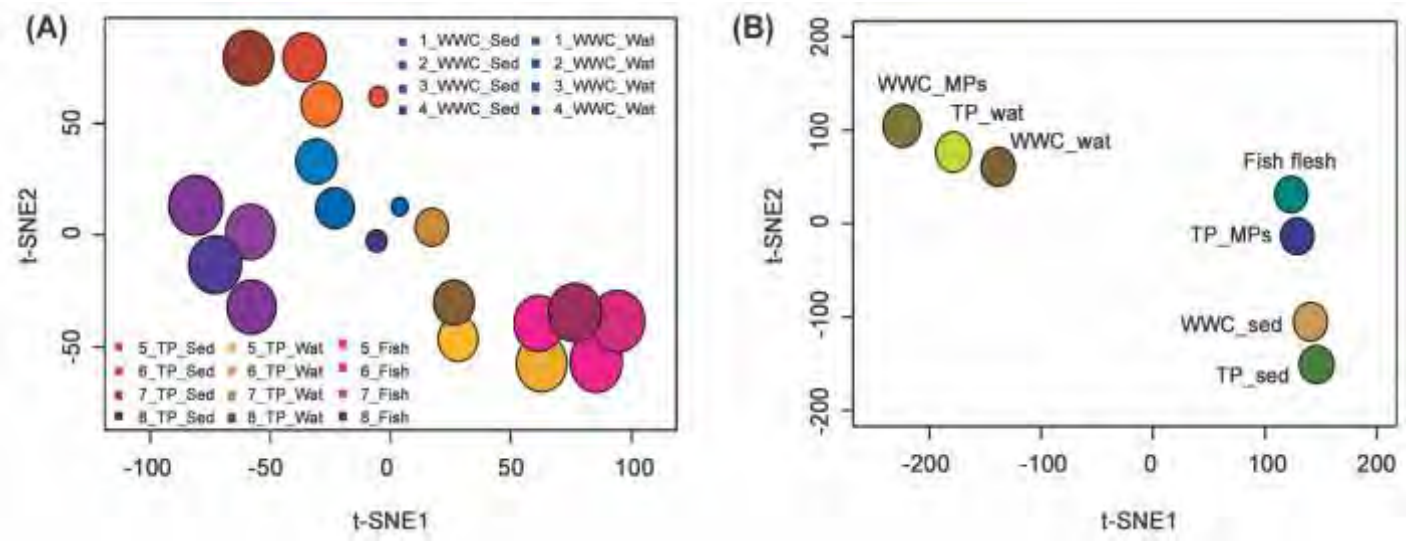
Microplastics (MP) pollution in aquatic ecosystems is a great concern; however, systemic investigation is still lacking in freshwater wetland systems. Deliberation was made to study microplastics occurrence and their fate in East Kolkata wetlands and further, the association of microplastics with heavy metals was also estimated. Microplastics were heavily found in the surface water and sediments of East Kolkata wetlands (7.87 to 20.39 items/l and 2124.84 to 6886.76 items/kg) and associated wastewater canals (30.46 to 137.72 items/l and 1108.78 to 34612.87 items/kg). High content of toxic metals (As, Cd, Cr, Cu, Ni, Pb, and Zn) were also found on the microplastics surface. Fishes and macroinvertebrates of East Kolkata wetlands were found contaminated with microplastics. Microplastics were present in the gut content of the finfishes (*Labeo rohita, L. bata, L. catla*, etc.). Machine learning algorithm (t-SNE cluster analysis) revealed a close association between microplastics content in fishes and surface water, indicating risk associated with floating microplastics to the aquatic biota. Analysis also revealed that microplastics were acting as heavy metals vector resulting contamination in fish besides bioconcentration and biomagnification.

Occurrence and fate of microplastics in drinking water treatment plant (WTP)

There is global concern about the possible ill effect of microplastics on the human and other organisms, especially aquatic biota. Hence efficiency of various water treatment processes is being tested to estimate their microplastics removal efficiency. Deliberation was made to study the occurrence of microplastics in a typical water treatment plant with a pulse clarification system and

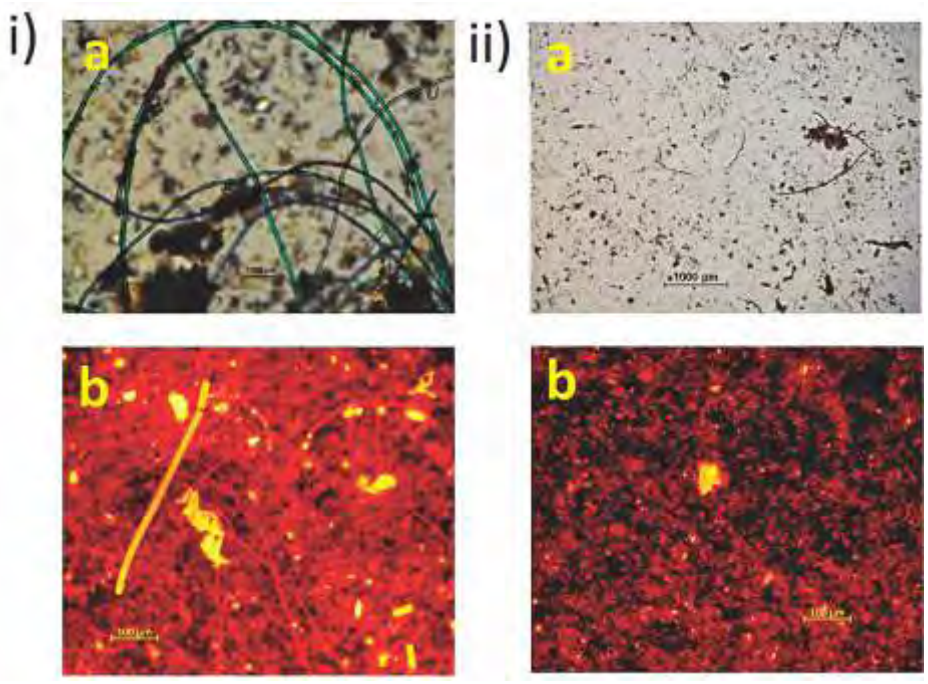


Optical images of microplastics found in the sediments of wastewater canals (A) and wetlands (B); Optical image and corresponding ATR FT-IR spectrum of microplastics found in *Labeo rohita* (C) and Indoplanorbis exustus (D) collected from the wetland.



t-SNE cluster analysis of number distribution of MPs in sediment, water and fish gut (A) and heavy metal content in water, sediment, MPs and fish muscle (B)

further its microplastics removal efficiency was evaluated. In the test water treatment plant raw water was sourced from river Ganga and found to contain microplastics at a concentration of 17.88 items/l. It was found that different water treatment stages like coagulation-flocculation, pulse clarification, and sand filtration reduced the microplastics content in the final treated water. The cumulative microplastic removal at key treatment stages *viz.* pulse clarification and sand filtration was found to be 63 % and 85 %, respectively. The most frequently occurring microplastics were fibers and films/fragments. The t-distributed stochastic neighbor embedding machine learning algorithm revealed a strong association between microplastic abundance with turbidity, phosphate, and nitrate.



Visible (a) and fluorescence (b) images of microplastics in the raw water and final treated water of test WTP

Circos diagram showing compositions of different water sampling stages in the WTP with various water quality parameters including microplastics

Compound characterization, antioxidant potentials, antibmicrobial and antiparasitic efficacy of *Terminalia arjuna* extracts

Different parts of the plant i.e. bark, leaf and fruits were used in the experiment. Two prominent metabolites, *viz.* gallic acid (m/z 170.0208) and ellagic acid (m/z 302.0063) were identified in 50% of fruit extracts with acetone, ethanol and ethyl acetate, 60% of leaf extracts with acetone, ethanol and methanol out and 5 bark extracts with acetone, ethanol, ethyl acetate,

methanol and purified bark ethanol extract. Gallic acid, also known as 3,4,5-trihydroxybenzoic acid, belongs to group of hydrolysable tannins. Ellagic acid is a dimer of gallic acid formed by dimerization by oxidative aromatic coupling. It has a role as an antioxidant and is generally found in many fruits and leaf extracts. The antioxidant constituents were analyzed by spraying 2,2-Diphenyl-1-picrylhydrazyl (DPPH). For this 0.05% of DPPH solution in methanol was sprayed on the surface of developed TLC plates and incubated for 10 min at room temperature. The active antioxidant constituents of the T. arjuna extract was detected as yellow spots produced via reduction of DPPH on the TLC plates. R_f value of the bands was also determined.

Study of the antioxidant potential and free radicals scavenging activity showed that both ethanolic and methanolic extracts of bark and fruit have high amount of total flavonoid contents and total phenolic compounds which exhibited strong antioxidant activity at 0.48 mg concentration against DNA nicking due to H_2O_2 condition. Antibiogram profiling of 17 bacterial strains using ethanolic, methanolic, and acetone extracts of both bark and fruit were done. Data showed that the above-mentioned solvent extracts can be utilized as broad-spectrum antimicrobials after minute manipulation in dose-response to the target host species.

The ethanolic and methanolic extracts of bark and acetone extracts of fruit were found to be effective against *Argulus bengalensis*. Moderate to highly intensified argulosis (25-30-40-50 no. of *A. bengalensis*/ fish) in *Labeo rohita* could be controlled by the preparation. LC50 values of extracts for fish and *A. bengalensis* was maintained in the ratio of 4:1. Thus the extracts were found to be safe to host and a potential source for designing bio-pesticide.

Toxicity study of *Terminalia arjuna* extracts in *Artemia salina* model

The present study advocates the inclusion of relative LC50 (Lethal concentration 50), % relative LC50, absolute LC50, % absolute LC50, consideration of 95 % upper and lower Fiducial class intervals, and TI value while fixing the nature of toxicity and designating the safety aspect to the host. The ethanolic and methanolic bark extracts could exhibit a maximum % of absolute LC50 fractions out of total toxicity which showed their potential as safe therapeutic agents.

Utilization of *Terminalia arjuna* bark powder (TABP) as feed additive to improve fish health

An inclusion of 10-15 g *Terminalia arjuna* bark powder per kg feed resulted in enhanced growth performances in *Labeo rohita*. *Terminalia arjuna* based powder at 12.3 g/kg could be used for commercial production having tried in field conditions. As feed additive, it can be used for producing healthy green fish for human consumption and to maximize profit margin. This is an environmental friendly synergetic approach to safeguard the aquatic microbiota and replenishing beneficial microbial community

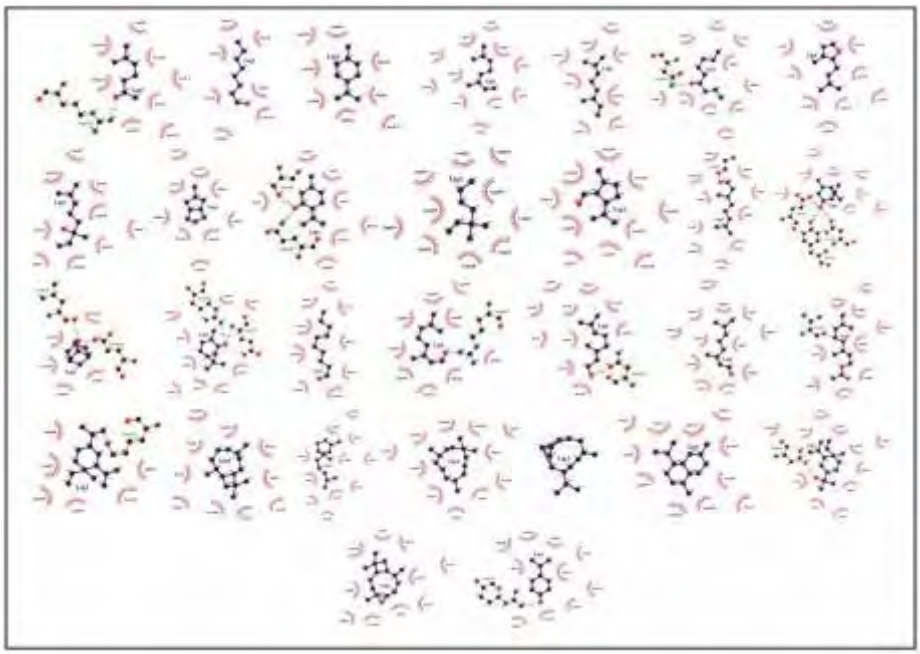
Treatment with TABP (10 g/kg) offered a better health characteristic of midgut in its mucosal epithelium, submucosa, muscularis, and serosa layers as comaped to control. More mucosal folds and thickening of the mucosal epithelial area were noted in treated groups. RBC and eosinophilic granular cells were more than control and thickening of mucosal epithelial area was also higher than control.

Intestine of experimentally challenged fishes with *Edwardsiella tarda* showed erythrocytic aggregation in submucosal layer, necrosis & hyperplasia of enterocytes in mucosal epithelial layer. Necrosis of sub mucosal layer with hemorrhage, necrotic lumenal epithelial cells & hypertrophic mucus cells in the mucosal epithelial layer. Treated groups showed improvement in these parameters. The signal

transducer and activator of transcription 1 (STAT 1), Mx protein, and interferon-stimulated gene 15 (ISG 15) were amplified and real-time quantification was also done. Comparatively, Mx was expressed more, followed by ISG15 and STAT 1.

Molecular docking of plant essential oil components with target protein of *Aeromonas hydrophila*

Essential oil of a plant of the Poaceae family effectively controlled *Aeromonas hydrophila*, a known fish pathogen through in vitro study. The oil has the potential to be used as a co-component of the recommended antibiotic, oxytetracycline (OTC) to control the bacteria. An effort was made to substantiate the wet lab findings with bioinformatics. Molecular docking with DNA gyrase enzyme by the components of the essential oil was attempted. The essential oil contains 30 components (in GC-MS analysis) and nearly 50% of the components (ligands) formed H-bonding with the target protein (DNA gyrase), justifying the efficacy of the essential oil against the bacteria. Some of the components namely, d-verbenol, pulegone, 1-adamantanol, caranone having alcohol or ketone moiety produced multiple H-bonding. However, oil components such as citral-a, citral-b, trans-geraniol, sulcatone are attributed to the efficacy of the oil. Hence, further study is required to establish the mechanism of action of the oil against the bacteria.



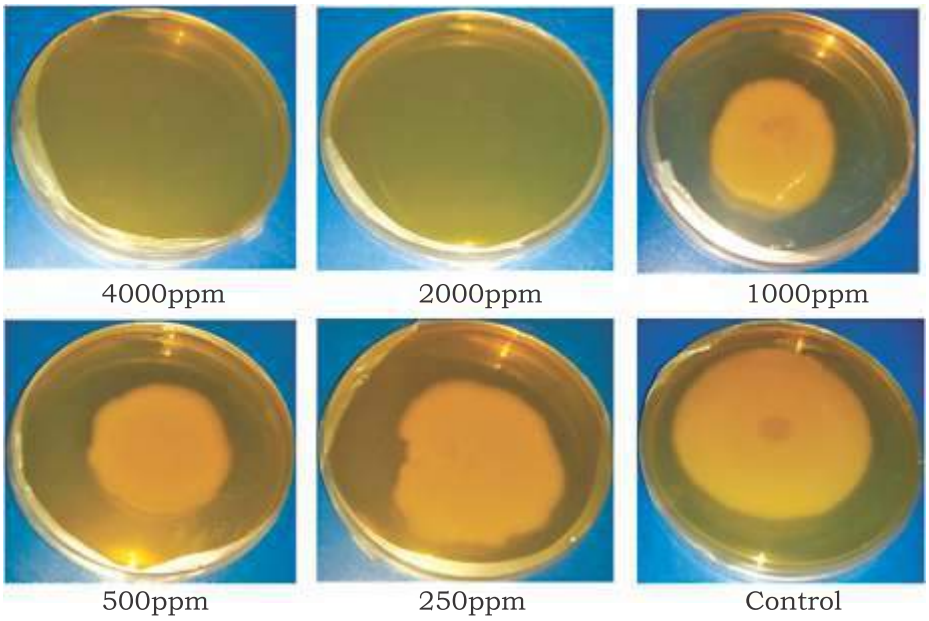
Molecular docking of DNA gyrase (substrate) with essential oil components (ligands)

Antifungal effect of plant extracts

Dried leaf powder of a plant (Asteraceae family) was successively extracted with hexane and methanol after 72 hrs of soaking, after evaporation of solvents the crude extracts were tested in the laboratory against *Aphanomyces* sp., a well-known fish pathogen in the laboratory. The methanolic extract produced dose-dependent efficacy against the fungus and 100% growth inhibition was recorded at 2000 ppm concentration of the crude extract after 48 hrs of treatment. About 58% and 42% growth inhibition was recorded by 1000 ppm and 500 ppm concentrations of the crude extract.

Detection of flexirubin pigment of bacterial origin having antibacterial and antioxidant properties

Nine bacteria isolates were found to produce yellow pigment in the nutrient agar media. The bacteria were identified as members of Flavobactericae family. Out of nine pigment-producing bacteria 8 were identified as *Chryseobacteria* spp. and one as *Cloacebacteria* sp. The pigment was tested and identified as flexirubin using KOH test which has known antibacterial and antioxidant activities. Further, the pigment could be detected at 490 nm wavelength using the spectrophotometric method.



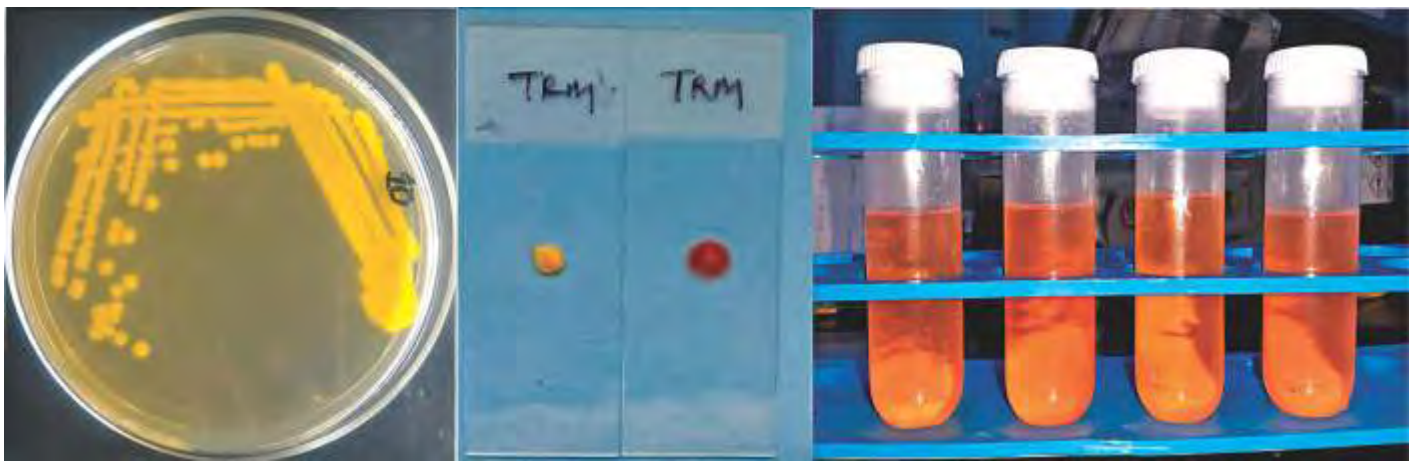
Effect of methanolic extract plant against *Aphanomyces* sp.

Use of plant extracts as fishing agent

Leaf powder of a plant (Polygonaceae family) was extracted with petroleum ether (pet-ether), dichloromethane (DCM) or methanol at room temperature. After evaporation of solvent, the extracts were dissolved in solvent mixtures to make them dispersible in water. The extracts were added in water separately to produce 50 ppm concentrations of the crude extracts. In hexane extract-treated tank, gulping at the surface, restlessness, erratic swimming, continuous jumping, and quiet settling at the bottom of the tank by fish were recorded. In the DCM extract-treated tanks, erratic swimming with frequent jumping of fish followed by knockdown after 5 min were recorded. All the treated fish died after 30 min. In the methanolic extract treated tanks, no abnormal behaviour of fish and no death were noticed. Further study is needed to develop a non-toxic formulation of the plant extract which can quickly dissolve in water, can drag fishes out to the surface of the water from inaccessible places, and quickly arrest their movement at a very low dose so that the fishermen can easily collect the fish. This formulation may be helpful in easy, convenient, and eco-friendly fishing.

Freshwater microalgae as a potential source of biodiesel

A freshwater microalgae was isolated and identified as *Graesiella emersonii* (Shihara & R.W. Krauss) with help of



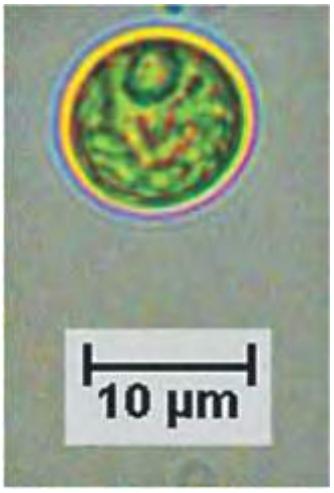
Pigment producing bacteria on NA Detection of flexirubin by KOH Flexirubin extracted from the nutrient broth

key morphological characters such as ellipsoidal to somewhat spherical cell, a thick cell wall, and sub-cellular pyrenoids embedded in the chloroplast. The size of the cell ranged from 4.1- 12.0 micron in diameter. The taxonomic identity was further reaffirmed by the molecular method of 18s rRNA sequencing (Accession no. Mn877773).

Following standardization of the growth condition, the isolated pure strain of *G. emersonii* is maintained at algal culture laboratory of the Institute. The cells are grown under BG11 medium at 27°C, and light intensity of 1300 ± 400 lux at 14 h light and 10 h dark conditions. The lipid contents and fatty acid profiling of *G. emersonii* were evaluated using Bligh and Dyer and acid transesterification methods. The lipid content and lipid productivity were found to be 15.11% and 3.59 ± 0.0004 mg/l, respectively. Methyl palmitate was the dominant fatty acid as revealed by GC-MS analysis.

Formulation of a low-cost organic nutrient medium

Vermicompost was prepared from organic waste materials like garden wastes, leaf litters, and kitchen refuges, weed biomass, etc. using earthworm as a composting inoculum. Subsequently, vermicompost extract was prepared by both aerobic and anaerobic digestion method. The culture media was prepared by adding vermicompost extract to BG11 medium at different proportions and the culture was kept at standard culture condition. Results revealed that 50:50 combination of anaerobically digested vermicompost extract and BG11 medium improved the growth performance (biomass ~34±0.7 mg/l/day) and lipid production (~0.11 g/l) of *G. emersonii* among all the combinations.



Microscopic view of *Graesiella emersonii*

Vermicompost extract as microalgal culture media for biofuel production

Project title : Applications of statistical tools for assessing Inland Fisheries Management

Project code : FREM/17-20/15
Duration : 2017- 2020
Scientific personnel : M. Naskar (PI), M. Karthikeyan, S. K. Sahu, D. N. Jha, A. K. Yadav , C. Jana and R. K. Raman

Fish species richness prediction model of the Krishna river

A prediction model for fish species richness has been developed for the Krishna river using fish species richness and environmental data from 17 sampling sites. Generalized Linear Model (GLM) framework was used for modeling. Since fish species richness is recorded as count, the Poisson regression model was used to develop the prediction model. Based on the estimated regression coefficients, predicted fish species richness was obtained. The Root Mean Square Error (RMSE) based on the observed and predicted 'fish species richness' was found to be 3.284, indicating a good prediction accuracy. The developed model can be used to predict the fish species richness at an unsampled location and season, provided values of environmental parameters are given. The site-season specific predictive fish species richness is shown in figure.

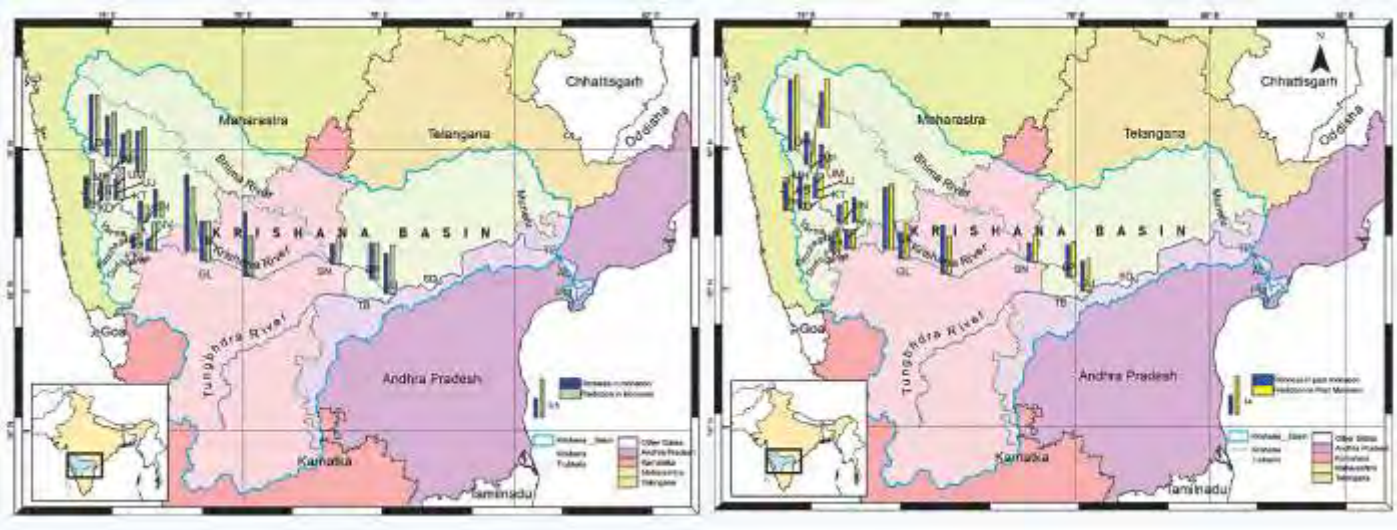
Model-based determination of harvest levels in stocked reservoirs for sustainable fishery

In fishery management studies, Surplus-production Models (SPM) are commonly used for the determination of optimal harvesting of the stock. The general practice adopted in the development of reservoir fisheries is stocking and harvesting. Some of the SPM—a modified Verhulst-Schaefer model that incorporates the factor stocking (of fingerlings) also in addition to effort, is being proposed to estimate sustainable harvest levels from stocked reservoirs.

Population growth is depicted in several ways, but the most commonly used model to characterize this population growth has been the logistic growth model described by the following logistic equation:

$$\frac{dX}{dt} = rX\left[1 - \frac{X}{K}\right] - F_{(X)}$$

where F(X) is the natural population growth; X is the stock biomass; r is the intrinsic growth rate; and K is the carrying capacity. Since the stocking has a profound impact on the growth of the fish population, a modified



Observed and predicted fish species richness of the Krishna river in monsoon and post monsoon

Verhulst-Schafer model (that includes stocking as one of the factors) is proposed as follows:

$$\frac{dX}{dt} = (r_0 + aS)X\left[1 - \frac{X}{K}\right] - H$$

where (ro+aS)-Intrinsic growth rate affected by stocking S. A simple algebra provides the solution of optimal harvest and CPUE as

$$H_{(E,S)} = qEK\left[1 - \frac{qE}{r_0 + aS}\right]$$

$$CPUE_{(E,S)} = qK\left[1 - \frac{qE}{r_0 + aS}\right]$$

Catch and effort data are essential to solve optimal harvest and effort from the above two equations. The above model was applied for a data of Bargi reservoir. The numerical solutions of the above function were carried out by Mathematica, and the model fitting accuracy was R^2 = 0.99. The sustainable solution of effort and stocking (fingerlings) at Maximum Sustainable Yield (MSY) are E_{MSY} = 1.66 and S_{MSY} = 12.0, respectively. The maximum sustainable yield depends on effort and stocking and the same can be obtained from the following equation:

$$MSY = (0.685126)(1387.2)E_{MSY}\left[1 - \frac{0.685126\,E_{MSY}}{0.614290 + 0.137866\,S_{MSY}}\right]$$

For the present case, the maximum sustainable yield is MSY=787 tonnes (at EMSY = 1.66 and SMSY =12.0).

A Bayesian risk assessment framework for phytoplankton diversity loss

Barge movement affects the river ecosystems in multiple dimensions, including aquatic biodiversity and is of global concern. The phytoplankton community-a bioindicator of an aquatic ecosystem and extremely responsive to external perturbation-are possibly the foremost victim of barge movement. This study postulates a hypothesis of phytoplankton diversity loss induced by barge movement in a large river. Quantifying barge movement-induced phytoplankton biodiversity change or loss is far from trivial. Classical index-based diversity assessment suffers from an inability to quantify diversity loss. A new index-based diversity assessment framework has been developed to overcome such difficulty.

A new index of diversity loss and interpretation

At each site, there are three states of independent sample collection: before (B), during (D) and after (A) barge movement. Let, X_{i1}, X_{i2} and Y_i three latent variables defined for i^{th}(i=1,2,....,N) site as follows: X_{i1}=0, for control vs 'D' comparison; X_{i1} = -1, for control vs 'A' comparison; and X_{i1} = 1, for 'D' vs 'A' comparison, X_{i2} = 1, if control and X_{i2} = 0, otherwise; Y_i =1, if species belongs to non-shared species group; and Y_i = 0, if a species belongs to shared species group. At the i^{th} site, the probabilities of species sharing pattern between control and any one of the states, are shown in Table.

X_{i1}	X_{i2}	Y_i=1	Y_i = 0
1	1	$P_{i\,11}$	(1-$P_{i\,11}$)
1	0	$P_{i\,10}$	(1-$P_{i\,10}$)

The quantity, $P_{i\,11}/P_{i\,10}$ describes the relative risk of species loss against gain between two states: before (X_{i2} = 1) and during (X_{i2} = 0). Generalizing this idea, the Relative Risk of Species Loss (RRSL) given X_1 is defined as:

$$RRSL(X_1) = \frac{P(Y = 1|X_1, X_2 = 1)}{P(Y = 1|X_1, X_2 = 0)}$$

If $RRSL(X_1)$ = 1, then there is no loss or gain between the two states. If $RRSL(X_1)>1$, then species loss in control is more than the gain in the sample compared with control, and $RRSL(X_1)<1$ indicates a species gain in the sample compared with control.

A Bayesian GLMM framework for risk assessment

The challenge lies in estimating the Relative Risk of Species Loss (RRSL) defined in aforementioned equation. A Generalized Linear Mixed Model has been proposed to parametrize and subsequent estimate the RRSL. The proposed GLMM is described as:

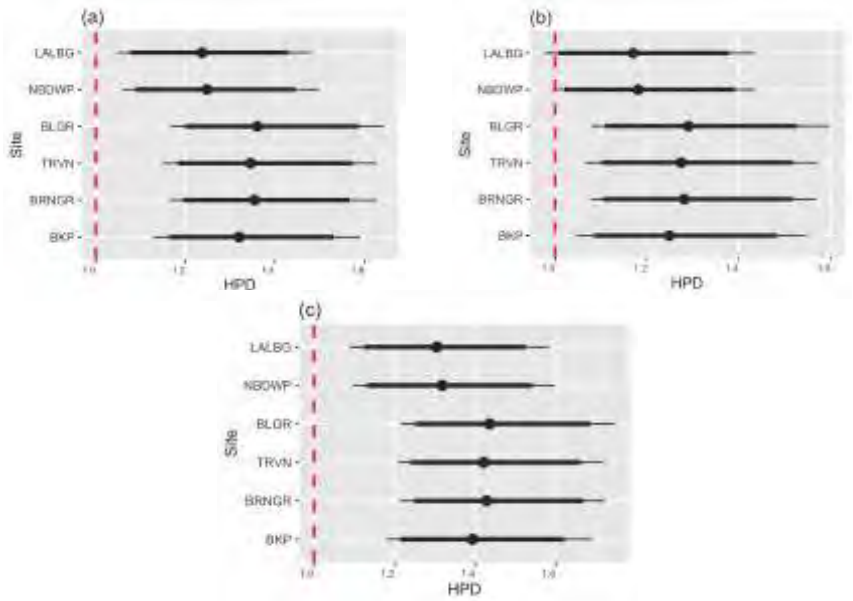
$W_i/(X_{i1}, X_{i2}) \sim$ binomial $(P_i(X_{i1},X_{i2}),T_i)$;

$\log(P_i(X_{i1},X_{i2}))=\alpha+\gamma X_{i1}+\beta X_{i2}+u_i$,

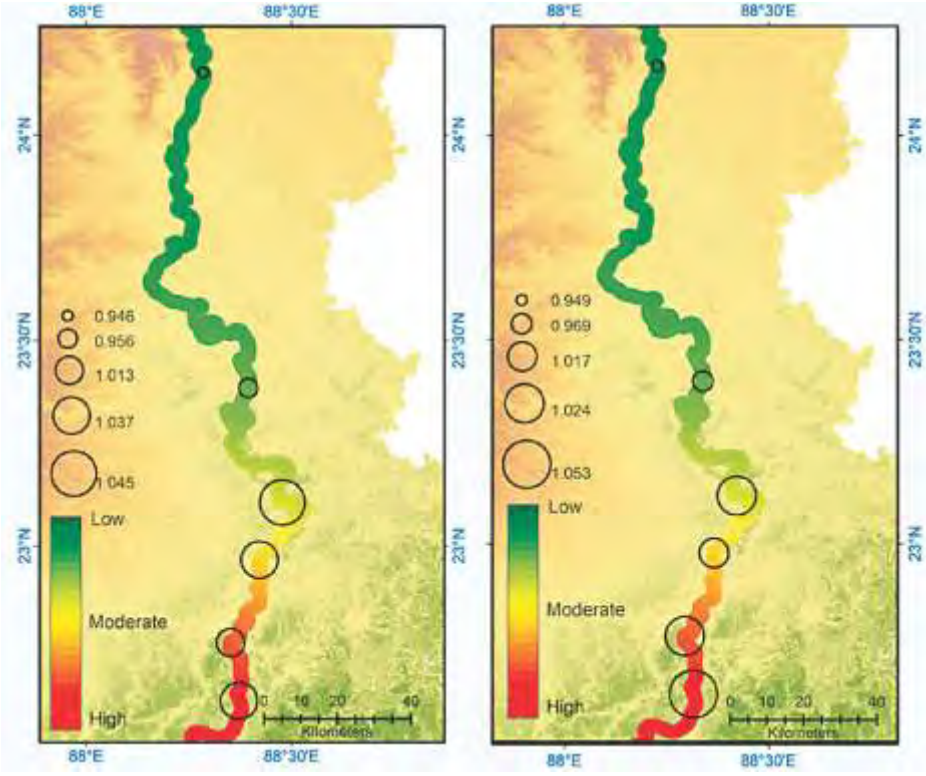
Where W_i and T_i are the number of individuals belonging to non-shared and the total number of individuals in two assemblages, respectively, corresponding to the two sate of observations. Here, the term u_i is a random component, which accounts the site-specific uncertainty, assumed to follow a normal distribution with mean 0 and variance τ For the estimation of RRSL and other parameters full Bayesian analysis method has been applied. The advantages of this method are as follows: (1) this method conveniently estimates full posterior of model parameters, which allows hypothesis testing and calculates confidence intervals; (2) even if the distribution of RRSL-which is a non-linear function of model parameters-is unknown, this method has the capability to draw inferences on RRSL; (3) moreover, it allows to investigate the critical insight of the nature and magnitude of site-specific uncertainty. We used 'JAGS' software which implements BUGS, for fitting the model via R using 'R2jags'which is an R package that allows fitting JAGS models from within R.

Significant findings

In order of magnitude the relative risks of species loss were as follows: BALAGARH (36.9%) >BARANAGAR (35.9%) >TRIVENI (35.7%) >BARRACKPORE (32.7%) >NABADWIP (25.3%) > LALBAG (22.2%).The site-specific mean of the random components has shown variation towards the downstream direction in order of magnitude, which follows the tidal influx. Though the extent differs, results have shown a similar pattern for both abundance and presence-absence data. A threshold value of '0' separates study sites into two groups. Two upstream sites-NABADWEEP and LALBAG-have had negative, while the remaining four sites have positive mean values. However, the HPDI lengths of TRIVENI and BALAGARH are relatively higher than that of other sites, indicating a relatively greater extent of uncertainty exists at TRIVENI and BALAGARH.



Site-specific HPD interval of RRSL. Sites are in order of upstream direction. The red dashed line demarcated the threshold value of RRSL to indicate species loss. (a) denoted for Before vs After ('BA'); (b) denoted for Before vs During ('BD') and (c) denoted for During vs After ('DA').



Site-specific estimate of mean of uncertainty estimate in plankton diversity loss. Left and right panels represent abundance and presence-absence data, respectively.

Implication to river water management

River water management is a complex issue, as it offers multiple services to a society. Nevertheless, the results of this study have some utilities in river water management, especially by controlling barge movement:

- Barge movement affects the river ecosystem in multiple dimensions, thereby needs holistic assessment to maintain a trade-off between social benefit and sustainable ecosystem. However, a holistic evaluation of the impacts of barge movement on the aquatic ecosystem level is still somewhat speculative. The reason is partly due to the limited knowledge of the consequences of barge movement in all dimensions of aquatic systems- especially on the plankton communities. Hence, the results of the study have utility in water management, as inland waterways navigation is expected to increase dramatically worldwide. It is imperative to mention that the riverine system needs sojourn time to self-regenerate plankton communities. Literature reported a minimum of one day of phytoplankton regeneration, which would help in controlling barge movement frequency. Precisely, the quantitative estimate of phytoplankton diversity loss will facilitate to mitigate the direct and cascading effects of barge movement and to protect the biodiversity of inland waters in the future.

- All abiotic and biotic components get affected by the barge movement in inland waterways. But abiotic indicators- specifically physicochemical indicators - are mostly used for impact assessment of barge movement and subsequent water management. The biological indicator developed in this study complements the traditional physicochemical indicators, facilitating better assessment and management of freshwater ecosystems.

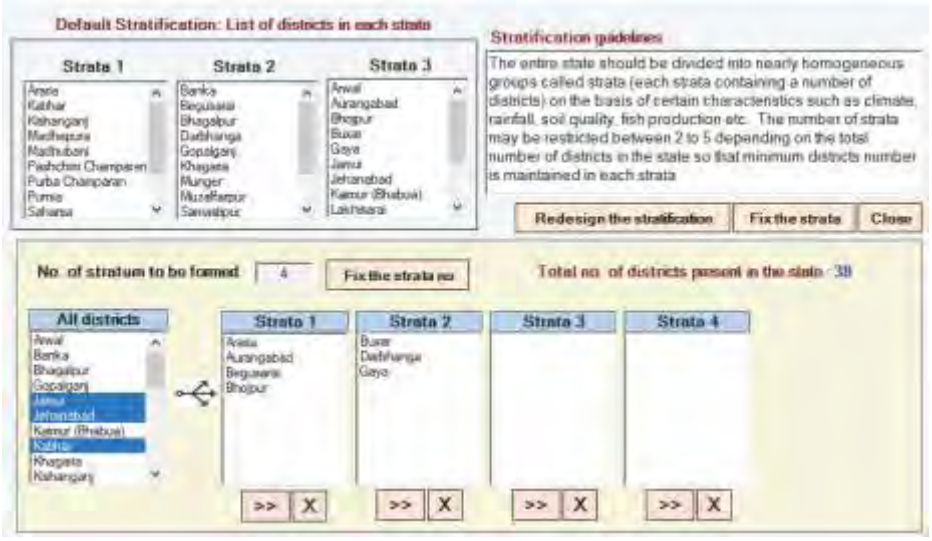
- Very often a multimetric composite index is used to prioritize or assign different weight components, for water quality and water management in the river ecosystem. The proposed index and its estimate can be one of the vital components of the composite index for water management.

Software upgrade for estimating state-level catch estimate for group-I (below 10 ha) water bodies

The institute had developed a standalone software 'Catch

Assessment Survey' (CAS) (Version 1.5) date back in 2003 to estimate the inland open water resources as well as catch by evolving suitable sampling methodologies. The developed software had also been deployed to the respective State Government. Based on the user's feedback, an all-new version (2.0) of the software has been developed to keep pace with the latest Windows operating system. However, the new version will provide simple and elegant user interfaces with all possible options to easily execute different operations. A series of activities/changes have been performed to simplify the software, making it more user friendly and adaptable.

CAS Main user interface



Window for stratification strategy design

A. Simplifying questionnaire schedule: Keeping in view of an old questionnaire, which was data-intensive and complicated to some extent, a new simplified questionnaire has been framed to minimize the complexity and hardship of the data collection process as well as voluminous data entry method into the software as experienced by the users. However, the simplicity of the questionnaire will encourage the end-users to collect the data and use the software more efficiently and effortlessly.

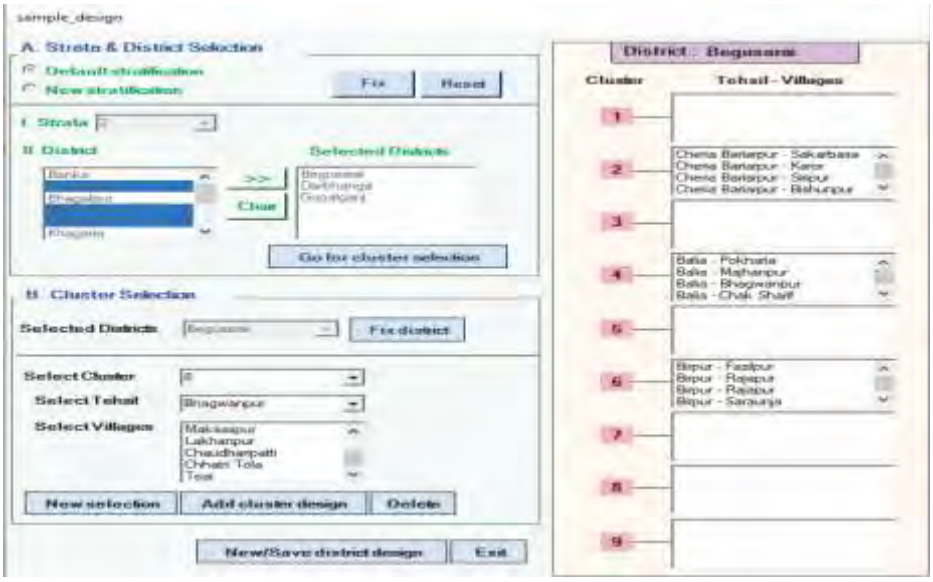
B. Database design and development: Based on the modified questionnaire and software data flow process, the database structure has been completely changed to a new design framework. The new database has been designed with latest 2011 census data.

C. Customization of stratification strategy: A new interface was developed to enable end users to create their own strata (group of districts) of their state following the stratification principle. The strata number may vary but be limited to 2-5 based on the requirement and convenient.

D. User defined survey design: The new software provides provision for designing the sampling strategy for field

data collection. This feature will help to capture the user's sampling framework design well ahead of the data entry and estimation process which will minimize the data flow complexity.

Finally, software will estimate the different fish catch data along with total fish catch for the state if minimum data criteria for each species is fulfilled. Generated reports can be viewed, saved, and printed for future reference. The standalone software has been developed in VB.NET 2012 and the database developed in Microsoft Access 2010.



Window for sampling survey design

Project title: Ecosystem health risks and food safety assessment in relation to chemical contaminants in inland aquatic environment

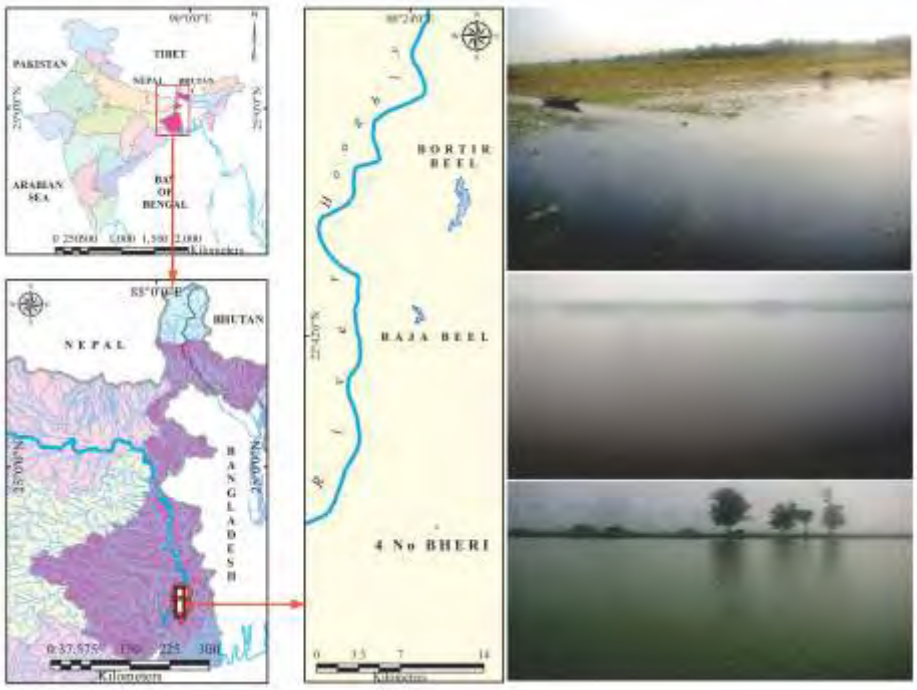
Project code : FREM/20-23/16
Duration : 2020-2023
Scientific personnel : S. K. Nag (PI), S. K. Manna, S. Das Sarkar, A. Saha, K. Kumari, V. Kumar, D. J. Sarkar, S. Samanta, V. Santhana Kumar, P. R. Behera, T. Bera
Associates: K. Saha, S. Bandyopadhyay, S. Saha

Borti Beel

Borti beel is a stretch of marshland crept up on several agricultural and fishing area which is a network of several canals previously connected to Vidyadhari River and also included the riverine network of Ganga in North 24 Parganas district of West Bengal. It is a seasonal wetland that remains dry during winter and summer months. The Beraberia sector of the beel (22°47'2.99" N, 88°26'11.82" E) was studied for physico-chemical and pollution status in water and soil. The water of the wetland was acidic (pH 6-6.8); other parameters were: sp. conductance 333-371 µS/cm, free CO_2 6-15 mg/l, dissolved oxygen 7-8.2 mg/l, alkalinity 78-90 mg/l and hardness 110-136 mg/l. The soil is sandy loam with acidic (pH 5.6-5.8) and 3-4% organic carbon content.

Toxic elements, *viz.*, Pb, Cd, Cr were below the detectable levels (BDL) in water by Flame-AAS method of analysis. Zn and Cr were also at BDL, but Mn (up to 0.12 mg/l) was present. In soils too, no accumulation of Pb, Cd and Cr was observed. But the level of Zn (114-134 mg/kg) and Cu (47-55 mg/kg) indicate moderate pollution according to the USEPA guideline for sediments.

Water samples were analysed for targeted 34 compounds including pesticides and their metabolites belonging to three groups, *viz.*, Organochlorines (OC), Organophosphates (OP) and Synthetic pyrethroids (SP). Among them, only cypermethrin (0.33-0.69 g/l), a SP compound was detected. Residue of other compounds could not be found.



Geographical locations of the studied wetlands

Sampling work at Borty beel

Raja Beel

Raja beel (22°42′ 56.84″ N, 88°24′28.06″E) is a fresh water wetland located by the side of Barrackpore-Kalyani expressway on the eastern part of Khardah and Sodepur in North 24 Parganas district of West Bengal. It is connected to the Ganga River through a canal. The water quality was in the acceptable range for most of the parameters like pH (7.1-7.5); free CO_2 10 mg/l, dissolved oxygen 6-10 mg/l, alkalinity 150-170 mg/l and hardness 110-125 mg/l. The sp. conductance was slightly higher (754-760 µS/cm). The soil is basically sandy (95% sand) with 1-2% clay containing 6-8% organic carbon and 0.68-0.7% nitrogen.

Toxic metals like Cd, Pb, Cr along with Zn and Cu were at BDL in water. In soil, Cd and Cr were BDL, but Pb (22-26 mg/kg) was detected, though at safe level. Zn was also found at safe level but Cu (37-47 mg/kg) was at moderate pollution level as per USEPA guideline for sediments. Accumulation of toxic metals (Cd, Pb, Cr) was not observed in fishes raised in the wetland. Residues of chlorpyrifos (1.6-2.8 g/l) and cypermethrin (0.15-0.2 g/l) were recorded in water. In fish tissues and snail, residues of OCs (DDT metabolites) were found but at concentration much lower than the tolerance limit. OP pesticide chlorpyrifos was also detected in Puntius sp. and in Tilapia (Oreochromis nilotica).

Sampling work at Raja beel

Bheri No.4 (East Kolkata Wetland)

Bheri No.4 (22°33′23.66″ N, 88°25′19.18″E) is a sewage fed wetland where semi-intensive aquaculture is practiced. The water of the wetland was slightly alkaline in reaction, DO varied from 6-12 mg/l, specific conductance 730-740

Bheri No. 4

µS/cm. Other water quality parameters were in the normal range, though nutrient (nitrate and phosphate) load was high. The soil is sandy in texture, acidic in reaction and contains 2.5-3.5% organic carbon.

All the targeted metals were BDL in water. In soil Pb was present below the USEPA safe level, Cd and Cr again being at BDL. But Zn (223-282 mg/kg) and Cu (57-76 mg/kg) concentration in soil were in the heavy pollution category as per USEPA guideline. No accumulation of toxic heavy metals (Cd, Pb, Cr) was observed in fishes. Among the pesticides, trace amount of DDT metabolites were found in fishes and snail.

Project title: Fisheries resource assessment and prediction in inland open water under AI and Big Data platform

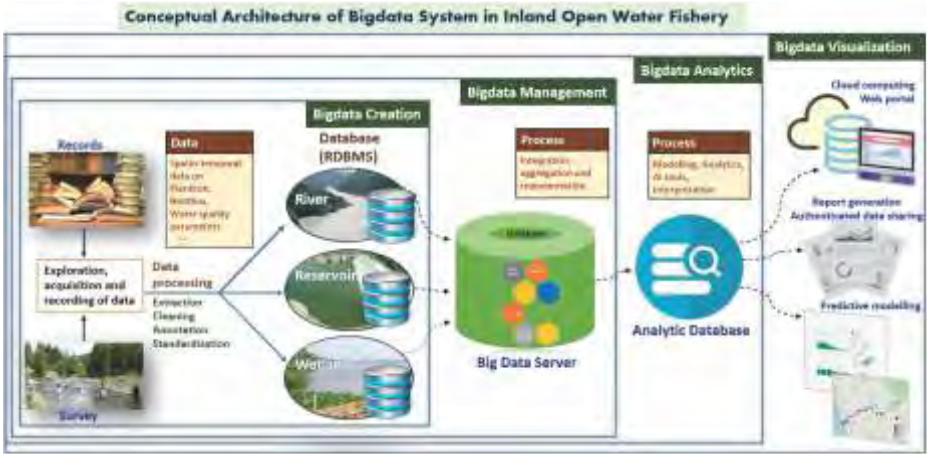
Project code : FREM/20-23/18
Duration : 2020 - 2023
Scientific personnel : M. Naskar (PI), B.K. Das, S.K. Sahu, C. Jana, A. Pandit, T. N. Chanu, A. K. Das, N. S. Singh
Associate : Md. Naim

Conceptualization and planning

The open water fisheries resources assessment requires a variety of data over spatial and temporal scales. Numerous research programmes have been undertaken by multiple stakeholders on inland aquatic resources. Each research program has its own specific objectives and data are generated accordingly. ICAR-CIFRI has the legacy of acquiring a variety of data on open water resources, which encompasses fishery-dependent data, fisheries independent biotic and abiotic data, socio-economic data, RS and GIS data, etc. All these data are unstructured and in the form of format available for rivers, wetlands, reservoirs, estuaries, etc. The conceptualized data platform and associated components are summarized in a graphical format as shown in the figure.

Data structure for creation of data platform

The first targeted water resource is river aquatic system, focusing river monitoring and survey data. An extensive literature survey has been carried out to identify data element. After a couple of brain storming sessions, the broad categories of data components for riverine fisheries assessment are shown below:



Implementation plan for the proposed project

The total number of environmental parameters included in the data portal is ninety seven (97) which includesPhysical Habitat = 23; Water Quality = 46 (Physical = 9, chemical = 16, Nutrient = 10, Heavy Metal = 11); Sediments Quality = 28 (Physical = 7, Nutrient = 10, Heavy Metal = 11)

Data standardization for river assessment

Spatial data entity

River monitoring data is always collected over space, such as the whole river, river stretch, site, gridded, and geo-reference points. Most frequently used sampling involves the selection of a river or a river stretch and sites withing a stretch.

- Basin: the broadest spatial scale of river data is a river basin in which at least a stretch of studied river belongs. For basin level, data processing centroid (longitude and latitude) of the basin can be taken as the georeferenced point data
- River: a river is identified as the name, e.g, Ganga, Brahmaputra, Cauvery, Krishna, etc.
- Site is the very basic element of the river sampling data. A site is uniquely defined by the GPS location, i.e., longitude and latitude. For value addition to the data, altitude has also been incorporated. Standard measurement units for longitude and latitude are degree up to six decimal places. Proper data conversion is required to make an entry in the data to maintain uniformity.

Timestamping the data

The river environment is highly dynamic over time. So, relevant data on environmental characteristics, biotic components, such as fish plankton, etc. need timestamping. More specifically, every data record should have a time tag-similar to georeferencing or geotagging, which is highly variable depending upon the sampling frequency. A preliminary survey revealed that most of the data is recorded from field visits or surveys wherein data is generally recorded within a span of time interval, such as weekly, seasonally, monthly, bi-monthly, six-monthly, even yearly (for rapid survey). The present database uses date as the timestamp. So, the best practice is to keep a record of the date of data recording. In case of non-availability of the date, the middlemost date of the sample of time interval is set as the time stamp. For example, time stamp of the second week of April in 2020 is 10/04/2020. The date format for data entry is dd/mm/yyyy.

Environment data

River environment is a very broad term and context-specific. The present context defines the environment characteristics required for riverine fisheries assessment. The mechanism has been created to use international units for each data. However, a unit conversion facility is also available depending on the users' requirement

Schematic data structure for river aquatic system

Project title : Impact assessment of CIFRI technologies (cage and pen culture) and training

Project Code : FSE/17-20/03
Duration : 2017-2020
Scientific personnel : A. Pandit (PI), G. Chandra, A. Roy, A. Ekka (up to July 2017), A.K. Yadav, P. DebRoy, S. Som (since 01.10.2018)
Associates : D. Biswas (up to 30.11.2018), L. Chakraborty, A. Das (since 01.04.2019)

Impact of cage and pen culture on fish production, economy, and livelihood of fishers

The project aims at studying the impact of enclosure culture technologies on the inland fisheries sector in the country. In the adoption study, it was found that around 14,000 cages were installed in different reservoirs of the country during 2017-18. Around 30% of the cages are GI made. Pangasius is the species of choice for cage culture across the country. The economic analysis showed that the technology has yielded positive net economic returns across the states and is contributing around 39,000 metric tonnes of fishes to the fish basket of the country. These cages in the country employ 7.46 lakh man-days of labour. The cage culture also contributes significantly to the livelihood of fishers. A study in the state of Jharkhand shows that the cage fishers draw around 30 % livelihood. The technology has not only enhanced the family income but also reduced the occupation migration (9 % from 29 %). The consumer surplus model estimated total net benefit generation from cage culture at around ₹4 crores during 2010 to 2019 in Jharkhand; the net benefit may go up to ₹14.83 crores during the period of 16 years (2010-2025). The total surplus was distributed between producers and consumers in the ratio of 45:55. High initial cost, high feed cost, and low market of fish are the major constraints faced by the adopters. The initiative of cage fish farming has solved the livelihood problems of the displaced population to some extent. However, there is a requirement of developing low-cost cage materials and also suitable indigenous candidate species having good market acceptance.

Similarly, the study shows that fingerling production through pens in the beels of Assam had a considerable positive impact on fish yield (from 492 kg/ha/yr to 1011 kg/ha/yr) in the wetlands. The pen culture practice has also significant positive effect on the monthly income of the fishers of Manipur. Adoption of the technology has resulted in a 49.6% increase in the mean monthly income of the fishers.

A fisherman household of Tilaiya reservoir, Jharkhand

Impact of trainings imparted by ICAR-CIFRI

ICAR-CIFRI imparted trainings to 5211 farmers during 2012-13 to 2018-19. A study involving trainee farmers from fourteen districts of Bihar indicated that the training has been enabling the fish farmers to build up their knowledge, skill, and attitude. The study further showed that farmers adopted many techniques of fish production. About 82 % of farmers adopted composite fish culture practices while 67 % of the trainees adopted scientific fish disease control. The technique of pond renovation/preparation/construction was adopted by 53 % of the trainees. Further, it was found that 7 % of the farmers have taken fisheries for their principal occupation while about 23 % of the farmers have adopted fisheries as a secondary occupation. This implies that rural youths may be trained for gainful employment in fisheries for enhanced livelihood. Trainings imparted to the farmers of Bihar on inland fisheries management helped the farmer trainees to supplement their livelihoods.

A post-training assessment of perception of the officers trainees of the Model Training Course showed that 50 % of the participants rated the training programme as excellent, while 34.62 % perceived it as very good. Further, a significant positive association was found between the training need and fulfillment of expectations of the trainees.

Training impact score (Bennett's hierarchy model

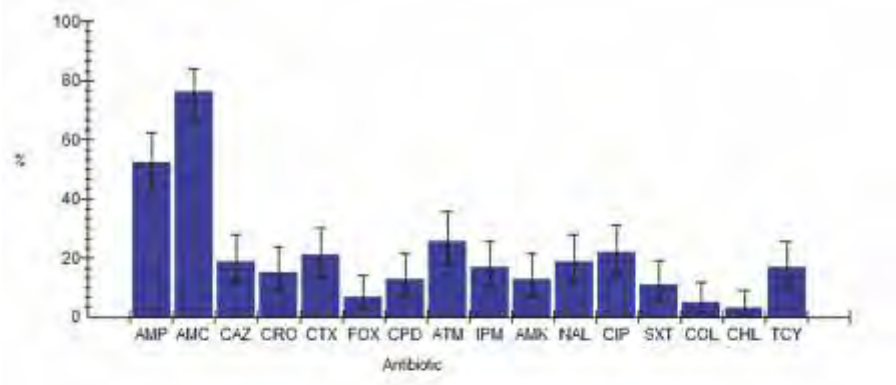
A study on 107 Officers trainees of the five training programmes indicated that most of the trainees were 'highly satisfied' in most of the components under facility and resources. The mean test scores of knowledge and attitude of the trainees after the training programmes were much higher than before the trainings. Around 38 % of trainees stated that they had acquired skill to satisfactory extents. Behavioural intention (90 %) was found to be the single most important factor affecting the extent of transfer of training. The composite training impact scores of five programmes were found to range from 64 to 83 % using Bennett's Hierarchy model. The transfer of training analysis showed that the trained 107 officers disseminated information to 5231 farmers, trained 2985 farmers. As a result, 3715 farmers were benefitted socio-economically and 38 entrepreneurs developed. They also shared their knowledge with 108 colleagues.

It could be concluded that self-efficiency has greater roles to play in affecting behavioural intention of trainees which in turn reflects on their performance. It is suggested that the inclusion of a socio-psychological counselling session in the training programmes would be helpful to enhance the self-efficacy of the trainees and to help them to deal with organizational stress. Some of the suggestions for future improvement are arrangement of microlabs for building a positive attitude, application of simulation techniques for skill development, inclusion of more practical and field-oriented sessions, post-training counselling for improved performance at workplace and follow up with mother organization.

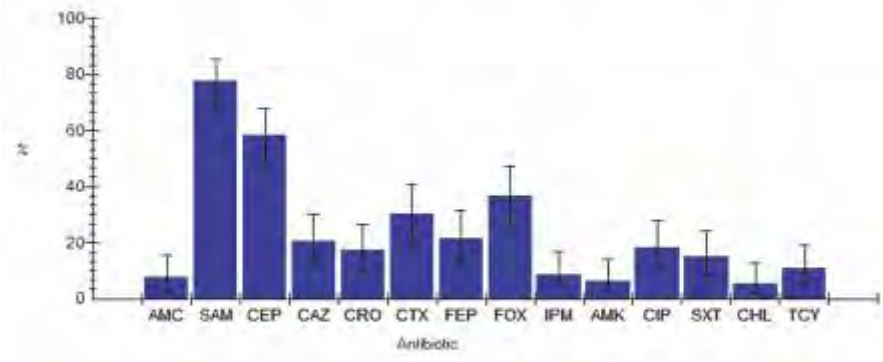
Project title : Antimicrobial resistance (AMR) in fisheries and aquaculture

Scientific personnel : A. K. Sahoo, A. K. Bera

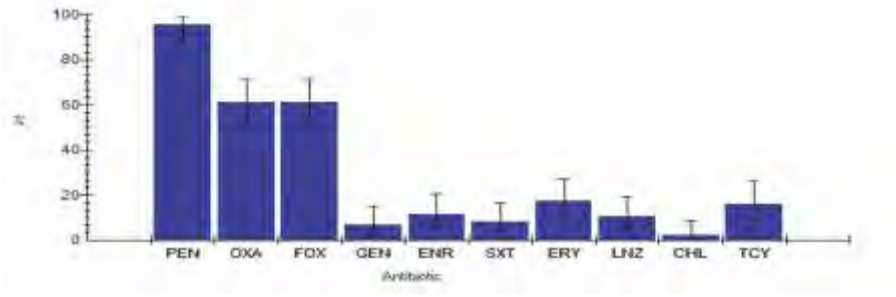
A total of 74 strains of Aeromonas, 71 strains of *E. coli* and 22 strains of *Staphylococcus* were isolated from 78 farms of five different districts of West Bengal. Antibiotic sensitivity test (AST) of the *E. coli* isolates showed that 80% strains were resistant to amoxicilin-clavulanic acid while, 50% strains were resistant to ampicillin. Nearly 80% of *Aeromonas* isolates showed resistance against ampicillin-sulbatam, and 60% and 40% were resistant to Cephalothin and Cefoxitin, respectively. A large majority (97%) of *Staphylococcus* spp. showed penicillin resistance; resistance of oxacillin and cefoxitin antibiotics, which leads to methicillin resistance, showed 60% resistance.



Resistance pattern in *E.coli.*

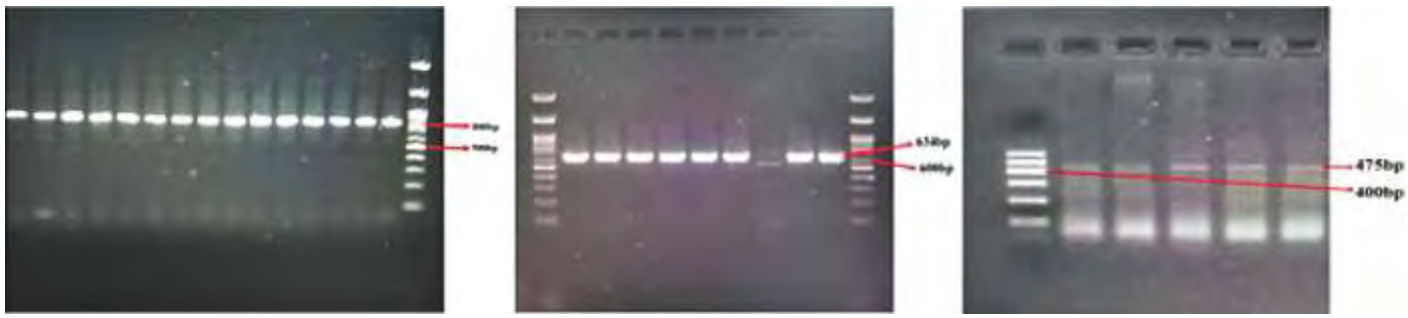


Resistance pattern in *Aeromonas* sp.



Resistance pattern in *Staphylococcus aureus*

Following the phenotypic detection of antimicrobial resistance, all the bacterial isolates were screened for presence of resistance genes by molecular methods. Ampicillin resistant *E. coli* isolates were detected by phenotypic method and use of resistance genes: out of 35 positive isolates, the resistance genes (Tem-1 and 2) were found in 18 bacteria. Plasmid mediated AmpC type of beta-lactamase gene was found in cephalosporin resistance gram-negative bacteria. Out of 64 phenotypically confirmed *E. coli* isolates, 48 bacteria were found to be positive for the resistance plasmids. New Delhi metallo-beta-lactamase-1 (NDM-1) enzyme that makes bacteria resistant to a broad range of beta-lactam antibiotics was detected in five isolates. Out of 25 phynotypic tetracycline resistant *Aeromonas*, Tet A was found in 15 strains, Tet G in 17, Tet E and Tet B in 3 strains. Beta-lactamase resistance gene (bla_{CTX-M}) was screened in 22 *Aeromonas* and molecular detection was confirmed in 4 isolates. Tem-1 and 2 were confirmed in 36,



Tem-1 & Tem-2 AmpC NDM-1

Genotypic confirmation of *E.coli* resistance gene

out of 66 *Aeromonas* isolates tested. Out of 22 *Staphylococcus* isolates, 3 were found to carry the penicillin resistance gene.

To create the awareness among the fish farmers, students and local people, the World antimicrobial awareness week (WAAW) was organized at Farakka, Murshidabad, West Bengal during 18-24 November 2020.

Project title: Breeding of indigenous fish species of ornamental value from West Bengal and Assam

Scientific personnel : A. Sinha (PI till September, 2020), S. Kumari (PI from October, 2020), S. Yengkokpam, H.S. Swain

Successful breeding of *Macrognathus aral*

A total of 400 numbers of *Macrognathus aral* (Peacock eel) were collected from different wetlands of West Bengal and reared in captivity, out of which about 150 matured in captivity and had shown sexual dimorphism during the breeding season. Similarly, a total of 570 number of *Macrognathus pancalus* (Indian spiny eel) were collected from different wetlands of West Bengal and reared in captivity. In breeding season 290 fish were observed to be matured in captive condition.

Breeding trials with 10 sets of peacock eels were conducted in glass aquaria of 2′ x 1.5′ size. The preferred water quality parameters were maintained. Breeding was trailed both in static and flowing water conditions. Synthetic substratum was provided to facilitate breeding environment. The sizes of mating female and male fish were 10-21 g and 7-15 g, respectively. Female and male fish were kept in 1:2 ratio for breeding. Spawning response varied from 16-18 h. Courtship behavior such as male and female encircling each other around the substratum were observed before spawning. Eggs were round, adhesive, green in colour and found attached to the substratum. Induced breeding with synthetic hormone (SGnRH + domperidone) was used. Spawning was observed after 12 h of injection and hatching was observed after 48-56 h of spawning. The fishes showed behavior of batch spawner. Hatchlings were found attached to the walls of the aquarium. Yolk sac was also visible after 96-100 h of fertilization and hatchlings started moving in the aquarium. Larvae were fed with Infusoria and boiled egg yolk. Maximum mortality of the larvae was recorded after first week of hatching. Young ones reached at the size of 4.5-5.7 cm in one month.

Sexual dimorphism of fish

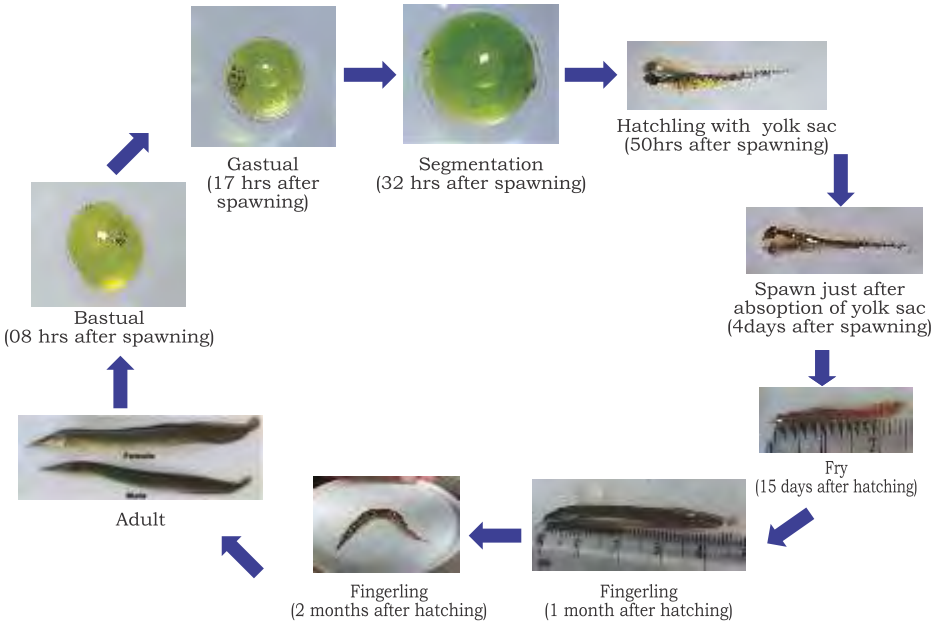
Courtship of male & female fish

Egg attached in bushy plants

Breeding of *M. aral*

Study of biometric, morphometric and reproductive biology of *Channa aurentimaculata*

A total of 30 numbers of *C. aurentimaculata* were collected from Oiramghat, Dhemaji, Assam for domestication and breeding in captive condition. The total length and weight of the fish ranged from 11.4-19.8 cm and 12.0-55.5 g, respectively. Standard length, head length, body depth, head width, pre-dorsal length, post-dorsal length and length of caudal peduncle were found to be correlated with increasing total length and body weight. The meristic counts showed 41-48 dorsal fin rays, 13-15 pectoral fin rays, 25-30 anal fin rays, 5-6 ventral fin rays and 13-16 caudal fin rays. The reproductive biology study revealed that the fish were in immature to maturing stage. The gonad weight of the fish ranges from 0.08–0.56 g.



Developmental stages of *M. aral* from egg to larvae

Study on ornamental fish trade in Assam

A study was conducted on ornamental fish trade in Assam based on inputs from ornamental fish traders of the state. Data were collected from 31 ornamental fish traders including wholesaler and retailers from 4 districts (Kamrup metro, Nagaon, Karimganj and Cachar) of Assam. Majority of the traders had educational qualification up to higher secondary (45%), followed by graduate (35%) and post graduate (20%). About 80% of the traders had 5-10 years of experience. In our study, 51.6% of the firm traded 10-20 varieties of fish while 25.8% traded more than 20 varieties. Majority of the fish traded were exotic fishes such as gold fish, Koi carp, guppy, mollies, fisher fish, angel fish, etc. Some of the indigenous ornamental fish traded are *Botia dario, Brachydanio rerio, Mystus tengra, Chanda nama, Hara hara, Puntius conchonius, Channa stewartii*, etc. The

Morphometric and meristic characteristics of *Channa aurentimaculata*

Morphometric trait	Minimum	Maximum	Average	Meristic characteristic	Minimum	Maximum	Average
Weight (g)	12.0	55.5	33.1	Dorsal fin rays count (no.)	41	48	44
Total length (cm)	11.4	19.8	15.8	Anal fin rays count (no.)	25	30	28
Standard length (cm)	9.3	15.9	12.9	Pectoral fin ray count (no.)	13	15	14
Head length (cm)	2.7	4.9	3.8	Ventral fin rays count(no.)	5	6	5
Body depth (cm)	1.4	2.4	2.0	Caudal fin rays count(no.)	13	16	14
Eye diameter (cm)	0.5	1.0	0.7	Scales in lateral line (no.)	47	51	50
Dorsal fin length (cm)	3.6	6.7	5.1	Scales from lateral line to dorsal fin base (no.)	4	5	4

Yearly turnover of ornamental fish traders of Assam

Rs.	Percentage of traders
< 3 Lakhs	16.12
3-5 Lakhs	29.03
5-8 Lakhs	51.61
> 8 Lakhs	3.22

yearly turnover of ornamental fish traders ranged widely. The major share of profit of the traders comes from sale of accessories, followed by sale of fish and fish feed & medicines. Some of the constraints faced by the traders are lack of training and technical advice, unpredictable demand, high cost of operation, absence of market information and difficulties to procure materials.

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

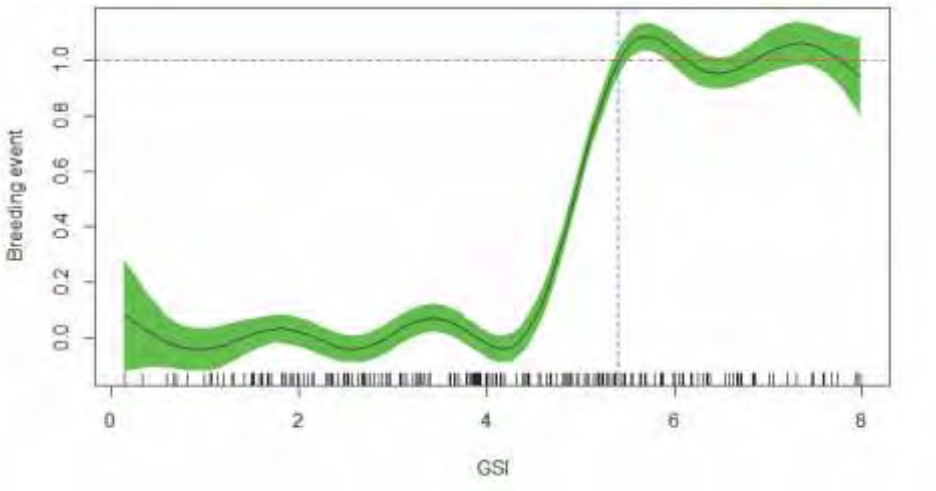
Funding agency : ICAR-NICRA
Scientific personnel : U. K. Sarkar (PI), B. K. Bhattacharjya, S. K. Nag, M. Naskar, D. Debnath, S. Das Sarkar, T. T Paul, S. Kumari, Lianthuamluaia, P. Mishal, G. Karnatak, Kavita Kumari, C. Johnson

Climato-hydrological anomalies have significantly impacted the aquatic ecosystems including the breeding biology of aquatic lifeforms, their recruitment patterns and the hydro-sedimentological regimes as a whole. A number of attempts have been made by the global scientific community to quantify these ecosystem vulnerabilities and developing suitable adaptation strategies. ICAR-CIFRI has undertaken several studies to assess impact of climatic variability on fish and fisheries of inland waters including breeding phenology of prioritized species, ecological and social vulnerabilities, and adaptation strategies with special reference to floodplain wetlands. New initiatives have been taken to study impact of heat wave on wetland fisheries, carbon sequestration potential and GHG associated microbiota in different categories of wetlands etc.

Climato-hydrological influences on breeding phenology of fish

Reproductive dependencies of clupeid *Gudusia chapra* (Indian river shad) were investigated in the lower Gangetic drainage (India) in the context of climate change and overfishing. Monthly rainfall (≥ 60–100 mm), followed by water temperature (≥ 31–32 °C) are breeding cues for females. The species has maintained consistent breeding phenology over last two decades. Other breeding thresholds, relevant to fishing, include size at first maturity (≥ 6.8 cm; now reduced) and pre-spawning girth ($Girth_{spawn50}$ ≥ 7 cm; first record). $Girth_{spawn50}$ is a proxy of minimum mesh size requirement of fishing nets to allow safe passage of 'gravid' females (+22% bulged abdomen) and breed. Presently operating fishing nets (3-10 cm mesh) are non-specific, indulged in size-selective fishing for generations. As such, overfishing seemed to be a bigger threat than climate change.

Nandus nandus, the leaf fish of the family Nandidae, is a benthopelagic fish, commonly occurring in rivers, lakes, wetlands. In recent past, the availability of the fish has drastically reduced in the wetlands of West Bengal. The breeding phenology of the species was studied in relation to climatic cues and thresholds to predict the impact of changing climate on its breeding and recruitment success. Preliminary study indicates extension of breeding period upto November as compared to the information published in literatures indicating climatic influences.



Threshold gonadosomatic index for breeding of female *Gudusia chapra*

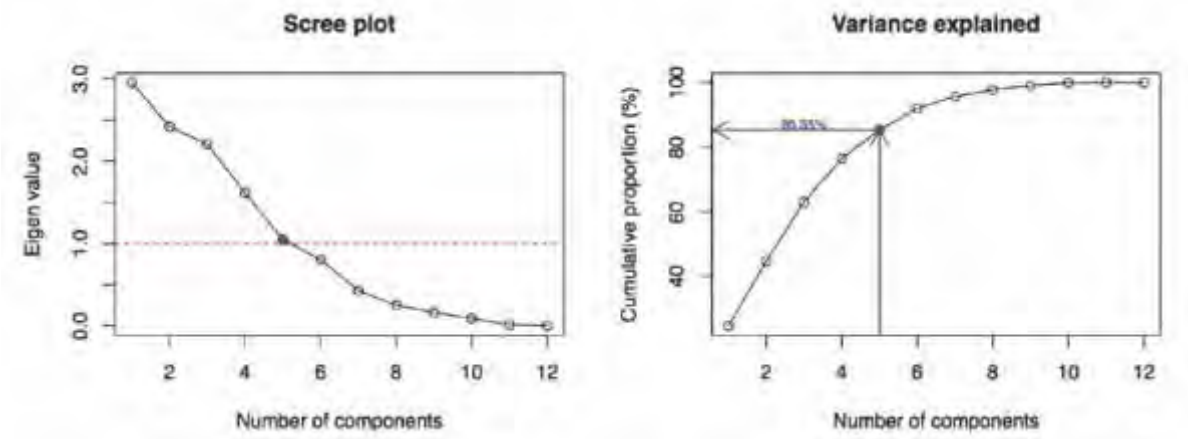
Nandus nandus

Ovary of a ripe female *Nandus nandus*

Stakeholder-driven vulnerability assessment of wetlands

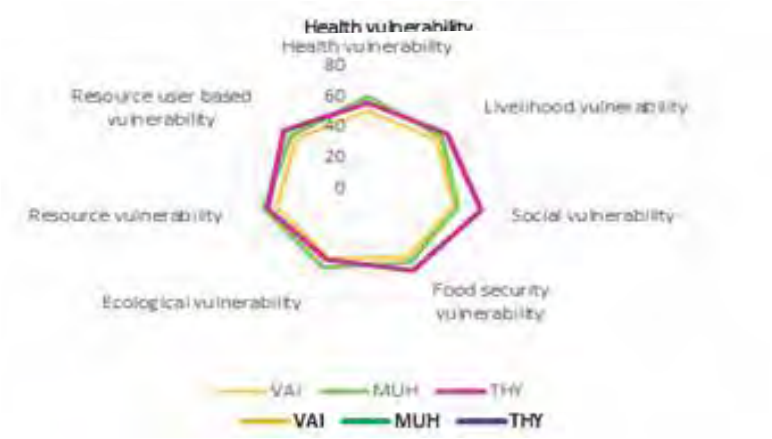
Vulnerability assessment based on stakeholder perception was carried out for 15 wetlands of Maldah and Murshidabad districts of West Bengal. Indicators of vulnerability were screened through eliciting response from respondents. Index-based vulnerability comprised of two types of indicators: climatic indicators with long-term quantitative data and stakeholder perceived vulnerability specific to wetland fisheries. The high level of consensus (92%) provided strong evidence of climate anomalies in the last 15 years, which has also been validated through long-term data analysis. Principal component analysis extracted five synthesized vulnerability indicators explaining 83.35% variability of the original twelve indicators. The relative ranking of composite index scores, as well as categorization of the degree of vulnerability of each of the selected fifteen wetlands were provided for prioritizing the wetlands for strategic planning. The study revealed some of the indigenous climate-smart mitigation strategies of wetland fishers to climate anomalies.

A study was conducted to assess socioeconomic vulnerability associated with the wetland fishers distributed across three stations (Vaikkom, Muhamma and Thycattussery) in Vembanad lake. The overall wetland vulnerability indices derived from various sampling stations indicated that Thycattussery (58.13) was highly vulnerable. A transactional analysis across each sampling stations indicated that Vaikkom



Scree plot and explained variance for the selection of the number of principal components

fishers were less vulnerable to resource, food security and resource user threats in climatic variability context. Poor state of livelihood (57), social (65.5), food security (59.75) and resource user-based drivers (60.2) attributed to fishers' vulnerability in Thycattussery. The fishers of Muhamma experienced greater ecological (56.75) and resource (59.4) based vulnerabilities.



Vulnerabilities of fishers of the Vembanad Lake

After vulnerability assessment, Climate resilient pen system (CRPS) has been installed at Thycattusserry to demonstrate the climate resilient aquaculture practices to enhance adaptive capacity of fishers.

Vulnerability study was carried out in 20 floodplain wetlands (beels) of Assam (16 in Dhubri, 3 in Morigaon and one in Kamrup (Rural) district) in respect of different natural and anthropogenic factors including climate change. The total water spread area of the beels varied widely from 8 to 280 ha. Most of the beels (70%) have now reduced water spread area than 30 years back. Variations in water spread area in the range of over 0 to 66.7%, across seasons was also observed in the beels. Chulkani beel experienced reduction in deep pool area, which is an important wetland area that provides shelter to brood fishes during the dry season. Only 12.5% of the beels practiced enclosure (pen) culture for rearing fish, and one beel (Thekera) practiced cage culture. Our study showed that only Bhoishpuri and Tariachora beels were free from exotic fishes; *Cyprinus carpio* (common carp), *Ctenopharyngodon idella* (grass carp), *Hypophthalmichthys molitrix* (silver carp), *H. nobilis* (bighead carp) and *Piaractus brachypomus* (pacu) have been observed in other beels. Fifty percent of the beels surveyed reported reduced number of fish species as compared to 10-20 years back. In addition to climate change (such as abnormal rains/ floods and drought-like situations), other natural (e.g., hyper-nutrification) and anthropogenic factors (e.g., road constructions) also adversely affected vulnerability of the studied wetlands.

Pens installed at Thykattuserry of Vembanad lake

Occurrence of heat waves and impact on wetland fisheries

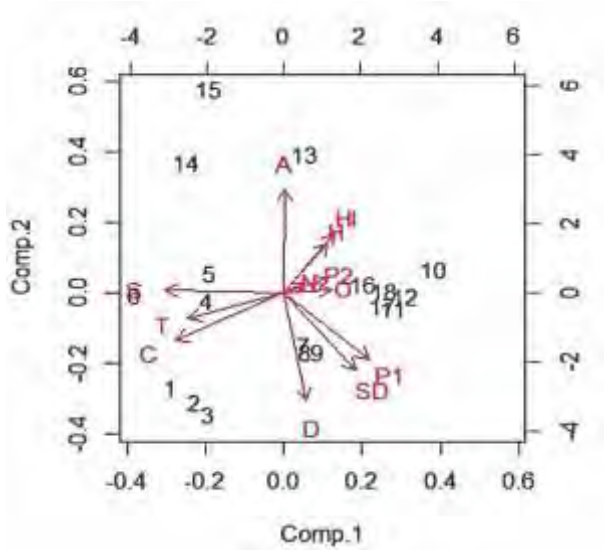
Impact of heat waves was studied in a stretch of Ganga River and Bhomra wetland of West Bengal. The inland heat index (IHI) was derived from monthly data obtained from IMD. It indicated predominant and periodic occurrence of inland heat waves under 'caution' category over these ecosystems during summer months (April-July). Principal component analysis revealed IHI influenced pH, transparency and water depth positively whereas TDS, salinity and conductivity were impacted negatively indicating that heat waves may affect the water quality affecting the sustainability and survival of aquatic life. IHI might affect plankton concentration and diversity thereby altering the food composition of the planktivorous fishes in the ecosystem. Periodic and frequent occurrences of anthropogenic inland heat waves can take a great toll on the diversity and ecosystem.

Carbon sequestration in wetlands

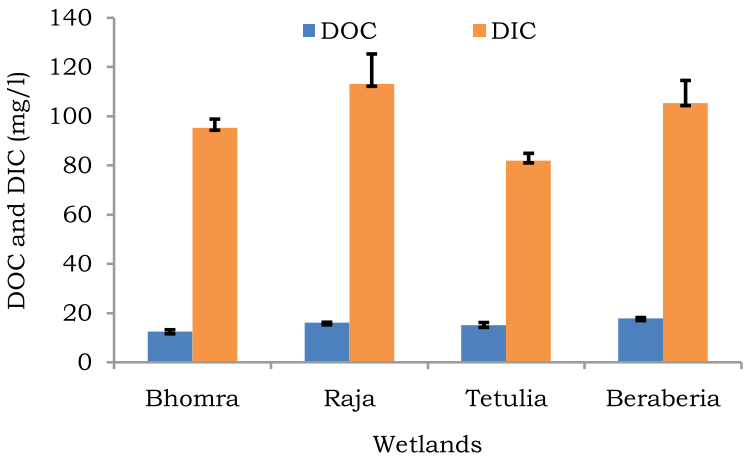
Dissolved organic carbon (DOC) contributes significantly to carbon pool and acts as an important energy source in wetlands. Carbon (C) dynamics was studied in 4 wetlands of West Bengal, *viz.*, Raja, Borti (Beraberia), Bhomra, and Borti (Tetulia). DOC concentration was highest in Beraberia (17.87±0.24 mg/l) and lowest in Bhomra wetland (12.50±0.64mg/l). Dissolved inorganic carbon (DIC) was highest in Raja wetland (113.11±12.15 mg/l) and lowest in Borthy wetland (Tetulia) (81.96±2.90 mg/l). The C contents of macrophytes also varied widely. These macrophytes contributed significantly to the C stock in wetland sediments which was estimated at 49.7, 144.36 and 165.82 Mg/ha in Jhagrasisa, Bhomra and Mathura wetlands, respectively. A positive correlation was observed between C stored in sediments and the macrophyte coverage in the studied wetlands.

Microbial diversity and abode preference in wetlands

Prokaryote community structure has been compared and their abode preference has been identified as an indicator of wetland ecosystem in three distinct wetland ecosystems (Bhomra, East Kolkata wetlands, and Malancho) using three universal prokaryote primers. Microbial community composition revealed distinct pattern by each primer in each wetland.



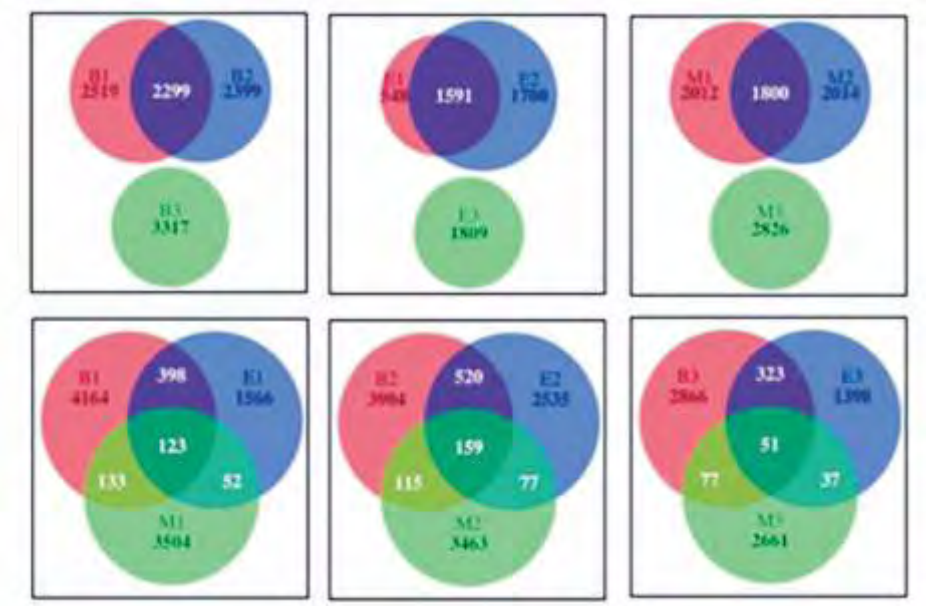
Biplot of PCA analysis of Bhomra wetland



DOC and DIC content in wetlands

Carbon contents of macrophytes

Name of the wetland	Macrophyte species	Macrophytes abundance (%)	C content (% DM basis)
Jhagrasisa	*Eichhornia* sp.	10	20.857
Bhomra	*Vallisneria* sp.	40	15.656
	Ceratophyllum sp.		16.015
Mathura	*Nelumbo nucifera*	25	19.259
	Eichhornia sp.		19.939
	Vallisneria sp.		13.766
	Hymphoides sp.		21.810



Venn diagram showing number of shared OTUs among primers within the wetlands (above) and among wetlands of the primers (below). The abbreviation used are as: B=Bhomra; E=EKW; M= Malencho; 1= 341b4_F/806_R; 2=N341b4_F/806_R; 3=Pro341F/Pro805R.

The study identified 21, 4, and 29 unique microbial genera as the diagnostic genera having abode preference for Bhomra, EKW, and Malancho, respectively. Further, the identified distinct microorganisms in each wetland ecosystem have their closest Operational Taxonomy Unit (OTU) in ecosystem or samples having similar respective environmental condition, such as more abode preference of various taxa inhabiting marine sediment in Malencho, freshwater in Bhomra and sewage in EKW. Prediction of potential roles of these microbes based on close OTU similarity revealed more abode preference of sulphate reducing microbes in Malancho and methanogens in Bhomra. Distinct phylogenetic differential abundance pattern along with microbial abode preference and their potential functional role predicts that ecosystem variables shape the microbial diversity.

Adaptation to climate-induced risks in a highly impacted wetland

Mathura wetland situated in North 24 Parganas district of West Bengal has undergone severe reduction in water depth (74.3%), increase in nitrate concentration (44.4%), area shrinkage (77.7%), macrophyte infestation (80%), decline in plankton diversity (54%), fish diversity (22.8%), and production making the wetland fisheries more vulnerable to degradation. The propagation of *Anabas testudineus*, a tolerant high value indigenous species, was undertaken as an effective tool to combat the consequences of climatic variability, especially the low water area and depth prevailing in the wetland. Generally, Primary Fisheries Cooperative Society practices staggered stocking of 1400 kg of fish seed in each session for 3 sessions, but in the year 2019 no stocking and harvesting of fish could be performed till the end of September 2019 due to extremely poor water availability in the wetland. *A. testudineus*, which formed 34.5% (326 kg) of the total catch during December 2019 to February 2020 supported the livelihood of the fisher-folk to a great extent.

A stakeholder driven primary investigation was conducted

Low water level in Mathura wetland due to low rainfall

in Chaltia wetland of West Bengal. All the respondents perceived rise in temperature, reduction in rainfall, and incidence of extreme events. The water quality parameters indicated the highly productive nature of this sewage fed wetland wherein aerobic plate count of bacteria was 5350±720 CFU/ml water. The trophic state index (67.7) indicated eutrophic nature of the wetland. The fishers adopted pen culture utilizing fast-growing species, viz. *Pangasianodon hypophthalmus* and *Oreochromis niloticus*, converting the waste to blue carbon. The present fish yield realized through culture-based fisheries (CBF) practices is 4745 kg/ha/yr which is much higher than the average yield of wetlands of India.

Eco-niche based stratification in tiny plankton in hydrologically disturbed wetland

Autotrophic picoplanktons largely act as storage of carbon for grazing animals of trophic food chain and thereby are micro-players with a macro-role. Econiche-based stratification for planktonic population entails mirror description of the cascading ecological states of the trophic food chain. Biological components (fish yields, plankton structure) were correlated with abiotic traits in Borti beel (with flow connectivity), Raja beel (closed system with anthropocene interference) and Bhomra (seasonally open floodplain wetland) of Gangetic belt. The study observed co-dominance of pennate diatoms and colonial cyanobacteria in closed wetlands.

Ecosystem health card for Vembanad lake, the second largest Ramsar site in India

The Ecosystem health report of Vembanad lake was created to initiate better management plans for freshwater (South Zone) and brackishwater (North Zone) based on 12 parameters segregated into 4 main indicators vis-a-vis

Water quality analysis in Chaltia wetland

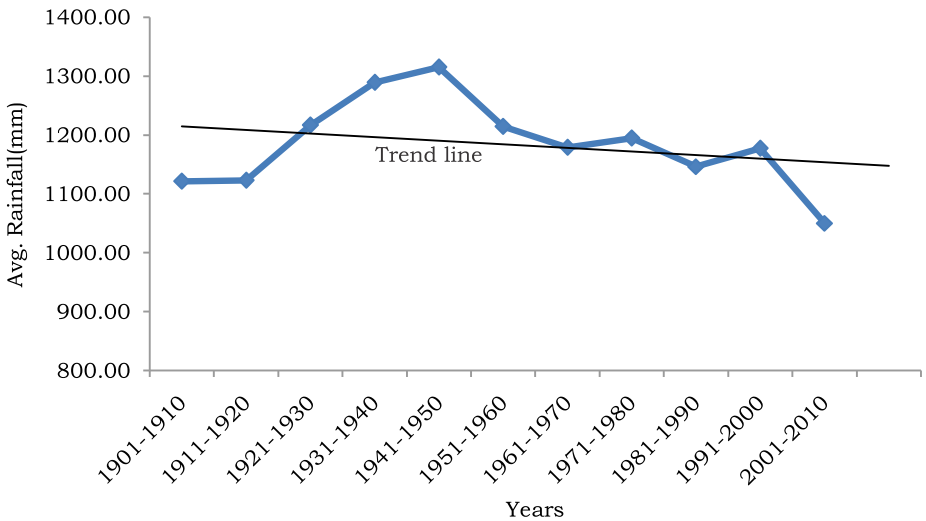
Health score for North zone (NZ)

Health score for south zone (SZ)

fisheries resources, fishers' livelihood, water quality and biodiversity. Overall, Vembanad lake scored a "D" for ecosystem health based on the performance of the selected indicators. North Zone (NZ) scored 'C' indicating better ecosystem health compared to south zone. NZ is vulnerable to biochemical oxygen demand, fecal coliform load and the relative species diversity. The South zone (SZ) scored "D" and is vulnerable to poor trophic state index and gender ratio.

Time scale changes in ecology and fishery of reservoirs and wetlands in the context of climate change

Secondary literature on ecology and fisheries of 250 wetlands from 11 states (West Bengal, Assam, Uttar Pradesh, Bihar, Manipur, Meghalaya, Madhya Pradesh, Rajasthan, Tripura, Kashmir, Punjab) of India were collected for the years 1980 to 2019. Similarly, ecology and fishery data of 121 reservoirs in India were collected for the same period. Rainfall data (Grid form) of 122 studied reservoirs during 1901-2010 were collected from Department of Agricultural Meteorology and Physics, BCKV, West Bengal. The result showed a gradually decreasing trend in average rainfall in last 11 decades.



Trend of average rainfall in the reservoir basins under study

Stakeholder's meet and distribution of inputs for climate smart wetland fisheries

A stakeholder meeting cum awareness program was organized at Media beel, North 24 Parganas on 16 December 2020 to create awareness on climate change and its deleterious impacts on wetland fisheries. About 45000 fish fingerlings of Indian Major Carps, bata (*Labeo bata*), punti (*Puntius sarana*) and tengra (*Mystus* sp.) were released in pen to boost culture-based fisheries production from the wetland and conservation of indigenous fish species. The Institute also distributed 3 FRP coracles and 2.5 tonnes of CIFRI CageGrow feed to the fisheries cooperative.

Stakeholders meet and seed stocking in Media beel

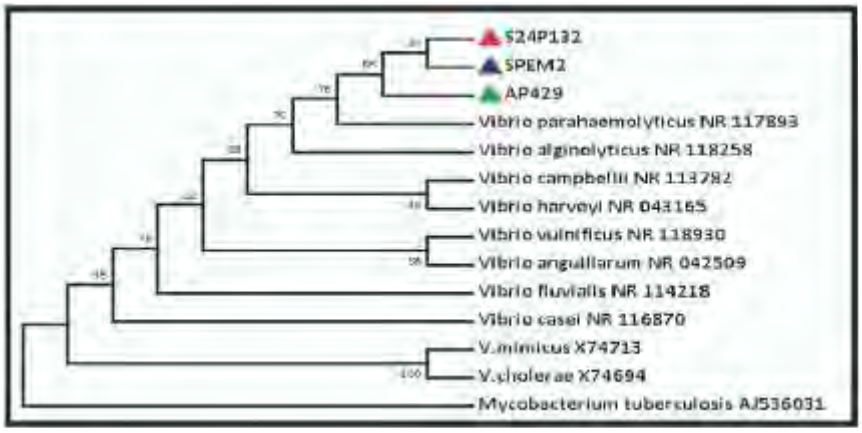
Project title : National surveillance program for aquatic animal diseases

Funding agency : NFDB
Scientific personnel : B. K. Behera (PI), B. K. Das, B. K. Bhattacharya, P. K. Parida, P. Das, S. Bhoumik
Associate : A. K. Jana

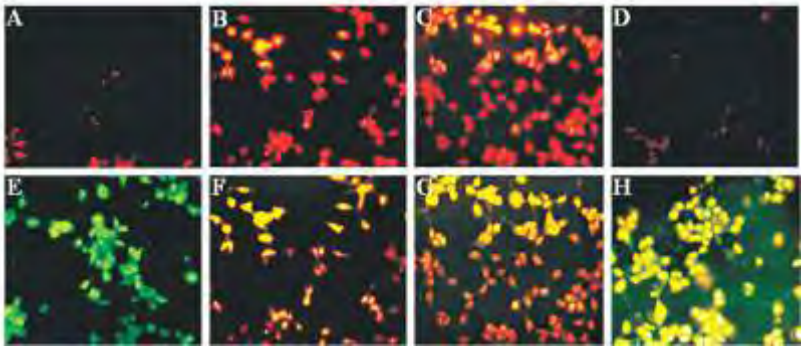
Pathogenicity study of *Vibrio parahaemolyticus* in *Labeo rohita*

Vibrio parahaemolyticus is a gram-ve halophilic bacterium responsible for gastrointestinal infection in human and vibriosis in aquatic animals. The thermostable direct hemolysin (tdh), tdh-related hemolysin (trh) and thermolabile hemolysin (tlh) positive strains of *V. Parahaemolyticus* were identified from brackishwater aquaculture farms of West Bengal and Andhra Pradesh, India. The presence of other virulent genes like vcrD1, vopD, vp1680 under type three secretion system 1 (T3SS1) and vcrD2, vopD2, vopB2, vopC2 under type three secretion system 2 (T3SS2) were detected in tdh, trh and tlh positive strain of *V. parahaemolyticus*. Study

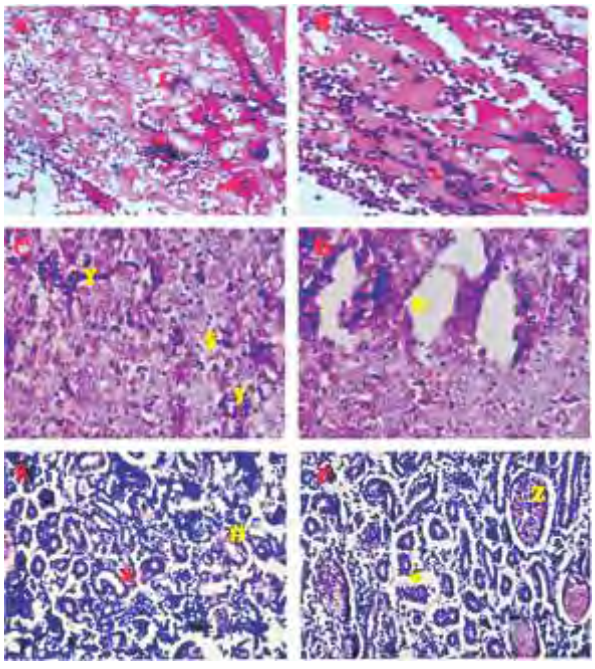
revealed that, the tdh, and trh positive isolates were resistant to β-lactam antibiotics and was able to lyse more than 95% human RBCs. Both the isolates showed high cytotoxicity in HEK cell line in comparison to tlh positive strain. Intraperitoneal and oral administration of tdh and trh positive strain of *V. parahaemolyticus* in *Labeo rohita* caused 100% mortality at the level of 2.0×10^8 and 1.6×10^8 CFU/ml respectively, whereas only 10% mortality was observed in case of tlh positive strain at the level of 2.5×10^7 CFU/ml. The histopathological changes like infiltration of blood cells and degenerated hepatic tissue of *L. rohita* were observed after experimental challenge. The changes like degeneration of glomeruli, necrosis of renal tubules and Bowman's capsule were observed in kidney. The relative expression study of some immune-related genes showed that following experimental challenge the expression of immune-related genes, *viz.*, Toll-like receptor (TLR), nucleotide-binding oligomerization domain (NOD), interleukin-1β (IL-β), interleukin-6 (IL-6), tumor necrosis factor α (TNFα) inducible nitric oxide synthase (iNOS), complement factor C3a (C3a) and heat shock protein 70 were upregulated. Furthermore, over-expression of nuclear factor kappa light chain



Phylogenetic tree analysis of *Vibrio* sp. based on 16S rRNA nucleotide sequences. Unrooted tree was generated using neighbour-joining method by the MEGA 6 software. Bootstrap values are shown at the nodes. The isolates S24P132, AP429 and SPEM2 identified in this study are indicated by the shaded triangles.

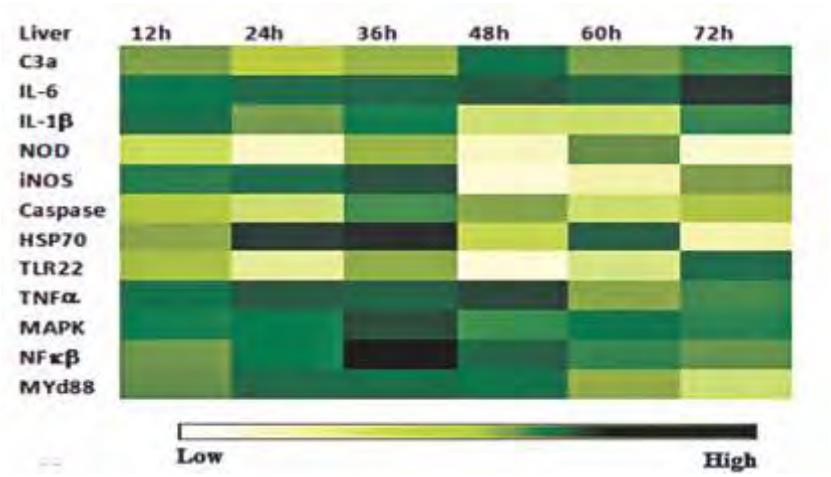


HEK cells stained with EtBr and Acridine Orange to show the cytotoxicity after 5 h of infection with *V. parahaemolyticus*. (A and E) Un-infected HEK cell control; (B and F) HEK cell infected with the tdh-positive strain (S24P132); (C and G) HEK cell infected with trh-positive strain (AP429); (D and H) HEK cell infected with the tlh-positive strain (SPEM2).



[A-G]. Histopathological examination of tissues of *L.rohita* infected with tdh positive *V. parahaemolyticus* (S24P132) through i.p. injection; [A-B] Photomicrograph of muscle. [A]: infiltration of the lymphocyte (L), myonecrosis (Z). [B]: infiltration of the lymphocyte (L); [C-D] Photomicrograph of liver. [C]: infiltration of the blood cells (Y), degeneration of the hepatocytes ($). [D]: vacuole formation in the liver (&); [E-F] Photomicrograph of kidney. [E]: Glomerular degeneration (X), necrosis of Bowman's capsule (#). [F]: necrosis of the renal tubules (*), Sclerosis of glomerulus with atrophic tubules (z).

enhancer of activated B cells (NF-κβ), myeloid differentiation primary response 88 (MyDD88), mitogen-activated protein kinases (MAPK) and cysteine-aspartic proteases (Caspase) were also observed post-infection. The present study strengthens the understanding of molecular pathogenesis and provides insights on gene regulation during infection with trh positive *V. parahaemolyticus*.



Expression of immune related genes in liver of *L. rohita* at different time interval after experimentally challenge with *V. parahaemolyticus*.

Project title : All India network project on fish health

Funding agency : ICAR (Through ICAR-CIBA)
Scientific personnel : S. K. Manna (PI), S. K. Nag, P. Panikkar, A. K. Bera, D. Debnath, R. Baitha

Economic loss estimates from diseases in cage culture in reservoirs

Economic loss from diseases, which includes mortality, cost of chemicals/medicines, hiring of expert services, etc. in cage culture, was assessed in different reservoirs of Jharkhand using a structured questionnaire. The survey is going on. Interim survey of 133 cages estimated an average 7.15% mortality loss from diseases incurring loss of ₹10,042/cage/crop. Additionally, use of chemicals for health management and disease control (potassium permanganate and lime, and vitamins in some cases) incurs a cost of ₹ 218/cage/crop.

Determination of withdrawal period of antibiotic florfenicol

Florfenicol is one of the approved antibiotics for use in aquaculture. *Pangasianodon hypophthalmus* is intensively cultured in Asia and for food safety purpose the withdrawal period of the antibiotic was determined for this catfish species. The antibiotic was orally administered with feed @ 15 mg/kg fish biomass for 10 days followed by 20 days further observation. Liver, muscle, and kidney of the treated fish were collected on different days of treatment and post-treatment periods. The antibiotic residue levels in all the tissues are in process of determination by LC-MS/MS.

Antibiotic sensitivity of fish pathogenic bacteria

Antibiotic susceptibility of *Aeromonas hydrophila* was studied to examine responsiveness to different antibiotics following the disc dilution method. In general, growth of *Aeromonas* was inhibited by most antimicrobial agents, with few isolates showing a multidrug resistance. Ampicillin, cefepime, streptomycin, methicillin, trimethoprim, tetracycline, nalidixic acid, cefadroxil, sulphadiazine, clarithromycin, oxytetracycline, penicillin-G were non-inhibitory. Antibiotic azithromycin, clarithromycin, gatifloxacin and kanamycin were moderately effective. Amikacin, cefoxitin, chloramphenicol and gentamicin were highly effective and imipenem and meropenem had highest activity.

Project title: Microbiome meta-transcriptomic assessment of Indian river basins for eco system health monitoring

Funding agency : ICAR (through ICAR-IASRI)
Scientific personnel : B. K. Behera (PI), B. K. Das, D. J. Sarkar, P. K. Parida
Associates : A. K. Jana, A. K. Talukder

Metagenomic study of sediments of river Ganga, Yamuna, Bhagirathi and Alakananda

The sediment samples from nine sites of river Ganga, Yamuna, Bhagirathi and Alakananda, namely, Koteswar-Bhagirathi, Bagwan-Alakananda, Bageswar-Ganga, Balkeshwar-Shivpuri-Yamuna, TajGung-Yamuna, Yamuna Expressway-Yamuna, Rasulabad-Triveni-Sangam-Ganga, Sahidabad-Ganga were collected for metagenomic studies. The sediment metagenome was sequenced using Illumina HiSeq sequencing platform. De novo metagenome assembly was carried out for each sample by assembling contigs from the reads using MetaSPAdes program. Taxonomic profiling of all the nine-metagenomics samples was performed using NCBI taxonomy data sets. KEGG Pathways analysis was carried out and a total of 135 common pathways were identified across nine samples.

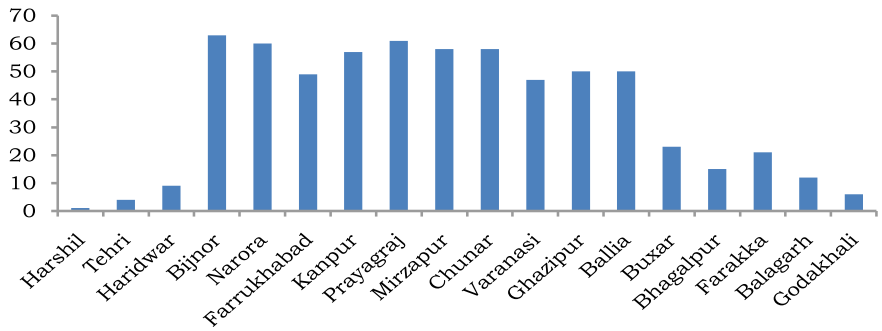
Project title : Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan

Funding agency : National Mission for Clean Ganga (NMCG), Government of India
Scientific personnel : B. K. Das (PI), R. K. Manna, D. N. Jha, A. Alam, V. R. Thakur, R. Baitha, T. N. Chanu, H. S. Swain, M. H. Ramteke, C. Johnson, T. Bera, M. Gupta
Associates : A. Roychowdhury, S. Mondal, L. Chakrabarty, K. Mondal, K. Shrivastava, S. Shrivastava

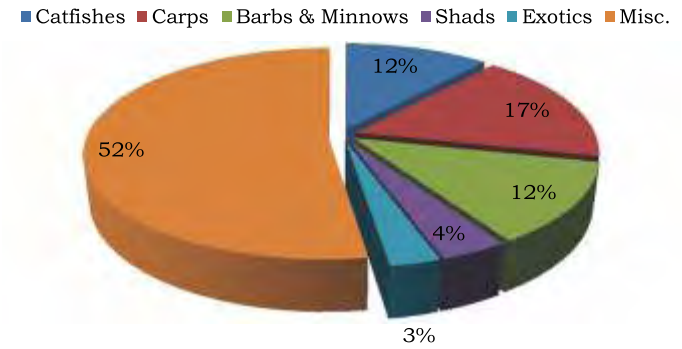
Assessment of fish and fisheries of the river Ganga

During 2020 a total of 104 fish species belonging to 74 genera and 32 families were recorded from Harshil to Frasergunj. Narora stretch has been found to be rich in fish species diversity (n=60). Cyprinidae has been recorded as the highest species rich family with 19.23 %, followed by Danionidae 12.5%. However, Bagridae (6.73%) and Aillidae (5.76%) marked the highest contribution among the catfish family.

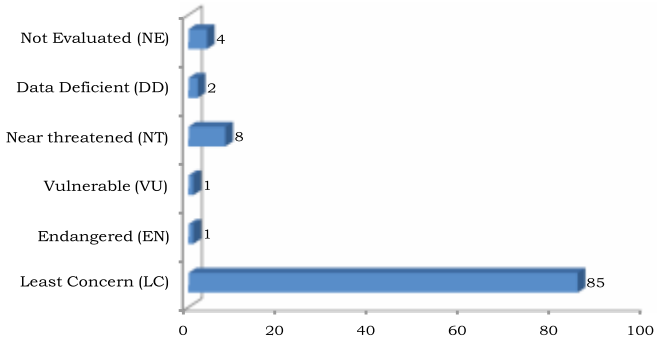
A total of 08 exotic fish species were recorded from entire Ganga river, out of which common carp (*C. carpio* var1. communis; var2. specularis) was recorded from Tehri to Buxar and contributed maximum among the exotics. Other exotics species recorded were *H. molitrix, C. idella, H. nobilis, C. gariepinus, O.*



No. of species recorded from freshwater stretch of river Ganga (2020)



Percentage of economically important fish groups in river Ganga



IUCN status of the recorded fish species from River Ganga

niloticus, *P. disjunctivus*. Exotic fish species contributed 3% of the total landing.

Exploratory fishery survey in the lower stretch of River Ganga, *viz.*, Balagarh, Tribeni and Godakhali, West Bengal revealed Hilsa (*Tenualosa ilisha*) fisheries to be the prime fishing activity during April-May. Average catch per day was estimated at 3 kg/day/boat with fish weight ranging from 350-900 g. However, the maximum fishing activity was found during September at Farakka. During nationwide pandemic in 2020, fisheries of Ganga witnessed marked migration of an estuarine fish species, namely, *Pomadasys argenteus* up to the freshwater tidal section of Hooghly-Gangetic delta during the period of April-May.

P. argenteus recorded from river Ganga at Balagarh

Assessment of the IUCN threat status of 104 fish species has identified 85 species in Least Concern (LC), 8 in Near threatened (*A. coila, A. punctata, C. chitala, B. bagarius, H. nehereus, O. pabda, O. bimaculatus* and *O. pabo*) and one in Vulnerable (*W. attu*) and one in Endangered (*T. putitora*) categories. Brackish water gobid, namely, *O. rubicundus* was found to be the maximum contributory species, followed by Prawn (*Macrobrachium* spp.) with 78.75 kg and 78.09 kg, respectively in lower stretches.

IMC landing at Prayagraj

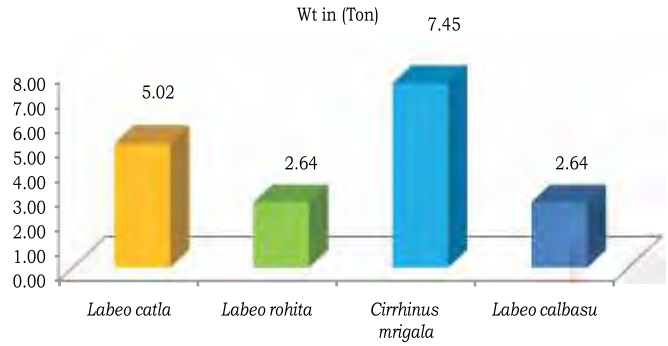
A total annual IMC landing at Prayagraj landing site during Jan-December 2020 has been estimated at 17.75 tonne. The IMC landing was contributed maximum by *C. mrigala* (41.99%), followed by *L. catla* (28.28%), *L. calbasu* (14.88%) and *L. rohita* (14.85%).

Assessment of key habitat variables

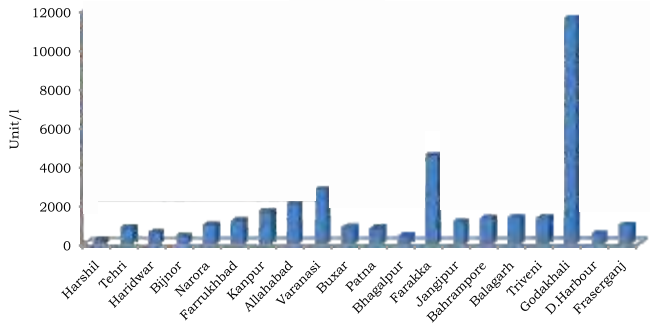
The average specific conductivity in the entire river varied from 0.06-32.2 mS/cm from Harshil to Fraserganj. The higher values were recorded in Varanasi-Buxar stretch. The average BOD in the entire stretch varied from 0.2 to 3.1 mg/l. The lowest BOD was observed at Harshil and highest was observed at Kanpur. Considering higher sp. conductivity at Varanasi-Buxar stretch and BOD at Kanpur of River Ganga, the stretch needs management interventions so that loading of untreated effluents may be reduced.

Plankton and benthos status of river Ganga

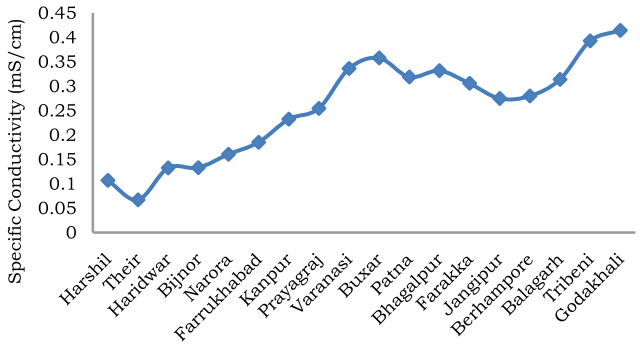
A total of 15 macro-benthic species were recorded comprising of both freshwater and brackishwater species during the study. The most dominant freshwater gastropod is *A. francisia* (2467 inds./m^2), followed by *F. bengalensis* (593 inds./m^2). *V. cochlidium* found to be dominant among the brackishwater species (130 inds./m^2). Chironomid larvae constituted a major part (3347 inds./m^2) among the benthic macro-invertebrates in middle stretch, whereas



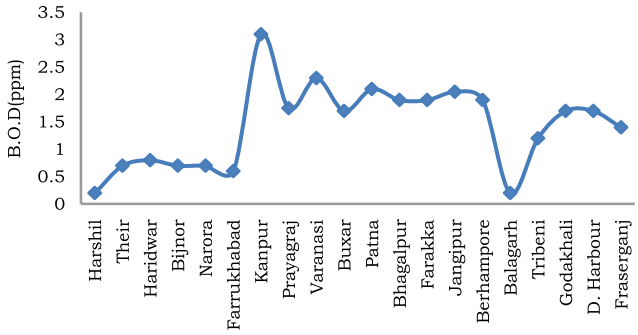
Species wise contribution of IMCs landings



Distribution of plankton density in entire stretch of River Ganga in 2020



Variation in Specific Conductivity of water of River Ganga in 2020



Variation in B.O.D in water of River Ganga in 2020

class Insecta has been recorded from the upper stretch.

Total 60 genera of planktons were recorded during the present study. Highest density was recorded at Godakhali (11590 units/l) dominated by *Coscinodiscus* sp. (8870 units/l) and lowest at Harshil (160 units/l). A total of 43 genera of periphyton, dominated by *Navucula* sp. and *Pinnularia* sp. have been recorded during the sampling period. Highest abundance was observed at Bhagalpur (30366 units/cm^2) and lowest at Harshil (320 units/cm^2) in the present study.

In situ seed production and ranching in the depleted stretches of river Ganga

Successful breeding of wild-caught IMC (*L. rohita, C. mrigala* and *L. catla*) germplasm have been undertaken. A total of 80 lakh fish spawns have been produced with 94% fertilization and 96% hatching

Fish ranching programme in river Ganga

Date	Place of ranching	Number of fish seed ranched
26.01.2020	Gandhi Ghat, Barrackpore	50000
28.01.2020	Narayani Ashram, Prayagraj	10000
06.02.2020	Dashashwamedh Ghat, Prayagraj	10000
11.02.2020	Sangam, Prayagraj	15000
25.02.2020	Manaiyaghat, Prayagraj	20000
29.02.2020	Vindhyanchal	15000
05.03.2020	Assi ghat, Varanasi	20000
17.03.2020	Barrackpore, West Bengal	20000
11.06.2020	Kalna, West Bengal	40000
12.06.2020	Nabadwip, West Bengal	50000
	Tribeni, West Bengal	30000
15.06.2020	Balagarh, West Bengal	50000
16.06.2020	Barrackpore, West Bengal	50000
23.09.2020	Farakka, west Bengal	120000
24.09.2020	Sahebgunj, Jharkhand	100000
24.09.2020	Maharajpur, Jharkhand	100000
04.11.2020	Gandhi Ghat, Barrackpore	50000
21.11.2020	Dihaghat, Prayagraj	15000

success. Spawns were reared in nursery rearing ponds up to fingerling and advanced fingerling size (>10cm) and then ranched in different depleted stretches of river Ganga.

Fish tagging, ranching & awareness programmes conducted in 2020

The Institute tagged 100 adult IMCs and released in river Ganga for studying their migration behaviour. Tagging was initiated on 16 June to monitor and develop proper sustainable management of exploited IMC fish stock in Ganga river. The tagged fishes were produced through artificial breeding of native fish species of River Ganga.

A total number of 18 river ranching and mass awareness programmes were conducted throughout the year 2020 and a total of 7,65,000 numbers of IMC fingerlings were ranched at 13 different depleted stretches of river Ganga from Prayagraj to Barrackpore covering Utter Pradesh, Jharkhand and West Bengal.

Tagging of fish (Inset: A tagging gun)

Project title : A study on input cost and farm gate prices in inland fisheries of India

Funding agency : Ministry of Statistics and Programme Implementation, Government of India
Scientific personnel : B. K. Das (Project Coordinator), A. Pandit (PI), P. Panikkar, M. Karthikeyan, P. K. Parida, A. Saha, S. P. Kamble, D. N. Jha, T. T. Paul, V. R. Thakur, A. K. Yadav, S. Borah, R. K. Raman (up to 30.11.2019)
Associate : L. Chakraborty

Among the agriculture and allied sectors, the fisheries sector has a very weak database. According to the Department of Animal Husbandry, Dairying and Fisheries (DAHD&F) availability of data on fishery resources and their potential in terms of fish production are some of the major challenges faced by fisheries sector of the country. Attention of the nodal national level data collection agencies like CSO/ NSSO could not be adequately leveraged to include fisheries sector as one of their focus areas. Lack of data on cost of production in the inland fisheries sector affects the compilation of gross value added of the sector as well as the policy formulation for its

State-wise resource coverage targeted in the study

State	Freshwater aquaculture	Brackishwater aquaculture	Riverine fisheries	Estuarine fisheries	Reservoir fisheries	Wetland fisheries	Back waters	Lagoon
WB		√	√	√		√		
Bihar						√		
Odisha	√	√		√	√			√
Chhattisgarh	√				√			
UP	√		√		√	√		
MP					√			
Assam	√		√			√		
Tripura	√							
Karnataka	√				√			
AP	√	√						
Kerala	√	√					√	
Gujarat		√	√	√				
Total	9	5	4	3	5	4	1	1

development. The present study is a step in this direction to estimate the input cost and farm gate prices of inland fisheries.

The study is survey based and the same is being carried out in 12 states covering fresh- and brackish-water aquaculture, capture fishing in rivers, estuaries, wetland, reservoirs, backwaters and lagoons. The survey has been completed in Odisha, UP, Karnataka, Tripura and Kerala for fresh water aquaculture. Similarly, the brackishwater aquaculture survey has been completed in West Bengal, Odisha, Gujarat, Kerala and Andhra Pradesh. Vembanad has been covered for backwater fisheries; UP and Gujarat have been completed for riverine fisheries; reservoir component has been covered for Odisha; wetland component has been covered for Assam and UP. All the states have been completed for estuarine fisheries. Major species cultured and caught in capture fisheries in the selected water bodies of sampled states were identified. The input cost, gross revenue and input-output ratio have been estimated for West Bengal (fresh water aquaculture), Odisha (brackish water aquaculture) and West Bengal (for riverine fisheries).

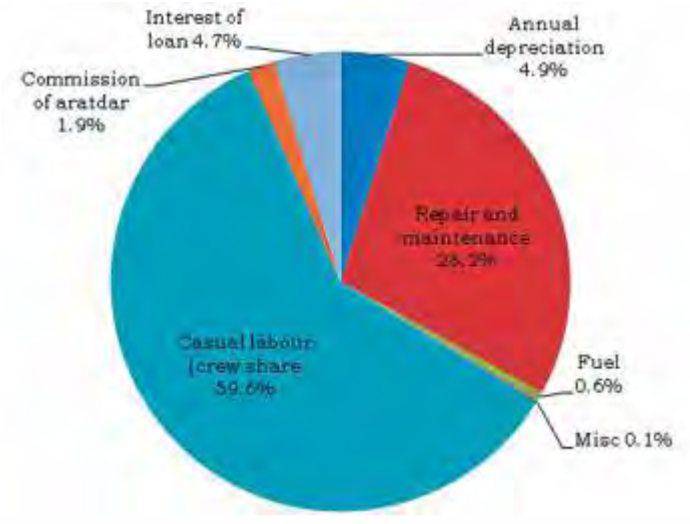
Riverine fisheries

It is observed that fisher households incurred ₹88,690 per year on fishing in river Ganga of which the operating cost was around 25% (₹ 22,512). The casual labour wages (63%), repair and maintenance (30%) and interest of loan (5%) shares the maximum cost of operating cost of fishing. Imputed value of family labour was found to be around ₹65,000 which is the largest item in the total cost.

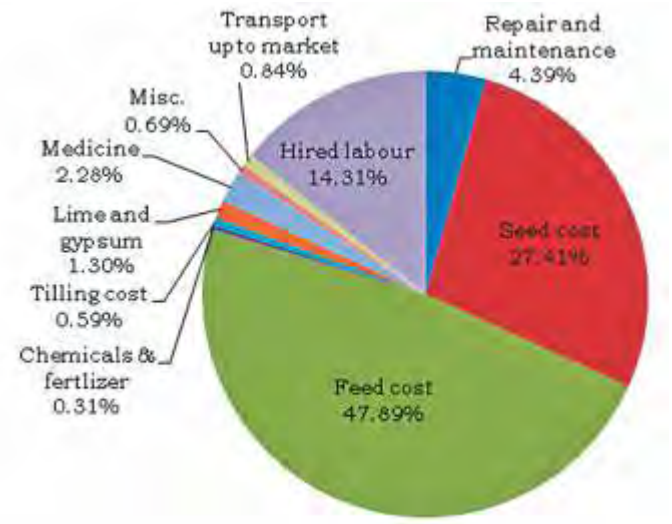
Freshwater aquaculture

Similarly, the interim report from Purba Medinipur and Hooghly districts on freshwater aquaculture showed that the selected 196 farmers operated 348 ponds with average pond size below 1 acre (0.82 acre). Majority of them practiced multiple harvesting after single or multiple stocking. Almost half of the farmers cultured fishes primarily for sale. Artificial feeding was done only in about 30% of ponds.

The different types of costs incurred in freshwater aquaculture in West Bengal includes seed, feed, chemicals and fertilizers, lime and gypsum, fuel charges, labour wages, cost of ice, transport cost to market, medicines etc. These are also the factors of intermediate consumptions. Imputed costs of family labour, annualized depreciation and repairing and maintenance costs are the other costs items. The study showed that a farmer household incurred ₹1,86,316 per acre per year, of which the operating cost was around 97% (₹1,81,139). The



Shares of different items (%) in operating cost of fishing in river Ganga in WB



Shares of different cost items in total operating cost of freshwater aquaculture

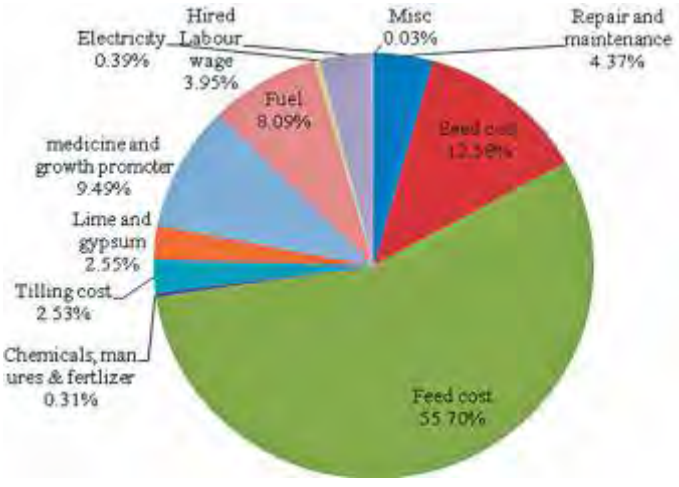
feed (47.89%), seed (27.41%) and hired labour wages (14.31%) were the major items of operating cost of fish farming in the selected districts.

The economic performance of freshwater aquaculture in Purba Medinipur and Hooghly districts of West Bengal was assessed and it has been observed that the average net operating income was ₹77,351 per year per acre of pond. On an average an acre of pond produced 1,436 kg of fish in a year. Assuming a farm gate price of ₹180/kg, the gross return in a year was found to be ₹2,58,480. The input-output ratio was found to be 0.60 which is much higher than in riverine capture fisheries.

Brackishwater aquaculture

The different types of costs incurred in brackishwater aquaculture in Odisha included seed, feed, fertilizers, lime and gypsum, fuel charges, electricity, labour wages, cost of ice, sea water transport, transport cost to market, medicines etc. Imputed costs of family labour, annualized depreciation and repairing and maintenance costs are the other costs items.

It was estimated that a farmer household incurred ₹6,10,110 per acre per year, of which the operating cost was around 97% (₹5,93,540). The feed (55.70%), seed (12.58%), medicine (9.49%), fuel (mainly diesel, 8.09%) and hired labour wages (14.31%) were the major items of operating cost of brackishwater fish farming in the selected districts of Odisha.



Shares of different cost items in total operating cost of brackishwater aquaculture

The economic performance of brackishwater aquaculture in Puri-Jagatsingpur districts of Odisha was assessed and it is observed that the average net operating income was ₹6,18,303/year/acre of pond without considering the family labour. On an average, an acre of pond produced 3,752 kg of fish in a year. Majority of the farmers went for 2 crops in a year. The actual farm gate price was ₹324/kg and hence the gross return in a year was found to be over ₹ 12 lakhs. The input-output ratio was found to be 0.48 which is much higher than in riverine capture fisheries but less than that in freshwater aquaculture sector. The annual average farm gate prices of major fishes cultured and captured have also been collected and analysed.

Project title : Fisheries development in Sirsa wetland of Bihar through in situ fish seed rearing and fisheries enhancement techniques for tapping fish production potential - An innovative project

Funding agency : NFDB
Scientific personnel : M. A. Hassan, G. Chandra, S. Kumari, Mishal P., G. Karnatak, R. Baitha, Lianthuamluaia, H. S. Swain

Integrated interventions for fisheries enhancement

Production of advanced fingerlings of IMC and exotic carp in prefabricated CIFRI pen HDPE, CIFRI GI cages were demonstrated. Production of table fish was also demonstrated to provide wetland fishers a source of compensatory income during fishing ban period. The standard protocol of culture based fisheries (CBF), such as fish species, seed size, species composition, stocking density, frequency of stocking, time/season of stocking; harvest schedule were implemented in participation with fishers.

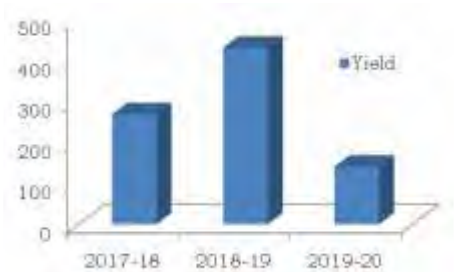
Empowerment of community

The fishers involved in managing these wetlands for fish production and livelihood did not have proper infrastructure, other than the water body, for supporting and complementing fisheries management. Therefore, infrastructure and management inputs (fishing boat, gill net, seed and feed) were provided to empower the fisher's community of the wetland. These included stocking material (carp advanced fingerling: a total of 5447 kg (284899 numbers) of advanced fingerlings comprising both IMC and exotic carp. In addition, 146 kg (74801 numbers) of major carp fingerlings were procured and stocked for demonstration of seed raising technology in pen; 25 kg seed of indigenous catfish *Heteropneustes fossilis* were provided for additional income from nursery cages during fallow period, 151 kg seed of fast growing *Pangasianodon hypophthalmus* were provided for earning compensatory income during fishing ban period from cage culture, CIFRI CAGEGROW feed, CIFRI GI cage, CIFRI pen HDPE were provided for nursery rearing and table fish production, and fishing net, FRP boat and wooden plank built boat were distributed among the needy fishers. In addition, capacity building and skill development, awareness and exposure visits were undertaken to improve confidence of fishers for self reliant

Demonstration of fish production in cages

Management and operation of enclosure culture technologies (cage and pen) was successfully demonstrated. Rearing of fast growing *Pagasianodon hypophthalmus* twice and indigenous catfish *Heteropneustes fossilis* once was demonstrated in cages. Singhi fingerlings (avg. wt. 4.21 g) were stocked at low density (30 fish/m^3) during late December and harvested after 5 months during early may. Fishes recorded average weight of 36 g during 5 months growth period. They were fed with CIFRI CAGEGROW floating feed during the period. A total biomass of 87 kg was obtained and sold at the rate of ₹ 400.00 per kg totalling ₹ 34800.00.

The outcome : The project has brought awareness and perception change among the fishers towards various aspects and techniques of fisheries management of oxbow lakes. Training has improved capacity of fishers for operation and management of seed production system and culture based fisheries. The improved infrastructure (cage, pen) for seed rearing has produced 1893 kg carp advanced fingerling for stocking in open wetlands. The empowered fishers are now actively involved in fishing, contributing to fish yield. Due to various interventions every year, fish yield due to stocked fishes under fisheries enhancement programme has improved in successive manner from 269kg/ha/yr in first year of project to 432 kg/ha/yr with improvement in catch per unit effort. Fishing days dependent on stocked fishes has improved from 32 days in first year to 92 days. However, there was fall of both fishing days and yield in the third year due to uncertainty of lease renewal and cessation of stocking support under the project. The impact of interventions has led to increased income and improved employment opportunity of local fishers, the practice of migration to other states has reduced to 2(1.89%) from 11(10.38%) in the base year 2017.



Fish yield trend in Sirsa maun

Project title: Fisheries development in Rulhi wetland of Bihar through stakeholders' participatory fisheries management model (co-management) in a sustainable manner- An innovative project

Funding agency : NFDB
Scientific personnel : M. A. Hassan, G. Chandra, S. Kumari, Mishal P., G. Karnatak, R. Baitha, Lianthuamluaia, H.S. Swain

Integrated interventions for fisheries enhancement

For production enhancement through culture based fisheries (CBF) and sustained supply of quality seed was ensured through production of advanced fingerlings of major carp and exotic carp in 8 CIFRI pen HDPE pens (0.1 ha each) installed in marginal areas, and 6 CIFRI GI cages (5m x 5m x 2.5m each) installed in deep pool areas of the wetland, and newly excavated earthen nursery ponds in the marginal area of the wetland. Production of table fish involving catfish *Pangasionodon hypophthalmus* in cages was also demonstrated to provide fishers a source of compensatory income during fishing ban period. The standard protocol of (CBF), such as, selection of fish species (mainly carps), seed size (>40-50 g), fish species composition (more plankton and macrophyte feeder and less detritivore), stocking density (2000/ha), frequency of stocking (>3 times), time/season of stocking (Feb-

April, Oct-Nov), harvest schedule (Sept-Oct, Dec-June) were also implemented.

Empowerment of community

Quality seed production in sufficient quantity was assured through excavation of 6 nursery ponds measuring 1.5 ha. A submersible pump was installed for water supply to maintain water level in the nursery ponds. The bank of the ponds was provided with bio-security fencing net to prevent fish escape during floods. The exit point of the link channel was provided with iron mesh erected with the help of concrete columns to prevent fish loss and entry of large predatory fishes. Stocking of open water with 4175 kg (261675 numbers) of advanced fingerlings of both IMC and exotic carp was done in phases. In addition, 357 kg (130052 numbers) of major carps and exotic carp fries were stocked in pond, 150 kg and 60 kg carp fingerlings were stocked in pens and in cages, respectively, for demonstration of seed raising technology. Seed (25 kg) of indigenous prized catfish *Heteropneustes fossilis* for additional income from nursery ponds during fallow period, and 26 kg seed of fast growing *P. hypophthalmus* for cage culture were provided. A battery of 6 CIFRI GI cage, and 8 CIFRI pen HDPE for nursery rearing and table fish production were installed besides provision of 6 tonne CIFRI CAGEGROW feed, 150 fishing net, 1 FRP boat and 2 wooden plank built boat to the needy fishers. Rooted emergent macrophytes were physically removed for habitat improvement of Rulhi maun. Further, initiatives were taken for capacity building, skill development, awareness and exposure visits were undertaken to improve confidence of fishers towards self reliance.

Demonstration of fish production in cages and nursery ponds

Considering the good consumer acceptability in the area, fast growing *P. hypophthalmus* was stocked at low density (21/m^3) to provide compensatory income to fishers during fishing ban period in the lake. Fingerlings (avg. wt. 8.0g) were stocked during April and harvested in August with weight range of 250-300 g. Fishes were fed with CIFRI CAGEGROW feed @ 3-6% of biomass during different growth stages. A total of 318 kg fish were harvested from 6 cages and sold at ₹34,980. The farmers were trained and whole process was managed by the fishers of the wetland under supervision of field staff.

Another pilot trial of rearing high value catfish *H. fossilis* was conducted in a nursery pond owned by lessee. Fingerlings (avg. length 5.2 cm; avg. wt. 5 g) were stocked at low density (14/m^3) in late December. Fishes were fed with CIFRI CAGEGROW floating feed. A total of 81 kg fish was harvested after 143 days with an average weight of 56 g and sold at the rate of ₹400 per kg earning ₹32,400.

Further, 317 kg fry of Indian major carps (avg. length 47 mm and weight 5.2 g) was stocked in 6 nursery ponds for production of advanced fingerling. The fish reached desired size (>30 g) for stocking in open water in less than two months of rearing.

Fry stocking in pen at Rulhi maun for advanced fingerling production

Project title : Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholders participation for capacity building and improved livelihood - An innovative project

Funding agency : NFDB

Scientific personnel : M. A. Hassan, G. Chandra, S. Kumari, Mishal P., G. Karnatak, R. Baitha, Lianthuamluaia, H.S. Swain

The outcome : The project has brought significant change among the fishers regarding various aspects and techniques of fisheries management in oxbow lakes. Fishers have learnt scientific seed production and culture based fisheries. Seed production infrastructure (nursery pond and cage) has been strengthened producing enough fish seed for wetland stocking. The trained fishers produced 2,766 kg of advanced fingerling from these nursery ponds and released in the open wetland as input for CBF. Selected fishers are empowered with fishing craft and gear. Fish yield from stocked fishes under fisheries enhancement programme improved every year, from 230 kg/ha/yr in first year of the project to present 391 kg/ha/yr with improvement in catch per unit effort. Fishing days based on stocked fishes has improved from 60 days in first year to 93 days now. However, there was fall of yield in the third year due to uncertainty of lease renewal and cessation of stocking support under the project.

Integrated interventions for fisheries enhancement

Development and creation of infrastructure was the major interventions in fisheries development of this wetland. In order to make self-reliant in seed production and sustained source of quality seed, the key input for CBF, *viz.* 4 nursery ponds (1.5 ha) were excavated on the bank of the oxbow lake. These nursery ponds were provided with submersible pump for round the year operation and the banks were protected with bio-security fencing net to prevent fish escape. In the marginal area, pen culture was integrated for production of advanced fingerlings. The exit points of the outlet channels were safeguarded with iron mesh. Production of table size *P. hypophthalmus* and indigenous *H. fossilis* in nursery ponds were also demonstrated to provide fishers a source of compensatory income during fishing ban period. The standard protocol of CBF, such as, selection of fish species (mainly carps, both indigenous and exotic), seed size (>40-50 g), species composition (more plankton and macrophyte feeder and less detritivore), stocking density (2000/ha), frequency

Iron mesh net installed at the outlet of kararia maun

of stocking (>3 times), time/season of stocking (Feb-April, Oct-Nov), harvest schedule (Sept-Oct, Dec-June) were also implemented. Floating macrophyte *Eichhornia crassipes* was manually removed to provide improved habitat for better survival and growth of stocked fishes.

Community empowerment

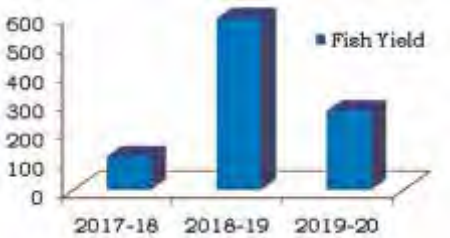
The major input in the form of fish seed for demonstration and development of culture based fisheries was borne by the project. Initially, seed stocking following standard protocols of CBF was facilitated through supply of outsourced carp seed. In the following years, seed production in the excavated ponds was initiated by the trained fishers. A total of 4,606 kg (213272 numbers) of advanced fingerlings comprising both IMC (rohu, catla and mrigal) and exotic carp (grass carp, common carp) were released in staggered manner in the open water as input for fisheries enhancement. In addition, 1,532 kg of IMC and exotic carp fingerlings were stocked in nursery ponds for production of advanced fingerlings as input for CBF in open wetland. Fingerlings of *P. hypophthalmus* (28 kg seed, 3911 numbers) were outsourced to demonstrate farming in newly excavated nursery ponds as a means of supplementary income. Similarly, indigenous catfish *H. fossilis* farming in fallow nursery pond was demonstrated by stocking 25 kg seed. In addition, 100 kg seed of major carp fingerlings were stocked in pen to demonstrate production of advanced fingerling technology in pen. Besides ponds, 8 (0.1 ha each) pre-fabricated CIFRI pen HDPE were installed in the marginal areas for production of advanced fingerlings. At the exit point of the outlet channels, iron mesh has been erected, supported by concrete base and angle iron frame, to prevent fish loss and entry of large predatory fishes. One 12 ft OAL fibre boat and two plank built 14 ft OAL wooden boat were provided to the fishers of this wetland. The boat was used by the members for common purposes such as security patrolling, pen monitoring, and also for fishing by the members of the wetlands. The fishers were provided with monofilament gill net of suitable mesh size. CIFRI CAGEGROW floating feed was provided to the fishers for nursery rearing in ponds and pen. Floating weeds was menace for this wetland and was physically cleared with active participation of the local fishers.

Training programme on various aspects of oxbow lake fisheries management and development and other fisheries technologies focusing seed production was organized. In addition, two batches of young and active fishermen from the wetland were provided exposure visit-cum-training at CIFRI headquarter, Barrackpore.

Wooden Boat distribution in Kararia maun

Demonstration of advanced fingerling and table fish production in nursery ponds

Fingerlings of IMC and exotic carp were stocked in nursery ponds for production of advanced fingerlings after thorough pond preparation for growth of natural fish food. Hatchery bred seeds were stocked following standard protocols. Fishes were regularly fed with formulated feed. Fish growth was regularly monitored and found to reach stocking size within 60 days of rearing. The suitable size seeds were intermittently harvested for stocking in the open waters. Rests of the seeds were reared beyond winter months and over wintered fish were released in the lake. Table fish production was demonstrated in newly excavated nursery ponds involving fast growing *P. hypophthalmus* as a means of supplementary income. Only 28 kg catfish fingerlings yielded 1589 kg table fish which was sold at ₹19,068. Similarly, another pilot trial of table fish production involving indigenous catfish *H. fossilis* was conducted in a pond owned by lessee. Fingerlings (avg. length 5.2cm; avg.wt. 5 g) were stocked at low density (14/m^3) during late December.

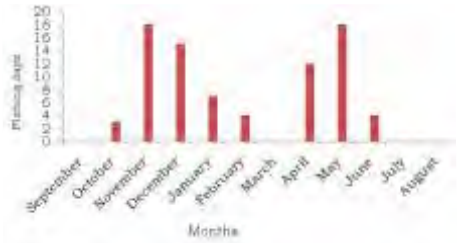


Fish yield trend in Kararia maun

The fishes were fed with CIFRI CAGEGROW floating feed. A total of 93 kg fishes were harvested after 5 months with an average weight of 51 g and sold at the rate of ₹ 400 per kg and thus earned ₹ 36800.

Outcome of the project

The project has brought awareness and perception change among the fishers regarding various aspects and techniques of fisheries management of oxbow lakes. Training has improved capacity of fishers for operation and management of seed production system and culture based fisheries. Seed production infrastructure (nursery, pond and pen) has been strengthened. Number of fishermen in the wetland has increased. Each year fish yield from stocked fishes under fisheries enhancement programme has improved every year, from 115kg/ha/yr in first year of the project to present 592 kg/ha/yr with increase in catch per unit effort. Fishing days based on stocked fish has improved from 118 days in first year to 153 days now.



Increasing trend of fishing days in Kararia maun

Project title: Fisheries development in Majharia maun of Bihar through refinement of site specific fisheries enhancement technology- An innovative project

Funding agency : NFDB
Scientific personnel : M.A. Hassan, G. Chandra, S. Kumari, Mishal P., G. Karnatak, R. Baitha, Lianthuamluaia, H.S. Swain

Integrated interventions for fisheries enhancement

Permanent infrastructures such as excavation of nursery ponds provided with submersible pump for water supply during summer and bio-security fencing net to prevent fish escape during flood were created for the purpose of assured and sustained supply of quality fish seed for supporting CBF in the wetland. Other seed production systems such as pre-fabricated CIFRI pen HDPE used as makeshift nursery and CIFRI GI cages used as contingent nursery and table fish production was integrated to ensure production of required amount of fish seeds to reinforce seed stocking programme. Production of table size *P. hypophthalmus* in cages and indigenous *H. fossilis* in nursery ponds were also demonstrated to provide fishers a source of compensatory income during fishing ban period. The standard protocols of (CBF),

such as, selection of fish species (mainly carps, both indigenous and exotic), seed size (>40-50 g), species composition (more plankton and macrophyte feeder and less detritivore), stocking density (2000/ha), frequency of stocking (>3 times), time/season of stocking (Feb-April, Oct-Nov), harvest schedule (Sept-Oct, Dec-June) was also implemented. Manual removal of marginal emergent macrophytes was demonstrated to provide improved habitat for better survival and growth of stocked fishes.

Empowerment of community

The fishers' community was provided with 3 nursery ponds (1.5 ha area) at margin of the wetland. In order to ensure round the operation of these ponds, they were provided with submersible pump for water supply during dry season and protected with bio-security net to prevent escape of fish and entry of predators. The major input of CBF in the form of advanced fingerlings was provided for demonstration and development of culture based fisheries. A total of 5,024 kg of advanced fingerlings comprising both IMC (rohu, catla and mrigal) and exotic carp (grass carp, common carp) were released in staggered manner in the open water. Fingerlings of *P. hypophthalmus* weighing 27 kg were outsourced to demonstrate farming of this species in cages as a means of supplementary income to support livelihood during fishing ban period. Nursery ponds were stocked with 829 kg fingerlings of IMC and exotic carps for advanced fingerling production. Similarly, 25 kg *H. fossilis* was stocked in nursery ponds during fallow period to demonstrate production of prized fish to supplement fishers' income. Eight CIFRI pen HDPE (0.1 ha each) were installed in the marginal area of the wetland and were stocked with 574 kg IMC and exotic carp fingerlings to supplement production of advanced fingerlings for stocking in open maun. The fingerling and table fish production systems in ponds, cages and pens were supported with 5.7 t of CIFRI CAGEGROW floating feed. The seed production infrastructure was further strengthened with installation of 6 GI cages (5m x 5m x 2.5m) after suitable modification of cage net in the deep pool area (depth >7 m) of the wetland for production of both advanced fingerling and table fish. In addition, one 12 ft OAL fibre boat and two plank built 14 ft OAL wooden boats were provided for security patrolling, pen monitoring, and also for fishing by the members of the wetlands. The fishers were provided with monofilament gill net of suitable mesh size. Marginal areas of the wetland are chocked with submerged and emergent macrophytes which were physically removed as part of habitat improvement for better fish growth and fishing operation.

The fishers were provided training and exposure visits to improve their skill, capacity and confidence on various aspects of oxbow lake fisheries management and seed production system in ponds, cages and pens.

Demonstration of fish production in cages and nursery ponds

Fast growing *P.hypophthalmus* was stocked at low density (15/m^3) to demonstrate table fish production for compensatory income of fishers during fishing ban period in the lake. Fingerlings (avg. wt. 8.0g) were reared for 142 days to produce 610 kg fish earning ₹73,200. Fingerlings were stocked in nursery ponds after thorough pond preparation. Hatchery bred seeds were stocked following standard protocols. Fishes were regularly fed with formulated feed. Fish growth was regularly monitored and found to reach stocking size (> 40-50g) within 60 days of rearing. The suitable seeds were intermittently harvested for stocking in the open waters and rest of the seed was reared beyond winter months for further growth. Table fish production involving high value *H. fossilis* was demonstrated in a nursery pond. Fingerlings (avg. length 5.2cm; avg. wt. 5 g) were stocked at low density (15/m^3). A total of 83 kg fish were harvested and sold at ₹400/kg earning ₹33,200.

Project title : Fisheries development in Kothia maun of Bihar - A pilot project

Funding agency : NFDB
Scientific personnel : B. K. Das, G. Chandra and R. Baitha

Outcome of the project

Awareness and perception change were brought among the fishers towards scientific fisheries management of oxbow lakes. Training has improved capacity of fishers for operation and management of seed production systems and culture based fisheries. *In situ* seed production infrastructure (nursery pond, cage and pen) has been strengthened. Selected fishers are empowered with fishing craft and gear. Each year fish yield from stocked fishes under fisheries enhancement programme has improved, from 62 kg/ha/yr in first year of the project to 154 kg/ha/yr at present with improvement in catch per unit effort. Fishing days based on stocked fishes has improved from 35 days in first year to 78 days now. However, there was a declining trend in yield in the third year due to lack of stocking.

Implementation of fisheries enhancement programme

Need-based technological interventions in the wetland such as species enhancement and stoking enhancement activities were implemented following scientifically proven norms developed by ICAR-CIFRI. Selection of fish species and their stocking density and proportions were based on the ecosystem characteristics prevailing at Kothia maun (26°23'37.54''N; 85°10'16.54''E) located in East Champaran district of Bihar. The maun has maximum water spread area of 60 ha and depth of 2-7 m. Stock enhancement activity with advanced fingerlings (weight: 25-50g) of catla, rohu, mrigal, common carp and grass carp was undertaken in a staggered manner at an interval of 45-60 days. The fish seed stocked in open wetland gradually was expected to start reaching harvestable size by mid of April 2021 onwards when the fishermen will reap the benefit of the stocking enhancement programme. However, fishermen had done harvesting during May-July 2020 during COVID-19 pandemic with total harvest of 2,910 kg of stocked fish species and fish weight

Fish Harvest in Kothia maun, (1) Seine net operation, (2) Harvested fish, (3) wild/self-recruiting fish catch and (4) Auction of harvested fish for market

Cage maintenance and monitoring of growth performance of Amur carp in cages, (A) Bank view of cage facility, (B) Cage cleaning and examination for damage, (C) Release of pond reared stock of Amur carp in cages for table size production, (D) Length-Weight measurement of Amur fish.

ranging from 0.5-4.8 kg. The harvest of stocked fishes from Kothia maun had registered more than double (2,910 kg) in 2020 in comparison to 2019 (1410.3 kg). Additionally, bumper catch of wild or indigenous fishes was also recorded (2,866.94 kg) during 2020 which additionally benefitted the fishers in their livelihood.

Fish seeds/table fish production in cages

Six numbers of CIFRI GI Cage {nursery cage – 02 (25 m^3); and production cage – 04 (87.5 m^3)} were installed in Kothia maun at a suitable site having water depth ≥5 meter. Fish seed can be stocked in cages as a measure of contingent source of stocking material in the open wetland during post flood period. Severely and prolonged flood condition in the wetland hampered timely stocking in the cages. Further, the winter arrival did not allow stocking of fish seeds of 40-50 gm size.

Amur carp, a Hungarian strain of common carp (*Cyprinus carpio*) was selected for experimentation to study the growth and survival and also to standardize their stocking density. In this respect, a series of experiments have been conducted to utilize vacant cages during non-seed production periods, especially winter. In one experiment, each of the two cages were stocked @ 1-2 fish/m^3 (avg. weight: 264.5 g) and fed twice a day with "CIFRI Cage Grow" fish feed during summer months of 2020. The fish grew double, to 440 g in 22 days of culture. In second experiment, Amur carp were stocked in two cages at stocking density of 2-3 fish/m^3 (avg. weight: 138 g) during summer period of 2020. The fish grew 3.5 times to 455 g in three months of culture. This trial gave us an opportunity to experiment

Nursery pond management; (a) Fish seed stocking, (b) Fish hauling, c) Growth monitoring and size grading of fish seeds

Snapshots of electronic media coverage of fish harvest at Kothia maun

with different stocking densities of various size groups of Amur carp under different temperature regimes for standardization of stocking density for an identification of a new candidate species for cage culture under species diversification programme.

Fish seeds/table fish production in pond

Land based nursery facility in the proximity of Kothia maun has been created for raising fry to fingerlings/advance fingerlings and table size fish production during vacant period. Four ponds were stocked with 386 kg (average body weight: 2.48-4.15 gm) seeds of catla, rohu, mrigal, common carp, grass carp and Amur carp. During monthly sampling in May 2020, the fish biomass was 831 kg with average body weight of 264.4-650.52 gm in 5-7 months of culture.

Mass media coverage of the project activities

The fish harvest was organized at Kothia maun during May-July 2020. The activities were widely covered by print and electronic media to showcase the production enhancement of fish from the wetland with technological interventions by ICAR-CIFRI.

Impact of flood on fisheries management

Kothia maun is seasonally connected to river Burhi Gandak and is flooded during June to September. Flood water enriches the maun with diverse fish fauna and others flora and fauna, but it also brings large catfishes like *Wallago attu*. These catfishes and flood water were observed to be major hindrances in culture based fisheries in the maun and limit timing of fish seeds stocking and harvest in the maun. Extended monsoon and severe flooding in 2020 had delayed the fish seeds stocking programme, damaged water screen nets, enclosures and pond facilities.

Project title : Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India

Funding agency : National Mission on Himalayan Studies, Ministry of Environment, Forest and Climate Change, Govt. of India.

Scientific personnel : B. K. Bhattacharjya (PI), Sona Yengkokpam, Dipesh Debnath, S. C. S. Das

Development of region-specific climate-friendly pen design using ITK in Takmu pat, Manipur

Two ITK (Phumdi) based circular floating pens (68 m and 74 m diameter) were installed in Takmu pat, Bishnupur district during January to March, 2020 with the active involvement of the local Meitei fishers. The pens were constructed using indigenous technical knowledge (ITK) related to the age-old practice of brush fishing (Phumdi) prevalent in the wetlands of Imphal valley region. Floating phumdis (dense macrophyte mass) present in the lake was cut and used to form a floating circular structure to which the nets were attached and suspended using ropes. The first pen covering an area of 3,632 m^2 (68 m diameter) was stocked with *Labeo catla* (catla, 450 nos.), *Labeo rohita* (rohu, 875 nos.), *Ctenopharyngodon idella* (grass carp, 1200 nos.), *Cyprinus carpio* (common carp, 500 nos.) and *Labeo gonius* (kuri, 225 nos.). The 2nd pen, covering an area of 4,300 m^2 (74 m diameter), was stocked with catla (600 nos.), rohu (850 nos.), grass carp (1500 nos.), common carp (400 nos.) and silver carp *Hypopthalmichthys molitrix* (250 nos.). Partial harvesting of the pens was done in August 2020 leading to sale of 983 kg of fish and revenue of ₹2,58,540 which were shared among the 30 participating fishers.

Pen aquaculture experiment using net-lined bamboo-screens in dense macrophyte infested areas of Bor beel

Bor beel, located in Namsai district in eastern Arunachal Pradesh, is an open beel with water spread area of 234.69 ha. The beel is heavily infested with aquatic macrophytes with 70% of its surface area covered with floating macrophyte mass leaving a majority of the beel unsuitable for fishery. For the first time, the Institute carried out pen aquaculture experiment in the densely macrophyte infested and derelict areas of the beel using net-lined bamboo-screens. The advantage of pen aquaculture as a technology

ITK- (Phumdi) based floating pens installed in Takmu pat, Manipur

for reclamation of unused areas of wetlands by clearing off macrophyte and erecting pens making it useful for fish production was successfully demonstrated in the beel. A suitable site for pen culture was selected based on water depth, water quality, ease of monitoring, etc. Macrophyte clearance was initiated in January 2020 using both machinery (JCB) and manual labour. Preliminary survey of the beel indicated presence of turtle in the beel which can cut off net materials of pens. Considering this fact, split bamboo screen (bana) was used in the pen construction to ward off turtles. The area for pen installation was marked using bamboo poles. Five pens of 0.1 ha area each were constructed in the beel using net (LDPE) lined bana screens and bamboo poles. The pens were partially stocked with fingerlings (5000 no.) of Indian major carps (*Labeo catla, L. rohita* and *Cirrhinus mrigala*) and exotic carps (*Cyprinus carpio, Hypothalmichthys molitrix*) with assistance from the ADF, Namsai district.

Pen in Bor beel, Arunachal Pradesh

Project title : Cage culture in reservoirs as collaborative programme between Department of Fisheries, Telangana State and ICAR-CIFRI

Funding agency : Department of Fisheries, Govt. of Telangana
Scientific personnel : B. K. Das (PI), U. K. Sarkar, A. K. Das, A. M. Sajina, P. Mishal, M. Ramteke, C. Johnson, A. Saha, P. K. Jesna

Demonstration of fish seed raising and table fish production in cages

Carp seed raising and table fish production of diversified fish species was successfully demonstrated in 64 CIFRI GI model cage installed in Palair reservoir, Telangana. The cages were stocked with fingerlings of *Pangasianodon hypophthalmus, Labeo rohita, Labeo rohita* (Jayanti variety), *L. catla* and *Macrobrachium* sp. The stocked species attained marketable size in 8-10 months. A total of 106.6 tonnes of fish was harvested comprising 75.9 tonnes of pangas and 30.7 tonnes of rohu (Jayanti rohu and rohu) and 0.1 tonnes of freshwater prawn. The total revenue generated was ₹96.4 lakhs/crop benefitting 40 fishers. Besides, a total of 1,20,000 advanced fry (35-40mm) of Indian major carps was stocked in cages (5m x 5m x 2.5m) @240 nos./m^3 and raised to advanced fingerling size (100-120 mm) with a survival rate of 79.4% (95,375 nos.) in 75 days for culture-based fisheries through fingerling stocking in the reservoir. Total 2 lakh seeds of pangas (50,000 nos./battery), 80,000 rohu (20,000 nos./battery) and 12,000 pabda were stocked for second crop production in cages. Partial harvest of 13.5 tonnes of table size fish fetching ₹15.2 lakh was done from the cages. The total estimated production from cages is 88 tonnes.

Habitat assessment

Periodic monitoring of important physico-chemical parameters revealed minimal impact of cage culture on reservoir ecology; however, carrying capacity must be taken into consideration to avoid any negative impact as cage numbers and density of these cage farms may increase in future. The assessment of phytoplankton community structure and abundance in Palair reservoir revealed spatio-temporal variations in plankton diversity and population structure. Even though Cyanophyceae dominated the plankton population, there was no plankton bloom associated toxicity in this reservoir indicating the healthy and dynamic nature of this water body. The elevated plankton density near cages may be due to the nutrient loading from the cages which support plankton feeders in cages and assemblage of micronutrient rich SIFs near cage site.

Jayanti rohu produced in cages

Project title : ICAR-WorldFish Collaborative Project (Window-3) : Small scale fisheries in wetlands for livelihood and nutritional security

Scientific personnel : B. K. Das (PI), B. K. Bhattacharjya, B. P. Mohanty, A. Pandit, B. K. Behera, A. K. Sahoo, A. Roy, P. K. Parida, G. Karnatak, S. Borah
Associates : S. Chakraborty, N. Rabha, P. Chandra

Small scale fisheries (SSF) accounts 81% of Indian open water fisheries and plays pivotal roles in nutritional and livelihood security; however, it is highly unregulated and mismanaged. Management of SSF in vast floodplains (0.5 mha) might not only increase production but also aid in income enhancement and poverty reduction. The collaborative project under W-3 aims to enhance livelihood and nutritional security of wetland fishers through technological interventions in a co-management mode. In this regard, the management strategies like pen culture, culture-based fisheries, macrophyte management, capacity building of stakeholders etc. have been implemented in wetlands of Assam and West Bengal for boosting SSF.

Demonstration of pen culture in wetlands

Assam

Pens were installed in Borbila beel, Nalbari, Assam where fishers constitute 65% of the

Pen culture activities in Borbila beel

Pen culture demonstration in Borkona beel

Growth performance of fish seed reared in pens in Borbila beel, Assam

Species	Average initial wt. (g)	Average final wt. (g)	SGR	Weight gain (%)	Survival (%)
Labeo catla	28.16	392.47	2.93	1293.70	57
Labeo rohita	23.69	213	2.44	799.82	63
Cirrhinus mrigala	12.27	78.35	2.06	538.30	55
L. gonius	16.58	214.17	2.84	1191.98	68
L. bata	12.38	62.39	1.80	404.15	74

total population with an average income of ₹6000-10000 per month. Fingerlings (26000 nos.) were stocked in 5 pens (0.1 ha each): *Labeo catla* (40%), *L. rohita* (30%), *Cirrhinus mrigala* (15%) and *L. gonius* (15%) were stocked in four pens, while in one pen *L. bata* (2000 nos.) and *Amblypharyngodon mola* (5 kg) were stocked. Fishes were fed @ 3% of body weight twice daily for a period of 3 months. The advanced fingerlings, weighing about 3.9 tonnes, were released to the beel proper for stock and species enhancement.

Pen culture was also demonstrated in Borkona beel, a seasonally open floodplain wetland located near Sarthebari in Barpeta district, Assam. The beel is managed by Bampara Fishery Co-operative Society with 65 active members belonging to scheduled caste community. A total of 350 fisher families depend on the beel for livelihood support. It is an unstocked beel with low fish production (average fish yield: 180 kg/ha/yr). Ready-to-install CIFRI HDPE pens (8 nos., 0.05 ha each) were installed in the beel and stocked with 30,000 fry of *Labeo bata* for enhancing fish production. The pen culture activity is being carried out with active involvement of the fisher community of Borkona beel.

West Bengal

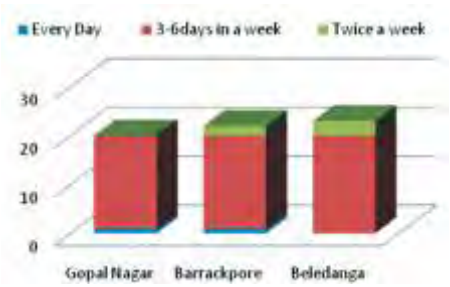
ICAR-CIFRI is working for production enhancement in Beledanga wetland, managed by Beledanga Barrackpur Fishermens' Cooperative Society Ltd. Out of 176 members of cooperative society, 170 members belongs to SC community. However, the society has no female member since inception. Fish production from the wetland was 356 kg/ha/yr in 2019. ICAR-CIFRI has adopted the wetland and started pen culture demonstration with a target to double the fish production in three years. In first year of operation, 471 kg/ha/yr productivity was achieved - a 32.3% increase in fish production. Grass carp culture in pen for biological macrophyte management, and IMC culture pen culture was successfully implemented in the year 2019 in participatory mode. The grass carps were released in the wetlands which registered high growth rate and achieved average size of 1-1.5 kg in 6 months. In continuation, four numbers of CIFRI Pen HDPE, 0.1 ha each, were installed this year in the wetland and fingerlings of Indian major carps were stocked (@20 nos./m^2) in 3 pens and grass carp (@ 10 nos./m^2 in one pen. The fishes were fed at the rate of 3-5% of body weight per day. ICAR-CIFRI is providing technical support and guidance apart from the

Fishing in Beledanga wetland, West Bengal

support in terms of fish feed, fish seed, coracle and boat to the society. Impact of production enhancement on livelihood of fishers is also being assessed.

Fish consumption pattern of the beel dependent community

A study was conducted in Beledanga beel, West Bengal to gather information on the fish consumption pattern among randomly selected households of the beel dependent community using a distinct questionnaire. The beel is surrounded by three villages and the survey covered all these villages. The study revealed that sampled households prefer to consume fish regularly in their diet, however only 3% of the sampled populace can afford to eat fish daily. About 89% of the sampled households reported that they consume fish almost 3-6 days in a week. The average fish consumption was estimated at 58 gm/day/person which was insufficient to meet protein requirements of an adult human. It was found that the consumers commonly prefer to consume catla, rohu, bata among the freshwater fishes and SIFs available from the beel. SIF has a significant contribution (67%) in their regular fish diet. Survey showed that family income was a major determinant of fish species consumed since market price vary with species and size. About 95% sampled populace prefer to intake fresh fish than frozen or processed fish.



Fish consumption pattern of the local populace

Participatory rural appraisal vis-a'-vis agro-aqua ecosystem analysis

The Beledanga beel forms a basis of livelihood for fishers in adjoining villages in form of supplementary income, food and other requirements and sustenance in difficult times. Physical degradation of the wetland is quite visible with significant implications for sustainable development. PRA was conducted to identify the threats perceived by the beel dependent community. Matrix ranking was done with active participation of the beel dependent community and it was found that encroachment, weed infestation, lack of technical knowhow, lack of capital in FCS, lack of willingness of the FCS in the wetland management, local politics, intensive poaching etc. are the major issues affecting production as well as the livelihoods of the beel dependent community. In COVID-19 lockdown period fishermen were catching unstocked fishes individually or in small groups earning ₹60-150 per person per day. However, only 10 to 15 people

Participatory rural activity in the village

Awareness-cum-fish stock enhancement in Borkona beel

were engaged in such activity due to restrictions in lockdown as compared to >100 people engaged in fish using indigenous fish traps or fishing devices in normal time.

Fish stock enhancement programme for livelihood improvement

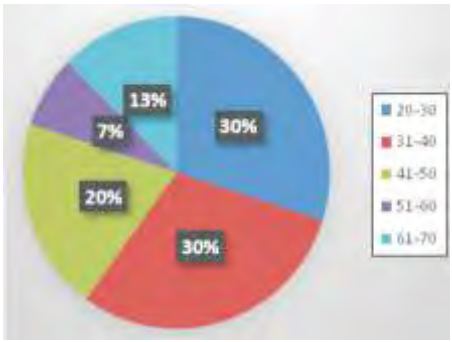
ICAR-CIFRI has initiated supplementary stocking of fingerlings of major and minor carps (40,000 nos.) in an unstocked beel Borkona (90 ha) in Barpeta district, Assam in collaboration with Bampara Fishery Co-operative Society. The objective is to enhance fish stocks in the beel, improve fish yield from the existing 180 kg/ha/yr to 300-350 kg/ha/yr and to provide livelihood support to beel fishers. The program is expected to benefit 350 fisher families belonging to Scheduled Caste community.

Project title: Hilsa fisheries improvement in middle stretch (Farakka to Prayagraj) of the river Ganga

Funding agency: National Mission for Clean Ganga (NMCG)
Scientific personnel: B. K. Das, A. K. Sahoo, D. K. Meena, M. Ramtke, A. R. Choudhury

Mass awareness on hilsa conservation has been recorded as one of the major instrument in Hilsa fisheries improvement in the river Ganga. During the study period, a total of 5082 adult hilsa of average weight 220g

Mass awareness programme on Hilsa conservation among the fishermen of middle stretch (Balia, U.P. and Vindhyanchal, U.P.) of the river Ganga



Analysis of age class among fishermen in the middle stretch of river Ganga

were ranched 5 to 10 km upstream of the Farakka barrage, Murshidabad. Among these, 332 fish were tagged with Floy T-bar anchor tags of standard size with serial number printed on them. One tagged fish was caught by fishermen from Rajmahal, Jharkhand which is approximately 57 km upstream of the ranching site on 12th day of ranching indicating upstream migration of hilsa in the river. During the period, awareness programme was organized from Farakka to Jharkhand region covering 5 stations and 260 fishermen. Among the 260 fishermen surveyed, those of age group 20-40 years contribute maximum to fishing in middle stretches of the river. A large majority (98%) of fishermen preferred television over modern day trending media indicating that this mass media could play a significant role mass awareness towards hilsa improvement in river Ganga.

Tagged Hilsa recovered from Rajmahal, Jharkhand

Project title: Assessment of endocrine disruption in fish reproduction

Funding agency : Department of Biotechnology (DBT), Govt. of India

Scientific personnel : B. K. Das (PI), S. K. Nag, Kavita Kumari

Endocrine disruption is a globally recognized environmental concern in fish, animals and humans caused by certain chemical substances. Endocrine disrupting chemicals (EDC) exert their actions through different mechanisms such as through various receptors, steroid biosynthesis and metabolism, and many others that converge upon endocrine and reproductive systems. The aquatic ecosystems are the recipients of numerous chemicals of diverse nature which include pesticides, metals, pharmaceuticals & personal care products, steroids & hormones, surfactants, plasticizers, flame retardants, etc. Many of these substances are potential EDCs. Therefore, this project was conceptualized, with Visva-Bharti university and ICAR-CIFA as partner Institutes, with specific objectives of targeted studies of known EDCs in reproduction of commercially important fish species, assessment of molecular mechanism and development of biomarker.

Experiments were conducted to determine the lethal concentration range of targeted EDCs viz., cypermethrin, triclosan, bis-phenol A and diethyl phthalate leading to 50% mortality through 96 h exposure in catla (*Catla catla*) and zebra fish (*Danio rerio*). The behavioural changes like lethargy, loss of reflex, mucus production were also recorded in experimental fishes after exposure.

Lethal concentration ranges of EDC chemicals in catla and zebra fish

Species/ Chemicals	*Labeo catla* (mg/L)	*Danio rerio* (mg/L)
Cypermethrin	0.008-0.08	0.006-0.03
Triclosan	0.2-1.0	0.3-1.3
Bisphenol A	4-10	7-10
Diethyl phthalate	10-18	46-54

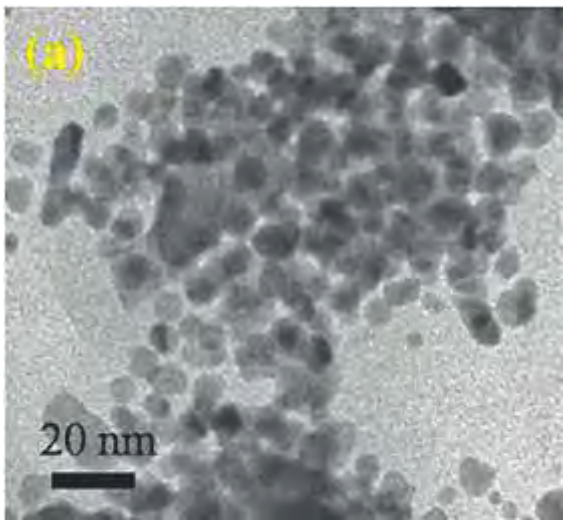
Experimental setup for EDC exposure

Project title: Development of biosensors for detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies

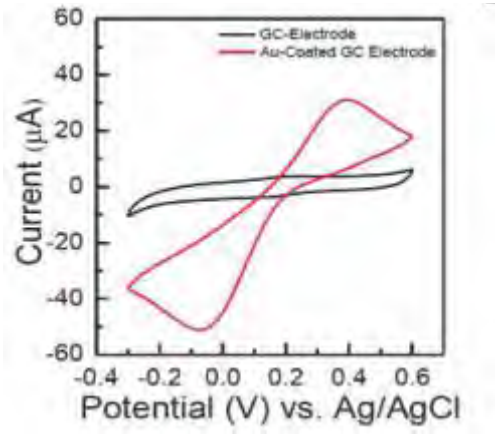
Funding agency: NASF, ICAR
Scientific personnel: B.K. Behera (PI), B.K. Das, P.K. Parida, D.J. Sarkar
Associates: A. K. Jana, A. K. Talukder

Development of molecular recognition element (MRE) for sensor development

For detection of hazardous metal and metalloids such as chromium, arsenic and fish pathogenic bacteria *Aeromonas veronii*, Au nanoparticles (NPs) were synthesized for the development of molecular recognition element (MRE). The synthesized Au NPs were also investigated using UV visible spectrophotometer with absorbance peak at 530 nm. The synthesized Au NPs were used to detect Cr (VI) ions. The varying concentrations of Cr (VI) ions solution (10-50 ppm) were added to the Au NPs solution in presence of 3,3′,5,5′-Tetramethylbenzidine (TMB) to detect Cr (VI) ions colorimetrically. The UV-Vis absorbance intensities were gradually increased with increasing concentrations of Cr (VI). The change in absorbance intensity exhibited a good linear relationship with Cr (VI) concentration indicating Au NPs as a selective absorbance probe catalyst for Cr (VI) ions in water samples. The effect of various ions, *viz.* K^{+}, Na^{+}, NH_4^{+}, Mn^{2+}, Cu^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+}, Co^{2+}, Cr^{3+}, NO^{3}, HPO_4^{2} and Cl were also studied to assess the selectivity of Au NPs towards Cr (VI) ions detection. The effect of common ions present in water samples did not significantly interfere with Au NPs during the detection of Cr (VI). Electrochemical analysis using the synthesized Au NPs was carried out for detection of arsenic and chromium. The study was performed with Au NPs modified glassy carbon (GC) electrodes by means of cyclic voltametry in the potential range of −0.4 to 0.6 V vs. Ag/AgCl with a scan rate of 50 mV/s using an electron mediator redox couple potassium ferrocyanide/potassium ferricyanide (0.01 mol/L) in phosphate buffer solution of 0.1 mol/L concentration (pH 7.4). The cyclic voltammograms of bare and Au NPs modified GC electrode shows superior electrochemical redox activity of Au NPs. Pathogenic bacteria *Aeromonas veronii* has been identified from diseased *Labeo rohita* samples for sensor development.



TEM image of Au NPs



Cyclic voltammograms of bare GC and Au NPs modified GC in presence of potassium ferrocyanide/ potassium ferricyanide (0.01 mol L^{-1}) in phosphate buffer solution of concentration 0.1 mol L^{-1} (pH = 7.4) with a scan rate of 50 mV s^{-1}

Project title: MEAN: Measuring EDCs and aquatic diagnostics through biosensor networks with special reference to NE India

Funding agency: Ministry of Electronics and Information Technology, Govt. of India
Scientific personnel: B.K. Behera (PI), B.K. Das, P.K. Parida, D.J. Sarkar
Associates: A. K. Jana, A. K. Talukder

Organophosphate, a group of pesticides, has been extensively used in agriculture as potent insecticide. However, its excess use leads to adverse effects, especially to aquatic organism. Therefore, presence of organophosphate in water bodies causes several health issues to the aquatic habitants, such as hormonal imbalance, reproduction disabilities, etc. This project aims to determine the presence of organophosphate (chlorpyrifos) in water using enzyme-based biosensor or through electrochemical approach. The glassy-carbon electrode is functionalized with novel polymer gel using drop cast method. The functionalized glassy carbon electrode is immobilized with the enzyme acetylcholine esterase to detect chlorpyrifos. Anoxidation peak position at potential 0.45 V is found in presence of acetylcholine. The organophosphate chlorpyrifos is detected in presence of acetylcholine esterase. The voltammetric peak shifted towards lower potential indicates the enzymatic inhibition effect of chlorpyrifos.

Project title: Introducing 'Ecosystem based integrated wetland management' in lower Gangetic plains of West Bengal: A tool to empower women of fishermen community

Funding agency: Department of Biotechnology (DBT), Govt. of India
Scientific personnel: A. Roy (PI), A.K. Bera, A. Pandit, P. Parida

Khalsi beel, a closed ox-bow lake spread across 62 ha area, is situated in Haringhata block of Nadia District in West Bengal. The fishery activity is operated by Khalsi Udbastu Samabay Samiti. The beel is surrounded by eight villages, out of which five were selected including one control, for this project for empowerment of women using cost effective technologies by employing "Ecosystem based integrated wetland management" method.

Demographic pattern of the study area

A survey was conducted to assess the socio-economic background of the participants. Data showed that almost 45% and 44% of the participants were from Scheduled Tribe and Scheduled Caste communities, respectively. A large majority (~92%) of the families are of smaller sizes (less than 5 persons in a family) and belongs to nuclear family category. A higher percentage of adult female population (50.76%) was recorded among the sampled households.

Implementation of the selected technologies for women empowerment

Pen aquaculture

Pen culture in inland wetlands proves to be very beneficial since it can be carried out along with the capture fisheries. Pen culture comprises of culturing fishes in a pen enclosure, was adopted in this project.

Aquatic plants and weeds were removed from the pen area manually by the fishers before installation of 5 pens (0.1 ha each). After installation, repeated netting

Awareness-cum-input distribution

Stocking of IMC fingerlings

Housing of distributed chicks

was done to remove the unwanted fish from the enclosures. Stocking of the pen was done with 212 kg fish fingerlings of 60-80 mm length at a stocking density of 73,297.87 nos./ha. Three species of Indian major carp, viz., rohu, catla and mrigal were stocked at the ratio of 40:30:30 and fed @6% of fish mass. Weight gain and health of fish were monitored time to time.

Backyard poultry

The standard protocol given by the Government of West Bengal was followed with proper bedding material and heating system for housing of poultry birds. Use of locally available material was encouraged for the construction of poultry house. Sides of the bird houses were guarded with nets to ensure protection from snakes, etc. and for proper ventilation. Electric bulbs were installed to achieve the desired temperature, especially during night time. Proper arrangements were made to provide feed and drinking water to the birds.

Each beneficiary was given 21

Production of Mushroom

Planting of vegetable seeds for kitchen gardening

numbers of 28-days old RIR chicks from West Bengal Comprehensive Area Development Corporation. Due care was taken to minimize transport stress and prevention of disease. Birds were vaccinated and given need based medication with help extended by the Block Livestock Development Officer and the Veterinary Officer in charge of the Gram Panchayat.

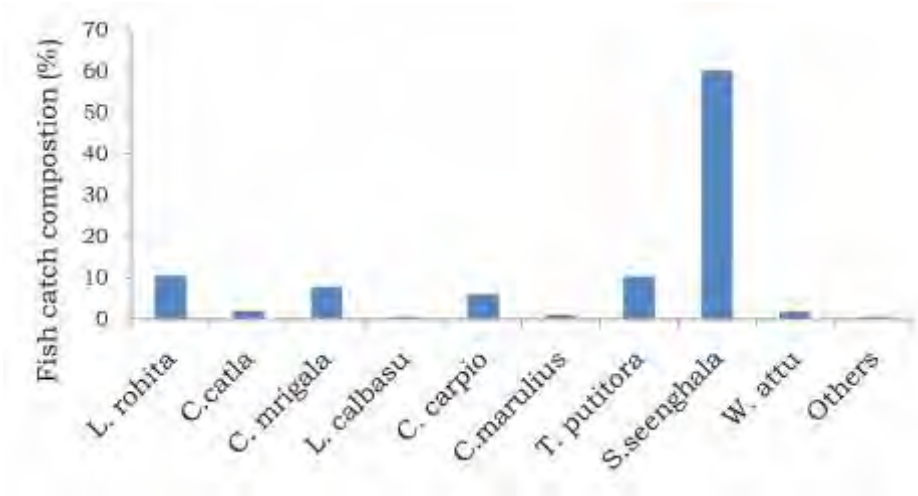
Extension methods used as delivery mechanism

An awareness - cum - training programme was organized on 25 November 2020 at Khalsi to sensitize the beneficiaries about various components of the project. Scientists from different fields highlighted key aspects of the "Ecosystem based integrated wetland management". Dr. B. K. Das, Director, ICAR-CIFRI encouraged the women to actively participate in the project. Besides 850 RIR chicks, seeds of winter vegetables and mushroom spawns were distributed to 40 beneficiaries. 212 kg of IMC fingerlings were also released in the pens installed at the Khalsi beel. Hand outs in local language were also distributed to educate the target beneficiaries about day to day management practices of the poultry birds. Regular monitoring of the various inputs and interactions with the beneficiaries are made to solve problems faced by the women beneficiaries. The growth of fish and production of mushroom are regularly monitored.

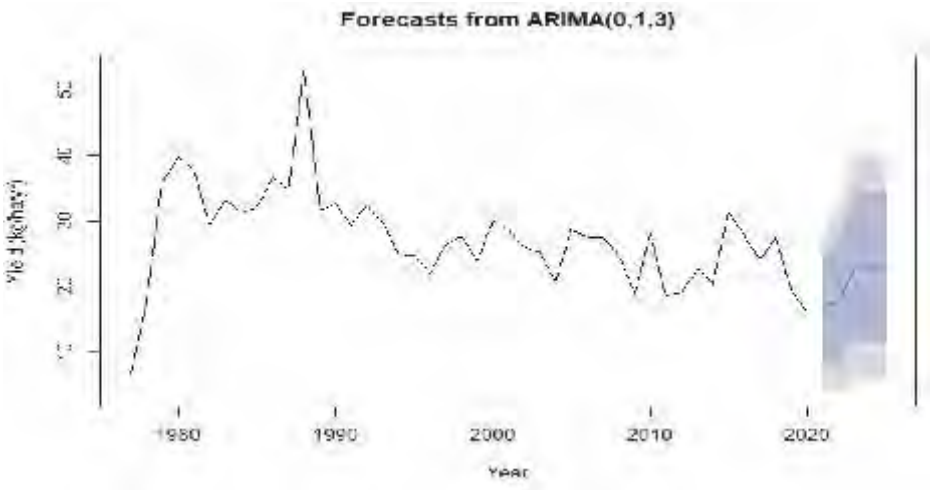
Project title: Assessment and management of fisheries resources of Pong reservoir, Himachal Pradesh (Project no: 16.9020.5-001.00)

Funding agency: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
Scientific personnel: B. K. Das, U. K. Sarkar, A. K. Das, Lianthuamluaia
Associates: S. Chakraborty, K. Mondal

Fisheries resources of Pong Reservoir in Himachal Pradesh, a Ramsar site, were assessed. Samplings were conducted to collect biotic, abiotic and socio-economic information of the reservoir. The ecological data were collected from the lotic, intermediate and lentic zones of the reservoir. Most of the water and sediment quality parameters were in favourable ranges for fisheries development and indicated medium productive nature of the reservoir. The spatial pattern of the water quality indicated that most of the nutrient parameters were higher in the lotic zones of the reservoir. The time series data from 1976-2020 indicated that the average fish catch was 411.46t per year with average fish yield of 27.43 kg/ha/yr. The pattern of fish yield during 1976-2020 indicated that the fish catch has gone down in last few years. However, a prediction model using ARIMA indicated a slight increase of the fish catch in the coming years. During the study period *Sperata seenghala* was the most dominant fish (60%) followed by Indian major carps (IMC). *Tor putitora* (10%) is also among the most abundant species contributing to the fish catch.



Fish catch composition in the Pong Reservoir



Trend and forecasting of fish catch in the Pong Reservoir

A total of 14 macroinvertebrates were observed with higher abundance in the lotic zone as compared to other zones of the reservoir. During the present study 36 phytoplankton genera belonging to 7 Classes were recorded. Phytoplankton abundance ranged from 795 to 2935 unit/l, and was found maximum at intermediate zone and minimum at lotic zone of the reservoir. Among the zooplanktons, Cladocera and Copepoda were the most dominant group. About 3900 fishers are registered for fishing in Pong reservoir, out of which, 2800 are actively involved in daily fishing.

Experimental fishing in the Pong Reservoir

Fish catch from the Pong Reservoir

Socio-economic status indicated that fishing is the major source of income, followed by agriculture / farming of the fishers of Pong reservoir.

Project title: Assessment and impact study on bio diversity, eco-hydrology, fish population dynamics and livelihood of fishers in Narmada river with special focus on downstream of Sardar Sarovar dam and Bhadbhut reservoir

Funding agency : Govt. of Gujarat, Narmada, Water Resources, Water Supply and Kalpasar Department
Scientific personnel : B. K. Das, S. Samanta, A. Pandit, A. K. Sahoo, D. Bhakta, G. Chandra, S. P. Kamble, L. Kumar
Associates : S. Majumdar, A. R. Chowdhury, D. Saha, S. Saha, R. K. Sah, J. K. Solanki, Ram Prasad

A total of 43 finfish and 4 shellfish species were recorded from 13 sampling sites during the year. Fishing was observed in 8 fishing sites downstream of river Narmada (below Sardar Sarobar Dam).

Fishing gears and CPUE

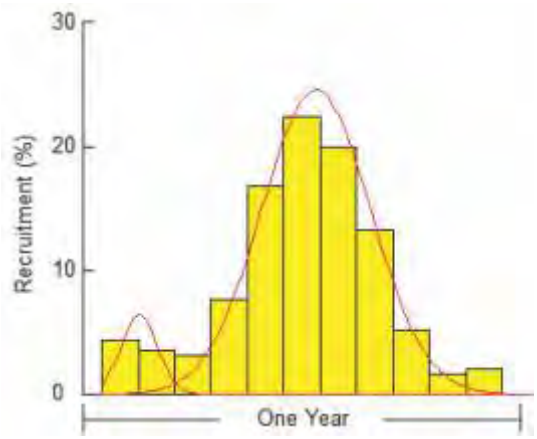
Gillnet and hook and line were found to be the operating gears in the lean period. A wide range of catch per unit effort (CPUE) was recorded from the different landing sites, *viz.*, 3.0-9.0 kg/boat/day at Garudeshwar, 5.5-7.5 kg/boat/day at Nareshwar, 3.0-5.0 kg/boat/day at Sisodra, 0.5-2.0 kg/boat/day at Bharuch, 2.25-3.5 kg/boat/day at Bhadbhut, 3.5-15 kg/boat/day at Mehegam, 1.0-2.5 kg/boat/day at kaladra and 2.5-3.0 kg/boat/day at Luwara point.

Stock assessment

Growth, mortality, and population parameters of *Macrobrachium rosenbergii* was estimated based on length-frequency data collected every month from the Narmada estuary. For the estimation, data were grouped into 10 mm class intervals and population parameters were assessed and computed using

Hilsa (*Tenualosa ilisha*) from downstream of Sardar Sarovar dam

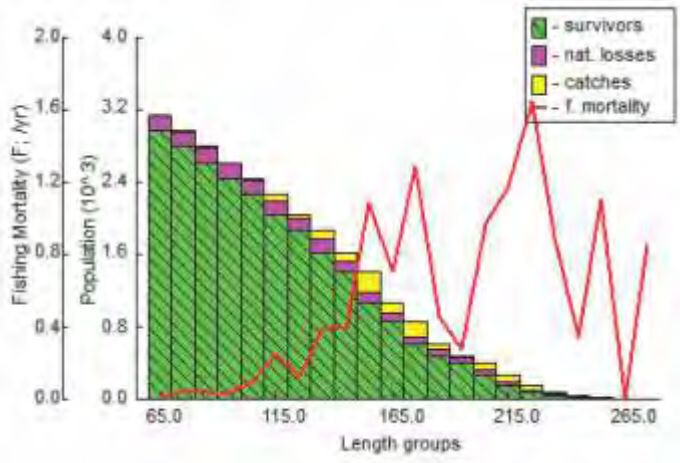
Fishing with gillnet at Garudeshwar



Recruitment pattern of *M. rosenbergii* in the Narmada estuary

the FiSAT-II software package (FAO-ICLARM Stock Assessment Tools).

Different growth parameters for *Macrobrachium rosenbergii* were estimated as L∞ = 288.75 mm, and K = 0.46/yr. Mortality coefficients Z, M, and F were estimated at 1.43, 0.57, and 0.86, respectively. The estimated value of exploitation rate (E) using the length-converted catch curve method was 0.60, which was a little higher than the optimum value. The recruitment pattern of *M. rosenbergii* from the Narmada estuary shows that the species follow two recruitment patterns in a year: one in January-February, and the major recruitment during May to August. The maximum sustainable yield (MSY) was estimated at 267.05 t if the recommended length at first capture (L_c = 137.91 mm TL) is maintained throughout the capture periods.

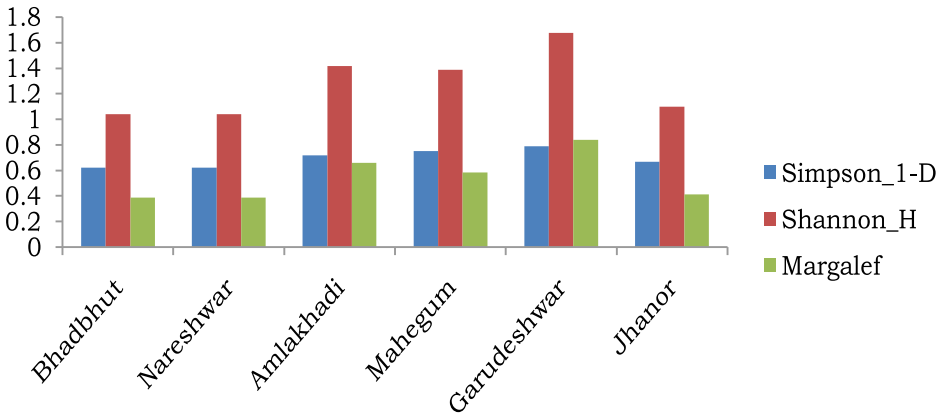


Length-structured virtual population analysis of M. rosenbergii in the Narmada estuary

Accidental catch of near threatened Arabian carpet shark, *Chiloscyllium arabicum*

An accidental catch of the Arabian carpetshark *Chiloscyllium arabicum* Gubanov, 1980 was recorded in bag net catch from Bhadbhut fishing site of river Narmada in February 2020. A single specimen was recorded with total length of 505 mm and fork length of 485 mm. Arabian carpet shark, an Elasmobranchii, comes under the order Orectolobiformes and family Hemiscylliidae. It is a tropical, reef-associated oceanodromous species inhabited in marine and brackish waters. As per the

Arabian carpet shark from bag net catch at Bhadbhut



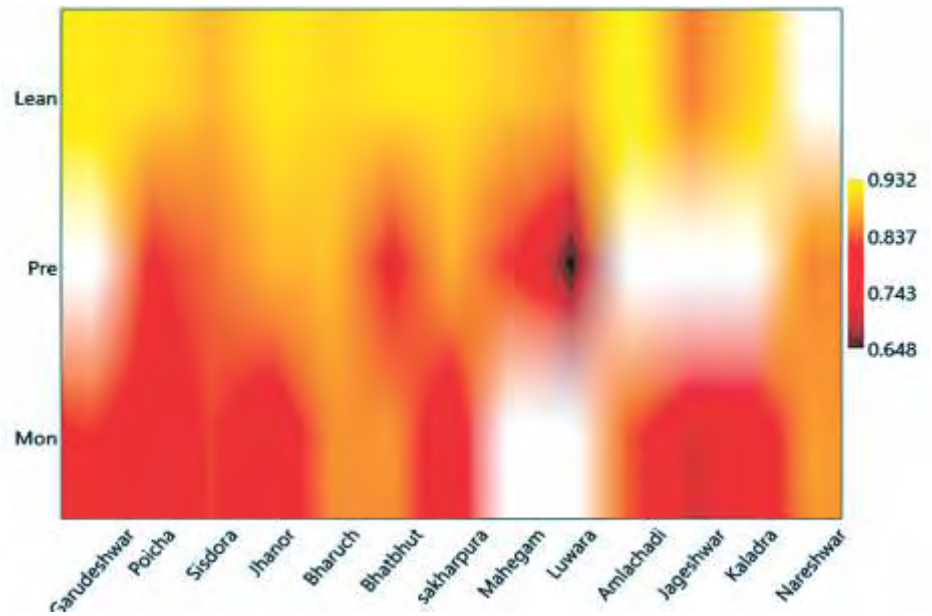
Station wise diversity indices of benthic population

IUCN Red List status, this is kept under Near Threatened (NT) category and needs proper management measures to stop them from exploitation.

Benthos community

During the pre-monsoon period, three groups of benthos, viz. Gastropoda, Insecta and Polycheta were recorded from different stations. Gastrpods constituted 89% of the total benthos, followed by polychetes (6%) and insects (5%). In monsoon, the benthic fauna comprised of gastropods (78%), bivalves (12%) and crustaceans (10%). Shannon index value of the benthic population during monsoon, ranged from 0 to 1.6 indicating low diversity of benthic fauna. Maximum value was observed at Garudeshwar. Simpson index value of benthic population ranges between 0.0-0.78 with the highest value observed at Garudeshwar. The Margalef index value ranged between 0.3 to 0.8 and highest value was observed at Garudeshwar.

A total of 39 genera belonging to 4 classes, viz. Bacillariophyceae, Cyanophyceae, Chlorophyceae and Euglenophyceae were recorded from all the sampling stations. Zooplankton community was represented by seven genera. Shannon-Wiener diversity index (H'), Simpsons diversity index (D) and Pielou's evenness index (J') were calculated for the planktons. Shannon-Wiener diversity index (H') ranged from 1.19 at Luwara station in pre-monsoon to 2.75 at Amalchandi in lean season indicating minimum to moderate diversity of planktons. Simpsons diversity index (D) ranged from 0.6 to 0.9 indicating fairly rich diversity of planktons across stations and seasons. The minimum value of Simpson's diversity index was recorded in the monsoon period while the maximum value was recorded in lean period. Pielou's evenness index (J') ranged from 0.7 to 0.9 indicating that the plankton diversity is fairly evenly distributed across the stations in different seasons.



Simpson's diversity index (D) of planktons across different stations and seasons

Project title: Assessment of efficacy of fish pass/fish ladder at Teesta Low Dam-III & Teesta Low Dam-IV power stations, Distt. Darjeeling, West Bengal

Funding agency: NHPC Ltd.
Scientific personnel: B.K. Das, A.K. Sahoo, D.K. Meena
Associates: S. Prasad, A.R. Chowdhury

The Efficacy of the fish pass at Teesta Low Dam-III and Teesta Low Dam-IV on river Teesta was assessed through tagging of the available distant migratory fish *Neolissochilus hexagonolepis*, commonly known as 'chocolate mahseer'. In the study, floy T-bar tag was used to record the migration pattern of the fish and efficacy of fish pass/ladder of TLDIII and TLDIV PS was calculated following standard method. A total 64 fish were tagged at the representatives sites covering the upstream and downstream of TLDPIII and TLDPIV in a stretch of 35 km from the Rangeet river confluence, Sikkim to the Teesta barrage, West Bengal. The overall recovery of tagged fish was estimated only at 6.25 %, though fish were recorded in both the fish passes of TLD-III and TLD-IV PS indicating establishment of these migratory fish species population in the reservoir. Furthermore, fish pass/ladder facilitates their accidental escapement or migration from reservoir to the downstream of the barrage/dam. Based on the observations and collected data, the efficacy of fish passes was found to be 8.33% for TLD-III PS.

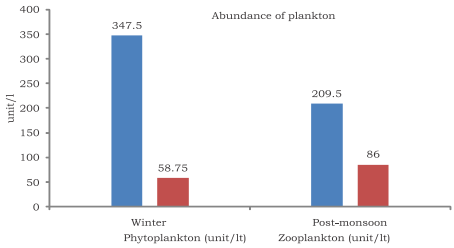
Measuring the water velocity and depth through the fish pass at TLDPIV PS

Fish pass at TLDPIII PS on river Teesta

A joint team of NHPC officials of Design Engineers and Officers and scientists of ICAR-CIFRI visited both the power stations during 26-28 July 2019 to find out practical ways to improve the efficacy of fish ladders. Based on the observations during the study and follow-up site visit, major recommendations are suggested to improve the efficacy of fish ladders. Major recommendations for TLDPIII PS were: 1) steel bar protrusions were found in the fish pass bed, which may cause injury to fishes. Its removal was advised to enable smooth fish migration, 2) in order to provide a natural habitat to the migrating fishes, it is also recommended to place small cobbles in the fish pass bed, 3) gate opening of the fish pass needs to be adjusted in line with the fluctuating reservoir level, 4) attractive flows @1.2-1.5 m/s needs to be maintained in the fish pass, 5) fish pass should not be used for the water release during monsoon only, there should be continuous flows throughout the year. Similar recommendations were made for TLDPIV, *viz.* 1) siltation was observed at the exit of Fish Pass at EL ± 152m choking the entry of the upstream migrating fish. It is therefore recommended to construct a guide wall enclosing the fish pass to enable the creation of a pool to guide the fish pass for enabling upstream migration of the fish, 2) the fish lure pipe provided in the fish pass was also found to be buried. The same needs to be cleaned and maintained for giving aeration and attraction of fish migration, 3) in order to give a natural habitat to the fishes, it is also recommended to place small cobbles in the fish pass bed, 4) attractive flows @1.2-1.5 m/s needs to be maintained in the fish pass.

Project title : Study on viable and feasible alternative on the blocked migratory movement of fish species due to construction of the Naitwar Mori-Hydro-electric Project

Funding agency : SJVN Ltd.
Scientific personnel : B. K. Das, A. K. Sahoo, D. K. Meena
Associates : A. R. Chowdhury, K. Mondal

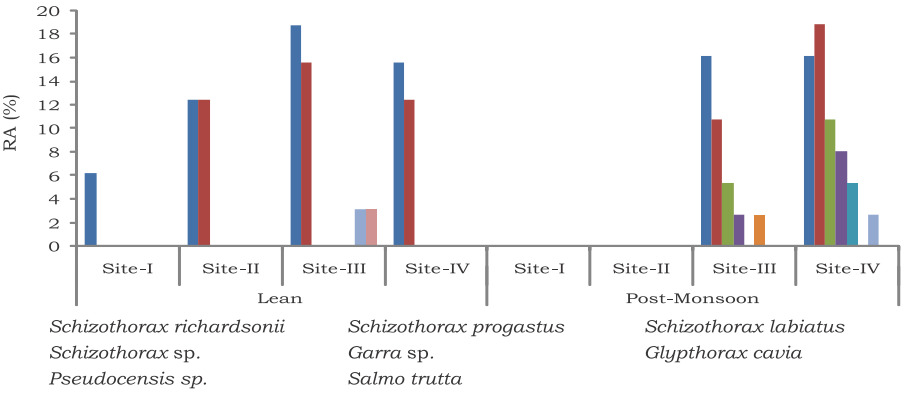


Plankton abundance of Tons river

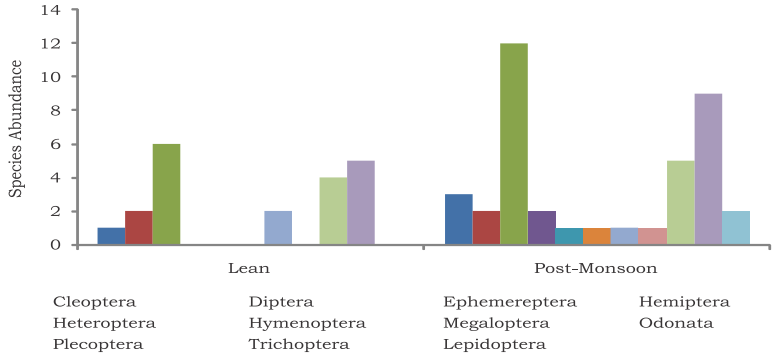
A total of 8 fish species belonging to 3 families, and 4 genera were recorded in the stretch of 15 km at Mori (28°39.825´N, 96°05.799´ E to 28°38.224´ N, 95°55.728´ E) in river Tons, a tributary of river Yamuna. During the study, *Schizothorax richardsonii* (RA 42.78%) represents the dominant species, followed by *S. progastus* (RA 35.17%) and *S. labiatus* (8.108) in all the sites. Interestingly it was recorded that Rainbow trout *Oncorhynchus mykiss* and Brown trout *Salmo trutta* were the dominant fish species in upstream of the proposed barrage and barrage site, while, Common snow trout *Schizothorax richardsonii*, and Snow trout *Schizothorax prograstus* were dominant in downstream of the proposed barrage. Therefore, two zonations were made based on the fish species availability, viz. brown/rainbow trout zone and snow trout zone. All the four fish species are migratory in nature and during study it was observed that brown/rainbow trout are the major species at the proposed barrage site while snow trouts majorly migrate through the streams or nalas. The gut content analysis of *O. Mykiss* and *S. trutta* in both the seasons revealed that the fish foods were dominated majorly by terrestrial insects (ants, beetles, grasshoppers), worms, arthropods, detritus, debris, sand particle, etc., besides some algae and plant matter indicating highly carnivorous feeding nature of the fish. Reproductive biology study of the four migratory fish species revealed that these species, especially brown/rainbow trout mature during monsoon with expected breeding/spawning during post-monsoon *viz.*, September to November.

Plankton diversity

A total number of 33 planktonic genera belonging to 8 phyla were recorded, of which 4 belonged to phytoplankton (Bacillariophyceae, Chlorophyceae, Zygnematophyceae, and Cyanophyceae), and 4 belonged to zooplankton (Protozoa, Rotifera, Copepoda



Seasonal relative abundance (RA%) of fish species in Tons river



Seasonal diversity of aquatic insects

Schizothorax richardsonii

Glyptothorax cavia

Schizothorax labiatus

Salmo trutta

Schizothorax progastus

Garra sp.

Schizothorax esocinus

Pseudocensis sp.

and Cladocera). Average total phytoplanktonic abundance was 347.5 unit/l, and average total zooplanktonic abundance was 58.75 unit/l. During post-monsoon, phytoplankton abundance was moderately low but zooplanktonic diversity was higher than the previous season.

Aquatic insect diversity

Aquatic insects are commonly used for environmental monitoring and assessment. In the lean and pot-monsoon seasons, 11 families of aquatic insects were collected from Tons river. Ephemeroptera was more abundant in all four sites, followed by Trichoptera and Plecoptera.

Catalog of aquatic insects in river Tons at Mori

Project title : Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar reservoir

Funding agency : MP Fisheries Federation
Scientific personnel : B. K. Das, U. K. Sarkar, A. K. Das, S. K. Koushlesh, C. Johnson
Associates : S. Das, A. Sengupta, B. K. Naskar, Y. Ali

The study was carried out at Maheshwar, Rajghat, Koteshwar and Kakrana sites to assess the status of fish biodiversity, ecological changes and suggest for sustainable development of the fisheries in Sardar Sarovar reservoir (SSR) in Madhya Pradesh.

Ecology and fish habitat

The physico-chemical parameters indicated good water quality conditions of SSR Madhya Pradesh region. DO levels never decreased below 6 ppm during the study periods, indicating healthy state to thrive fish and other aquatic organisms. TDS values indicated that water quality composition with respect to individual ions did not vary appreciably. The water pH was in congenial level. Spatial variation was less during pre-monsoon as compared to the monsoon. The most dominant macro-habitat was found to be the pool: 80 % and 100 % in post monsoon and pre-monsoon respectively in all the stations. The bed rock comprises majority of the bottom substrate in all station except along marginal areas.

Biotic communities

The study during 2018-2020 recorded presence of 30 Phytoplankton genera under 10 classes, 22 orders and 28 families. Phytoplankton under the class Bacillariophyceae (9 species), Chlorophyceae (6 species) and Cyanophyceae (6 species) were dominant. Analysis of overall abundance showed the dominance of class Bacillariophyceae (32%), Cyanophyceae (26%), Chlorophyceae (20%) and Zygnematophyceae (8%) among the phytoplanktons. It also revealed more or less constant pattern across seasons with evenness values ranging from 0.7485 to 0.8601. This indicates that the phytoplankton communities are not exhibiting drastic changes across temporal scale. There are spatial aberrations in macro-benthic abundance, in quantitative as well as qualitative terms, across the stretches. A total of 21 species of macro-benthic organisms under 08 families and 3 classes were recorded. During pre-monsoon and monsoon seasons highest macro-benthic population were noticed and revealed molluscs (51%) as the most prominent macro-fauna.

Fish and fisheries

A total of 56 finfish species belonging to 7 orders and 17 families were recorded from the Sardar Sarovar Reservoir part in Madhya Pradesh during the study period. About 74 % of the fish diversity belonged to two main orders, viz. Cypriniformes (32 species), and Siluriformes (11). The other major fish families found during the study were Daniodidae (7) and Bagridae (6). The overall mean annual catch composition for the Sardar Sarovar Reservoir part in Madhya Pradesh clearly indicates that the bulk

Carp catch from Sardar Sarovar reservoir

Catch of minor carps

of the catch was contributed by indigenous carps (35 %), indigenous catfishes (24.28 %), minnows and barbs (14.24 %), eels (7.01%) and murrels (4.52 %) which together forms about 85 % of the total fish catch. The analysis revealed lower contribution of exotic carps (2.95 %). This part of the reservoir also supports good fishery of predatory fishes (catfishes, murrels and freshwater eel). The dwindling Mahseer fishery that constitutes only 3.31 % of total catch is a concern in this part of the reservoir.

Productivity of the reservoir

Based on trophic state index Sardar Sarovar Part of the reservoir in Madhya Pradesh is oligotrophic (32.28±0.58) in nature. The study also finds that the calculated mean yield based on Morpho-edaphic index is 22.4 kg/ha/year, however, the predicted value of the potential fish yield could reach to a level of 42.8 kg/ha/year.

Socio-economic profile

The estimated literacy rate among the sampled fisher populations was 45%, of which 21% was educated to secondary level and the rest to primary level; illiteracy rate was high at Kakrana among all the sampling stations. The average income was around Rs. 2,130 (per month per fisher). Fishermen of this region use a wide variety of fishing gears for fishing. Among several fishing devices, gill nets were found to be the most effective means of fishing followed by cast net, and hook and line. It was also noticed that fishermen were having own boat for their economic and nutritional security.

Fishing craft

Fishers at Kakrana

Project title : Investigation on ecological status, conservation and enhancement of fisheries in Gujarat part of Sardar Sarovar reservoir

Funding agency : Sardar Sarovar Narmada Nigam Limited (SSNNL), Gandhinagar, Gujarat
Scientific personnel : B. K. Das, G. Chandra, A. K. Das, C. M. Roshith, S. P. Kamble, W. A. Meetei, Vaisakh G., V. Kumar
Associates: S. Das, R. K. Sah, J. K. Solanki, Sujata, N. Vadel

Water and sediment quality

Water quality monitoring revealed that the water reaction was invariably alkaline (pH 7.9-8.8) at all the representative sites in all the seasons which are indicative of the prevailing congenial environment for biological activities. The dissolved oxygen levels (6.0-9.1 mg/l) corroborated the above inference. Based on the total alkalinity (70-198 mg/l), total hardness (80-160 mg/l), total dissolved solids (67.8-238 mg/l), and specific conductivity (211.7-338 µS/cm) regime, SSR may be categorized under the high productive side.

Sardar Sarovar Reservoir

The water and sediment quality parameters were within the suitable range for the fisheries and aquaculture indicating that there was no pollution load from external sources. As per the studied water sediment quality parameters Sardar Sarovar Reservoir may be classified as having medium to high productive potential.

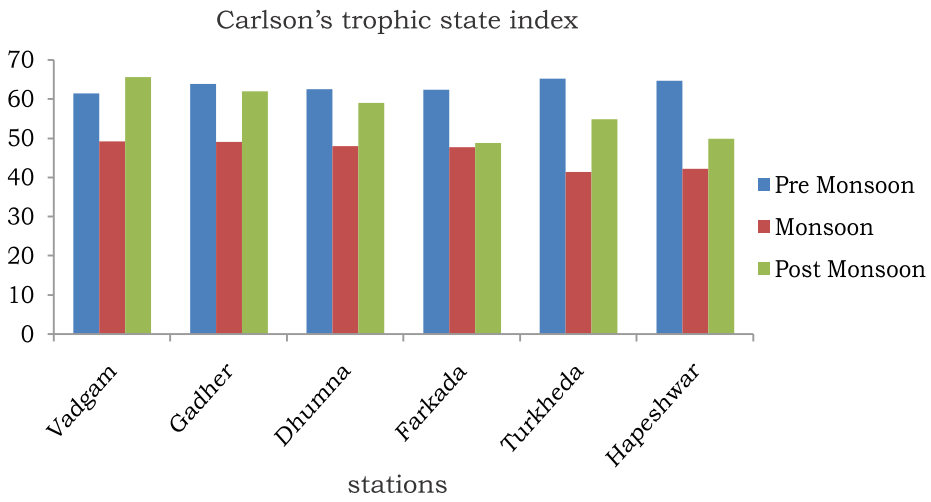
Trophic status

Sardar Sarovar reservoir could be classified as "eutrophic as well as mesotrophic (CTSI value 47.74 to 65.63)" water body in accordance with the comprehensive trophic state index. Seasonal inflow of water also contributed towards the variation of trophic level of SSR in pre-monsoon: eutrophic (CTSI value range 51.14-58.92, average 55.89); monsoon: mesotrophic (CTSI value range 47.74-54.53, average 50.39); & post-monsoon: eutrophic towards mesotrophic (CTSI value range 48.82-65.63, average 56.66). Salient features of a eutrophic water body is, they are rich in dissolved nutrients (phosphorus, nitrogen etc.), resulting in accelerated growth of plant and algae. It shows presence of high levels of biological productivity.

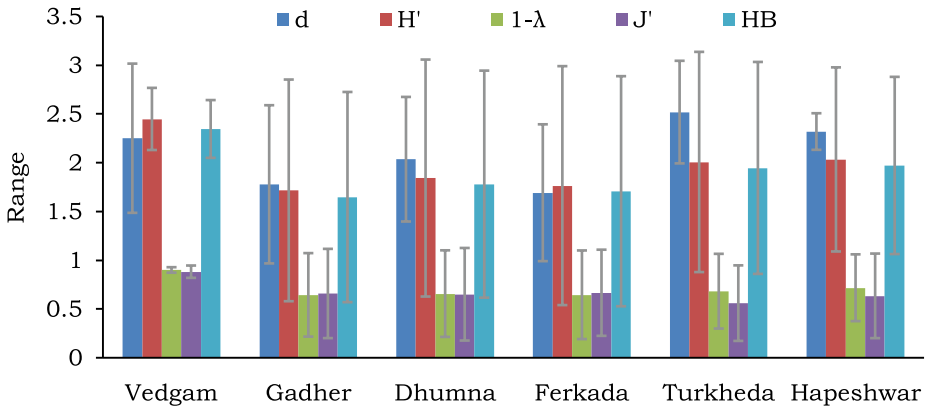
Plankton and macro benthic dynamics

Plankton of the reservoir in time and space indicated that community is undergoing succession as the blue-greens and diatoms which were dominant during the earlier study show transition to chlorophyceae and diatoms. This transition is of ecological significance and a reflection of changes in nutrient concentration, organic pollution, and aquatic productivity.

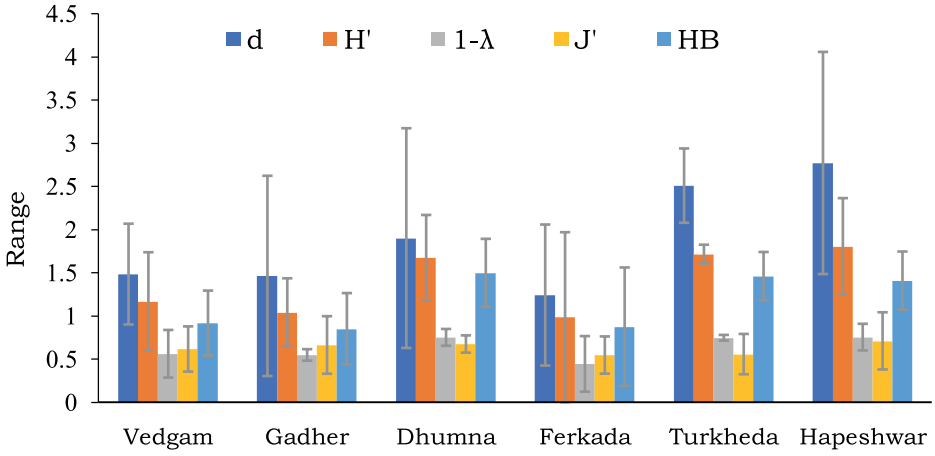
The benthic community is designated as mollusc type which is a deviation from the earlier benthic community being molluscs-dipteran type. This deviation has ecological consequences. Biodiversity indices revealed that



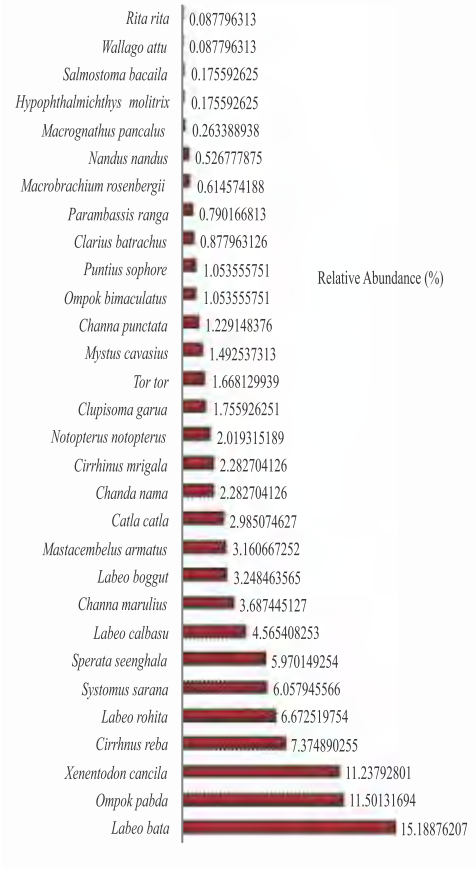
Trophic status of different stations of SSR



Biodiversity indices as a function of planktonic community at studied sites of SSR



Biodiversity indices as a function of macro-benthic community at studied sites of SSR



Relative abundance (in percentage) of the different fish species

Turkheda and Hafeshwar sites have the highest species abundance and richness in the part of the reservoir studied.

Fish diversity and catch composition

A total of 30 fish species were recorded from Sardar Sarovar reservoir wherein the family Cyprinidae dominated in the number of species (12), followed by catfish families Siluridae and Bagridae. The abundance of fishes varied significantly with season, with post monsoon season showing rich abundance for most fishes. The commercial catch of the reservoir were congregated into six major groups, viz. carps, catfishes, spiny eels, featherbacks, mahseer and murrels; carps dominated the catch in all the three sectors throughout the study period followed by catfishes. The estimated fish production potential of Sardar Sarovar Reservoir is 178.2 kg/ ha/ year.

Project title : Impact assessment of hydro ecological changes on fisheries and socio- economy of fishers downstream of Sardar Sarovar dam in Narmada basin

Funding agency : Sardar Sarovar Narmada Nigam Ltd. (A Govt. of Gujarat Undertaking)

Scientific personnel : B. K. Das, G. Chandra, H. Chowdhury, B. K. Behera, Sajina A. M., S. P. Kamble, W. A. Meetei, Vaisakh G.

Associates : A. Sengupta, S. Prasad, S. Saha, R.K. Sah, J.K. Solanki, B.K. Sahu, B. Gondaliya

The study was carried out in the downstream of Sardar Sarovar dam in Narmada river basin covering about 161 km. The total stretch of the river was divided into ten segments from upper (Kevadia) to lower stretch (Ambetha). The sampling segments selected were Kevadia, Garudeshwar, Poicha, Sisodara, Jhanor, Bharuch, Sakkarpura, Bhadbhut, Mahegam and Ambetha. Kevadia to Sisodara are freshwater zone, Jhanor is tidal freshwater zone and Bharuch, Sakkarpura, Bhadbhut, Mahegam and Ambetha are the estuarine zone.

Fish diversity

The total downstream stretch was categorized into three zones, viz. freshwater zone, tidal freshwater zone and estuarine zone based on salinity gradient to study fish diversity. A total of 98 fish species belonging to 35 families and 13 orders were recorded from the riverine stretch of Narmada downstream of SSD. Seven fish species were reported for the first time from the Narmada river system which included *Awaous grammepomus* (Bleeker 1849), *Plotosus canius* (Hamilton 1822), *Thryssa stenosoma* (Wongratana 1983), *Takifugu oblongus* (Bloch 1786), *Aulopareia ocellata* (Day 1873), *Parambassis lala* (Hamilton 1822) and *Carangoides ferdau* (Forsskal 1775). Among the recorded fish species only three species, *viz., Wallago attu, Ompok pabda* and *O. bimaculatus* are categorized as Near threatened (NT) in the IUCN Red List of Threatened Species. In addition to the finfish, there were several species of shellfish and other invertebrates that were frequently encountered in the fish landings along the studied stretch. These included 8 species of prawns, 5 species of crabs and one species of octopus. The record of pouched octopus, *Cistopus platinoidus,* is the first record of an octopus from Narmada estuary as well as from any estuarine system in India. The highest fish species diversity was recorded at Bhadbhut (54 species) and the lowest at Kevadia (12 species). The extreme changes in the physical habitat at Kevadia have made the river channel less favorable for majority of the freshwater fish species. The prevailing brackishwater conditions due to tidal influx of marine waters have favored migration of several stenohaline marine fishes to the estuarine stretch at Bhadbhut resulting in high fish diversity.

The mahseer (*Tor tor*) which

Sampling stations in Narmada river, downstream of Sardar Sarovar dam

fairly contributed to the fish catch (0.37 % of total fish landings) downstream of SSD (Zone – I) during 2010-11, has almost disappeared from the catches during 2018 – 19. We could record only two specimens of *T. tor* throughout this study. The freshwater species that formed the significant components in the riverine fish landings of Zone – I in 2010-11, *viz.*, *Eutropiichthys vacha* and *Ailia coila*, were not recorded in the present study. The reduced freshwater influx had adversely impacted the fishery of these economically important riverine species. A drastic reduction in the catch per unit effort (CPUE) was observed during the study. The observed CPUE in monsoon during 2018-19 was 17.8 kg/boat/day, which is significantly lower than the value reported during 2009-10 (74.2 kg/boat/day).

Among the shellfishes, *Macrobrachium rosenbergii* formed a major fishery in the freshwater (Zone I) and tidal freshwater zones (Zone II), while in the estuarine zone (Zone III) *Nematopalaemon tenuipes* (Spider prawn) and *Parapenaeopsis sculptilis* formed a significant catch in bag nets. The seasonal variations in the catch composition are mainly observed in the estuarine zone and the tidal freshwater zone. The inflow of freshwater from the upstream part during monsoon determines the extent of migration in species like hilsa (*T. ilisha*) up to the

Dominant species in the fish landings in Zone I

Sampling season	Species	% contribution
Pre-monsoon (summer)	*Channa marulius*	32.81
	Ompok bimaculatus	14.76
	Labeo boggut	9.85
	Systomus sarana	9.18
	Pethia conchonius	8.20
Monsoon	*Sperata seenghala*	15.93
	Labeo boggut	15.10
	Nandus nandus	13.36
	Trichogaster fasciata	11.22
	Macrognathus pancalus	10.73
	Notopterus notopterus	26.28
Post-monsoon (winter)	*Wallago attu*	14.37
	Labeo dyocheilus	14.34
	Cirrhinus reba	9.05
	Macrobrachium rosenbergii	8.54

Dominant species in the fish landings in Zone II

Sampling season	Species	% contribution
Pre-monsoon (summer)	*Wallago attu*	44.66
	Labeo rohita	35.71
	Mugil cephalus	7.14
	Tenualosa ilisha	4.46
	Scatophagus argus	2.23
Monsoon	*Tenualosa ilisha*	47.73
	Cirrhinus mrigala	35.80
	Systomus sarana	7.16
	Xenentodon cancila	5.73
	Macrobrachium rosenbergii	3.58
	M. rosenbergii	60.8
Post-monsoon (winter)	*Badis badis*	14.43
	Rhinomugil corsula	5.78
	Fenneropenaeus indicus	5.38
	Megalops cyprinoides	4.39

Dominant species in the fish landings in Zone III

Sampling seasons	Species	% contribution
Pre-monsoon (summer)	*Pama pama*	52.37
	Boleophthalmus dussumieri	12.32
	Mugil cephalus	10.47
	Eleutheronema tetradactylum	9.24
	Fenneropenaeus indicus	6.16
Monsoon	*Tenualosa ilisha*	98.43
	Metapenaeus monoceros	0.78
	Filimanus heptadactylus	0.35
	Macrobrachium rosenbergii	0.23
	Metapenaeus dobsonii	0.11
	P. pama	51.96
Post-monsoon (winter)	*R. corsula*	19.16
	Chelon macrolepis	4.04
	Nematalosa nasus	3.04
	T. ilisha	2.48

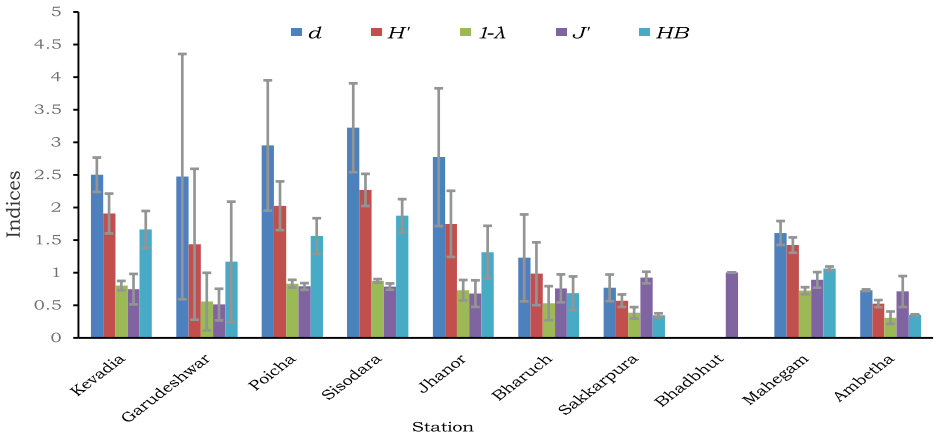
freshwater zone and also leads to availability of more freshwater stragglers in the estuarine zone. Though there was overall reduction in the catch of freshwater fish species downstream of SSD, the flood conditions during 2019 had favored the migration of the commercially important hilsa shad (*T. ilisha*), which was reported from upstream reaches at Garudeshwar.

Physico-chemical and nutrient characteristics of water and sediment

Monitoring of important water quality attributes revealed that the water reaction of the downstream stretch was alkaline (pH 7.74 to 8.90) during all the seasons and reflects congenial environment. The above pH variation also conformed to the criteria set by Central pollution Control Board (CPCB) relevant to best use of D class water meant for propagation of wildlife and fisheries. From eco-mapping perspective, there are observed horizontal demarcation based on transparency levels (4.0 to 90.0 cm) since freshwater eco-zone experienced higher levels of transparency as compared to estuarine during the study. The downstream also exhibited horizontal demarcation relevant to specific conductivity as estuarine expanse recorded higher conductivity due to tidal oscillations. The DO level varied from 5.6 to 9.6 mg/l for the downstream and was low during monsoon season. Free CO_2, a reflection of catabolic process and level of its utilization by producers during photosynthesis, was absent at many sites. Biochemical oxygen demand (BOD) levels for the downstream as a single entity was high in summer and reached up to 3.4 mg/l in different seasons. We observed static water condition and the water level of the downstream was significantly low without inflow; even soil bottom was visible at freshwater sites in summer and winter. The downstream environment is getting impacted gradually due to constrained inflow. Lowest DO particularly at Kevadia site, representing immediate expanse under SSP dam, may be considered as a warning signal. BOD recorded during summer 2018 (2.4 to 3.4 mg/l) should be taken as a word of caution. Based on criteria decided by CPCB for bathing in rivers, this stretch of Narmada downstream of SSP dam satisfies by and large the criteria since DO was above 5 mg/l and BOD slightly exceeded the set limit of 3 mg/l. With further constrained inflow conditions at full operational stage of the project, the downstream stretch shall get further impacted negatively. The monsoon season experienced almost freshwater conditions up to Sisodara which was earlier being felt upto Bhadbhut. However, Ambetha site in proximity of Narmada estuary mouth experienced salinity level up to 5.7 ppt which increased to 34.7 ppt during high tide in summer which convincingly projects the impact of constrained freshwater availability in the downstream environment as compared to earlier years when Narmada estuary used to be a 'positive estuary". This eventuality has relevance to anadromous migration of *Tenualosa ilisha*. Total flux of major nutrients namely, phosphate-P, nitrate-N and silicate-Si are not declining from earlier years due to anthropogenic loading that balances the sediments retention. Gupta and Chakrapani (2005) reported that the highest dam in Narmada basin namely Sardar Sarovar traps 60-80% of sediments carried by river before it reaches the Arabian Sea and as such corroborates our inference.

Sediment reaction was alkaline (pH 7.9 to 9.2) at all the sites and is indicative of congenial environment. Specific conductivity was high at estuarine sites and varied from 0.058 to 5.87 mS/cm for the downstream as a whole during the study period. Organic carbon content (0.03 to 1.43%) did not discern any particular trend of distribution except being recorded at comparatively high level at Sisodara site which is attributed to agricultural run-off with dislocation of organic mass. Total nitrogen (0.01-0.21%)

content was also high at Garudeswar site. Available phosphorus content varied in the range of 1.4-4.0 mg/100 g sediments contents exhibited by and large similar trend of distribution and their contents like the earlier study (CIFRI Exploratory Survey, 1999). Sediment texture was invariably sandy with 71-97% sand content.



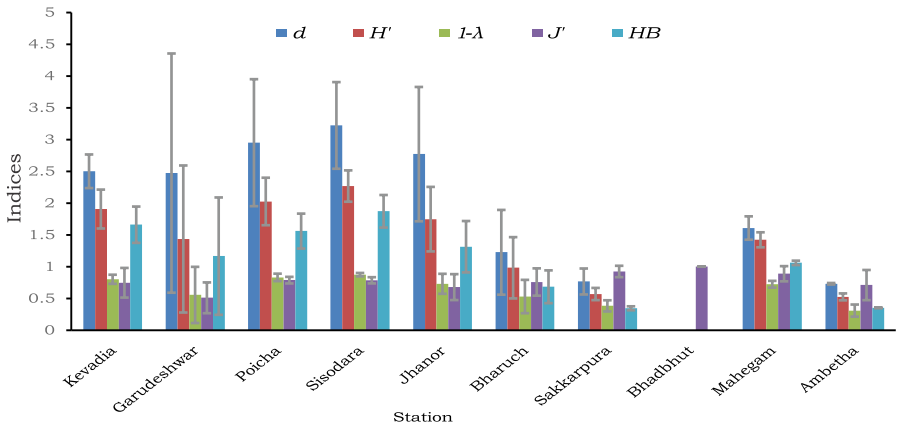
Biodiversity indices as a function of planktonic community at representative sites of river Narmada, downstream of Sardar Sarovar dam Margalef's species richness index (d), Pielou's evenness index (J'), Simpson's dominance index (1-λ) and Shannon-Weiner diversity index (H') and Brillouin index (HB)

Plankton and macro-benthic community

Study recorded spatio-temporal variations in total plankton abundance which varied from 198-2359 nos./l and 232-1426 nos./l in 1st and 2nd year of study, respectively. From qualitative texture perspective, phytoplankton (44.52 to 100%) excelled as the mainstay of this abundance while zooplankton (nil to 41.21%) had also sizable representation. In first year of study, diatoms or Bacillariophyceae were the preeminent component of phytoplankton assemblage in all seasons while Chlorophyceae was also significantly represented in summer and winter months. Zooplankton assemblage was shared by rotifers, copepods and cladocerans. Copepods were conspicuous and present at all eco-zones of the river stretch from freshwater expanse to the estuarine expanse, while rotifers were most conspicuous faunal components at freshwater expanse in 1st year. In second year, summer and winter seasons experienced by and large similar scenario but there was higher levels of chlorophyceae in monsoon season. The community is under transition stage as diatoms are emerging and their contribution in total plankton abundance has increased as compared to previous years which were dominated by the blue- green algae. This transition is of ecological significance and a reflection of changes in nutrient concentration, organic pollution and aquatic productivity.

Margalef's species richness index (d) indicated that the Garudeshwar site was the most species-rich site followed by Poicha in the freshwater zone but the richness variations were highest at Bhadbhut in the estuarine stretch. Shannon- Weiner index (H') ranged from 1.5 to 3.5, and reveals that all representative sites have a highly diverse species composition at all eco-zones of the river. Simpson's dominance index(1-) and Pielou's Evenness index (J') were used to delineate the abundance of each species contribution at the representative site. From this index, it was noted that the abundance of the species is evenly distributed at all representative sites along the entire stretch of river Narmada downstream of Sardar Sarovar Dam.

Macro-benthos abundance in the downstream varied from nil to 1638 nos./m^2 in 1st year and nil to 300 nos./m^2 in 2nd year. Summer and monsoon seasons contained higher macro-benthic crop. Molluscans and annelids shared bulk of benthic population while annelids, dipterans and crustaceans were scarcely represented. Summer season contained more diversified benthic crop as compared to monsoon and



Biodiversity indices as a function of macrobenthic community at representative sites of river Narmada downstream of Sardar Sarovar dam. Margalef's species richness index (d), Pielou's evenness index (J'), Simpson's dominance index (1-λ) and Shannon-Weiner diversity index (H') and Brillouin index (HB)

winter months. The benthic community is designated as mollusk type which is a deviation from earlier benthic community being molluscks-annelids and mollusk-dipteran. The benthic crop has also been observed less diverse as compared to earlier years which are indicative of gradually emerging stressed condition. Biodiversity indices, viz. Margalef's species richness index (d), Pielou's evenness index (J'), Simpson's dominance index (1-λ) and Shannon-Weiner diversity index (H') and Brillouin have been computed using PAST. The computed values of (H') for different seasons revealed that Bharuch, Shakkarpura and Bhadbhut and Ambetha sites are environmentally stressed due to freshwater crunch and the effluents inputs.

NEH Programme

Programme ; Refinement of management strategies for open water fisheries of north eastern region through location and ecosystem based approach

Programme coordinator : B. K. Das
Scientific personnel : B. K. Bhattacharya, S. yengokpam, A. K. Yadav, P. Das, S. Borah, SCS Das, T. N. Chanu, D. Debnath, N. S. Singh
Associates : B. C. Roy, A. Kakati

ICAR-CIFRI has made new initiatives in open-water fisheries development in the NE region of India in recent years under the NEH Component of ICAR. As part of the initiative the Institute organized a Regional Consultation on "Open Water Fisheries Development in NE Region" at Guwahati on 29 April 2017 to prepare a roadmap for open water fisheries development in the North Eastern Region. Forty delegates including Shri Parimal Suklabaidya, Hon'ble Minister of Fisheries, Govt. of Assam; Directors of Fisheries from Assam, Manipur and Mizoram participated in the Regional Consultation. In same year the Institute prepared the policy document "Roadmap for development of open water fisheries resources in North Eastern Region" which was released on 16 June 2017 on the occasion of stakeholders' consultation on "Formulation of National Inland Fisheries and Aquaculture Policy", organized by NFDB Regional Centre, Guwahati in collaboration with ICAR-CIFRI, and ICAR-CIFE at NIRD & PR, NERC, Guwahati.

The Institute has developed pen culture technology for floodplain wetlands of Assam and Manipur, locally called *Beels* and *Pats* respectively. It is a low-cost and medium input technology wherein cheap and locally available materials (such as bamboo and LDPE mosquito netting) are used for pen construction as well as for supplementary feeding (rice polish, mustard oil cake). The Institute has recently developed and commercialized CIFRI HDPE PEN for fast construction and longer durability. These have successfully being used in Takmu pat of Manipur and Borbila beel of Assam. The technology is also being demonstrated in the beels of eastern Arunachal Pradesh. The Institute also developed cage culture technology for floodplain wetlands of Assam for *in situ* raising of carp fingerlings as well as table fish production with thrust on indigenous fishes like *Labeo bata* and *L. gonius*. It started with cage made up of low-cost polyethylene net cages supported by a floating bamboo platform. The Institute has recently commercialized CIFRI-GI Cage with enhanced debility which has been successfully used for rearing minor carps (*Labeo bata* and *L. gonius*) in Samaguri beel, Assam and for Amur common carp and *L. gonius*. The Institute has also standardized parameters like size at stocking, species ratio and stocking density for fish stock enhancement in beels of Assam.

The present project aims at pilot-scale validation of CIFRI technologies in open-water bodies of NER and other work programmes under NEH Component of ICAR-CIFRI in collaboration with respective state fisheries departments and ICAR research Institutes/centres of the region. A proposal for rapid ecological characterization and fisheries of River Brahmaputra in Assam has also been submitted, considering its importance in open-water fisheries of NEH region. The main thrust of the programme lies on fisheries development in the open-waters of NEH region through empowerment of communities and stakeholder's participation, using high value indigenous fish species like *Osteobrama belangeri* as well as capacity building of all stakeholders (e.g., fishers, managers, fisheries officials, NGOs, prospective entrepreneurs). The project activities will continue for more than a year in many cases (e.g., fisheries of River Brahmaputra) depending on the technical programme,

response from the collaborators and the progress of the component even though initial budget estimates has been prepared for 2020-21.

Fish stock enhancement programme for livelihood improvement of tribal fishers in Bamuni beel, Bezera, Kamrup district (R), Assam

Bamuni beel is a seasonally open floodplain wetland in lower Brahmaputra valley connected to Madan Kuri, a small rivulet joining the River Puthimari (a north bank tributary of R. Brahmaputra). It is a small beel having 16-hectare water spread area. A total of 65 Bodo tribal households of Bamunigaon village under Bezera Development Block depend on the beel for meeting their nutritional and livelihood needs. Before 2006-07, the beel supported only capture fisheries and was annually leased to private parties at a paltry sum (Rs. 15,000-20,000/- p.m.). The beel was developed by ARIAS Society, Govt. of Assam during 2006-07 under the World Bank funded ARIAS project. Under the project, a periphery bundh was constructed around the beel for facilitating supplementary stocking for enhancing fish production. The bundh was further strengthened under the AACP project of ARIAS Society, Govt. of Assam during 2011-12. The local tribal community of Bamunigaon village formed the Bamunigaon Beel Development Committee (BBDC) for fisheries management of the beel during 2006-07. As the socio-economic condition of the beel user community is poor, the BBDC is only sporadically stocking the beel with fish seed, with no stocking done last year, reportedly for want of funds. As a result, the present estimated fish production is low (390 kg/ha/year approx.) and generate a modest annual income to the community (@ Rs 15,000.00 per household).

As part of the outreach activities, the Institute has stocked 48,000 fish fingerling (@3000 nos. per ha) comprising IMC, *Labeo bata*, grass carp and silver barb in October 2020 in consultation with the community. On the occasion, an awareness programme was also organized followed by fish seed stocking. The main objective of the programme was to create awareness among the fishers about fish stock enhancement programme in beels and improvement of livelihood of the tribal families. Mr. Bolin Boro, Secretary, BBDC explained about the present fisheries activities undertaken by the committee. He assured full cooperation from the members of the local community for successful implementation of the programme. Mr. Mohan Swargiary, President, BBDC expressed his gratefulness to ICAR-CIFRI for initiating the stocking programme which will definitely enhance income

Awareness-cum-fish stock enhancement programme in Bamuni beel, Assam

and livelihood of the tribal community.

Fish stock enhancement programme for livelihood improvement of tribal fishers of Saren beel, Baksa, Assam

Saren beel is a horse-shoe shaped closed floodplain wetland located in Mushalpur, Baksa district of Assam, with a water area of 13 ha and average water depth of 1-3 m. The beel is managed by Saren beel Min Palan Co-operative Society Ltd. A total of 9 villages comprising 503 households, belonging to Bodo community, are located at the periphery of the beel. As part of the outreach activities initiated by ICAR-CIFRI, a total of 39,000 advance fish fingerling (@ 3000 nos./ ha) comprising IMCs, *Labeo bata* and *L. Gonius* were stocked in Saren beel in consultation with the community. On the occasion, an awareness programme was organized on fish stock enhancement followed by supplementary seed stocking by the Institute in collaboration with Department of Fisheries, Baksa, Assam and Saren Beel Min Palan Co-operative Society Ltd. Mr. Sunil Boro, Member, Saren Beel Min Palan Co-operative Society Ltd. assured full cooperation from members of the local community towards successful implementation of the programme and expressed his sincere gratitude on behalf of fisher community of Saren beel to ICAR-CIFRI for initiative to improve income and livelihood of tribal fishers of the beel.

Fish stock enhancement programme for livelihood improvement of tribal fishers in Charan beel, Baksa, Assam

Charan beel is a horse-shoe shaped closed floodplain

Awareness-cum-fish stock enhancement programme in Saren beel, Baksa, Assam

wetland located in Deulkuchi, Baksa district, Assam, with water area of 11 ha and average water depth of 2-4 m. The beel is managed by Dhulabari Charanpar Janajati Unnayan Samiti with 25 active members. A total of 2 villages comprising 115 Bodo families are directly dependent on the beel for livelihood support. As part of the outreach activities initiated by ICAR-CIFRI, a total of 33,000 advance fish fingerling (@ 3000 nos./ ha) comprising IMCs, *Labeo bata* and *L. Gonius* were stocked in Charan beel in consultation with the community. On the occasion, an awareness programme was organized on fish stock enhancement, in collaboration with Department of Fisheries, Baksa, Assam and Dhulabari Charanpar Janajati Unnayan Samiti. The objective of the programme was to create awareness among fishers on importance of fish stock enhancement in beels and at the same time improving livelihood of tribal fishers through increased fish production and income. During interaction with fishers, scientists of ICAR-CIFRI explained the objective of the program along with different aspects of scientific beel fisheries management and the need for sustainable utilization of these valuable resources. Mr. Deepak Boro, President, Dhulabari Charanpar Janajati Unnayan Samiti, assured full cooperation from members of the local community towards successful implementation of the programme and expressed his sincere gratitude to the Director, ICAR-CIFRI for initiative to improve income and livelihood of tribal fishers of the beel.

Fish seed stocking in Charan beel

Cage culture of Pengba (*Osteobrama belangeri*) in Loktak Lake of Manipur

ICAR-CIFRI in collaboration with Department of Fisheries, Govt. of Manipur initiated an ambitious project of culturing *Osteobrama belangeri*, locally called 'pengba' in cages in Takmu pat, Sendra in Bishnupur district of Manipur. Pengba is the State Fish of Manipur with socioeconomic significance. The fish is highly relished and has a ready demand in the market due to its better taste and meat quality. Therefore, the fish is one of the most potential fish species for culture in open waters. Scientists of ICAR-CIFRI envisage that the cage culture of the high-value locally-demanded Pengba in Loktak lake of Manipur would be profitable and ensure year-round availability of the valued fish during local festivities.

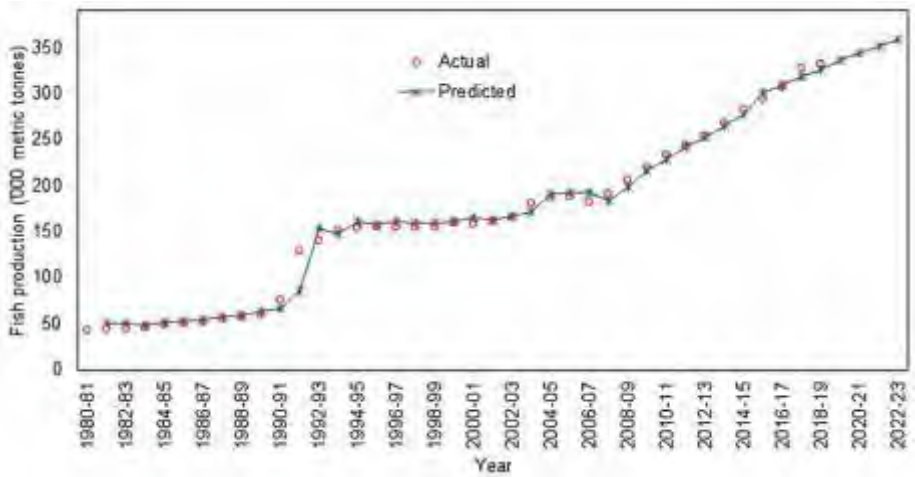
The present experiment of culturing Pengba as table-fish in cages in Takmu pat, Sendra, Bishnupur district, Manipur was initiated by ICAR-CIFRI under NEH Component. A total of 15,000 fingerlings of *O. belangeri* were stocked by Guwahati centre of ICAR-CIFRI in cages at different stocking densities. The water and sediment qualities were assessed for sustainable production of *O. Belangeri* in cages. Regular feeding was done by the fishers of the society. Initiation of the experiment was possible with active support from Shri N. Gojendro, MCS, Director of

Stocking of *Osteobrama belangeri* (pengba) fingerlings (15,000 no.) in cages in Takmu pat (part of Loktak lake), Manipur during Dec. 19-20, 2020

Fisheries; Shri T. Shyamananda Singh, DFDO, Bishnupur District; Shri N. Hemchandra, FO and other officials of Department of Fisheries, Govt. of Manipur.

Modelling and forecasting of fish production in Assam

Fish is an essential component of diet of most populace in Assam and fish farming has been one of the sources of livelihood in rural areas. Assam ranks first in fish production among the north-eastern states of India. The state has vast and varied resources under fisheries of around 2.86 lakh hectares (excluding river fisheries). Fishery sector provides direct employment in the producing units (primary level) and indirect employment through its ancillaries and associated activities (value chain). The total fish production in the state was 3.31 lakh metric tonnes (MT) during 2018-19 against the estimated nutritional demand of 3.43 lakh MT. A proper trend analysis and forecast of fish production is of immense value in an economic system. An unexpected decline or surplus in production can lead to a sharp increase or decrease in prices and has significant social implications as well, as it affects family and community life of farmers. Impact on price of an essential commodity has a significant role in determining various economic phenomena. The proper forecast would pave way for policy makers in



Fish production ('000 MT) in Assam during 1980-81 to 208-19 along with fitted values and forecasts for the ARIMA model

Parameter estimates of the fitted ARIMA (1,1,0) model

Parameter	Estimates	Standard Error	t-value
AR lag1 (φ1)	0.346	0.118	2.16 **
Constant	7.079	2.497	2.83

formulating appropriate policy measures and ensure profit for the fish farmers. The present study was carried out for modelling and forecasting fish production in Assam using Autoregressive integrated moving average (ARIMA) methodology. Augmented Dickey-Fuller test has been used for testing the stationarity of the series. Autocorrelation (ACF) and partial autocorrelation (PACF) functions have been estimated, which have led to the identification and construction of ARIMA models suitable in explaining the time series and forecasting the future fish production of Assam. Out of total 38 data points (1980-81 to 2018-19), first 34 data points, i.e., data from 1980-81 to 2014-15 were used for developing the model. The developed model was validated with the actual fish production for the remaining 4 data points (i.e., data from 2015-16 to 2018-19). On the basis of AIC and BIC values, the best model was found out as ARIMA(1,1,0). The mean absolute error (MAE), mean absolute prediction error (MAPE) and root mean square error (RMSE) values for fitted model were computed as 6.365, 2.021 and 6.816, respectively. The residuals of the fitted models were used for the diagnostic checking. The fitted model was used for out-of-sample forecast values of fish production in Assam for the period 2019-20 to 2022-23. The actual fish production and forecast values using fitted model were in close agreement. The out-of-sample forecast values of fish production in the state for the subsequent years 2019-20 to 2022-23 showed an increasing trend from 336.97 to 358.21 thousand metric tonnes.

Signing of MoU between ICAR-CIFRI and AFDC

Field station of ICAR-CIFRI RC, Guwahati at Amino gaon, Guwahati

ICAR-CIFRIand Assam Fisheries Development Corporation (AFDC) Ltd., Guwahati signed a MoU on 06.11.2020 for transfer of 2 hectares land by AFDC to ICAR-CIFRI on 99 years lease at a nominal one-time lease value of Rs. 99,000 (Rupees ninety-nine thousand only) to set-up a field station of ICAR-CIFRI at the periphery of Ghorajan beel, Amin goan, Sila Sendurighopa, Mouza, North Guwahati Revenue circle, Kamrup (R) district, Assam.

Scheduled Tribe Component (STC) Programme

As per the 2011 census, India has 104 million tribal populations which constitute about 8.6 % of the total population. This population comprises about 427 tribal communities. The tribal population is highly diversified in terms of their socio-cultural traditions. Geographically also, they are living in close boundaries at distant places, in remote, hilly and forest areas and still far from modern technological reach. The common issues and challenges related to the development of tribal groups are:

- Reaching the unreached is the greatest challenge in case of socio-economic upliftment of the tribal populace
- They speak tribal dialect
- They follow primitive occupations such as gleaning, hunting, and gathering of farm products
- They have nomadic habits and a love for alcohol and dance

However, during the last seven decades, various developmental activities in tribal areas have impacted their social and economic life. ICAR-CIFRI has taken several initiatives in this direction under Tribal SubPlan since 2012-13. ICAR-CIFRI's initiatives in 2020 for upscaling the tribal populace are as follows:

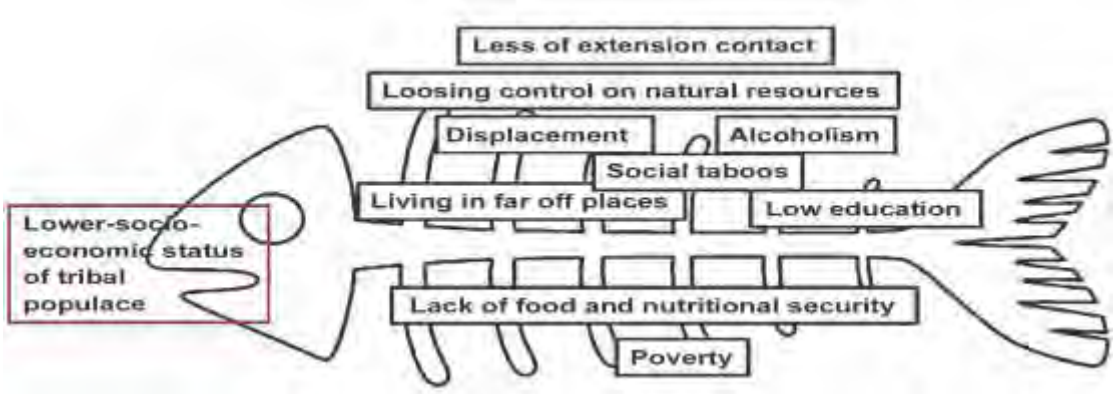
STC Programmes in West Bengal

Severe cyclonic storm Bulbul and ICAR-CIFRI initiatives under Tribal Sub Plan

On 9 November 2019 a severe cyclonic storm Bulbul caused severe storm surges, heavy rains, and flash floods in West Bengal. Bulbul made landfall near the Sagar Island, Sundarbans causing extensive damage. Two of CIFRI's STC adopted areas, viz., Sagar and Gosaba Islands of South 24 Parganas were highly affected by this cyclonic storm. The STC team of ICAR-CIFRI visited the affected areas in December 2019 and January 2020.

The team members advised the beneficiaries to immediately clean up the ponds by removal of all the fallen trees/ tree parts from the ponds and removing the bottom organic matter as much as possible. Team also recommended lime application in proper doses according to their pond size and demonstrated the procedure of lime application. The quantity of daily feeding to the fishes according to the stocking density into the pond was also recommended by the team to the beneficiaries.

Lime was distributed to the beneficiaries of Sagar Island (total 800 kg) and Goshaba Island (1000 kg). Fish feed was also distributed among the beneficiaries of Sagar Island (10 tonnes). On 12 February 2020, a total of 450 kg of IMC fingerlings were distributed among the beneficiaries of Sagar Island for restocking in their ponds. On 20 March 2020 total of 125 kg of IMC fingerlings were distributed among the beneficiaries of the Goshaba Island.



Fishbone diagram of the issues-challenges pertaining to their socio-economic backwardness

Inputs distribution in Sundarbans in post-Bulbul period

Beneficiaries	Inputs Distributed
Khasramkar Village (20 beneficiaries), Sagar Island	Fish feed-3 tonnes Fish seed-112 kg Lime-200 kg
Mansadwip Village (30 beneficiaries), Sagar Island	Fish feed-3.5 tonnes Fish seed-169 kg Lime-300 kg
Ganga Sagar Village (30 beneficiaries), Sagar Island	Fish feed-3.5 tonnes Fish seed-169 kg Lime-300 kg
Rangabelia Village (50 beneficiaries), Gosaba	Fish seed-125 kg Lime-1000 kg

Post-Amphan support extended in Sundarbans

The super cyclone "Amphan" made its landfall between Sagar Island, Sundarbans, and Kakdwip, West Bengal on 20 May 2020. The monstrous cyclone unleashed high-speed winds, heavy rainfall, and a storm surge. It ravaged the Sundarbans and wreaked tenfold devastation than "Aila" did. Besides these, saltwater entered into several fish ponds and agricultural fields due to high tidal waves during Amphan causing a huge loss of fisheries and crops in the area. Moreover, lockdown due to the COVID-19 pandemic had worsened the situation severely impacting fishers/fish farmers' income and livelihood. To stand by the affected ST community of the remote villages of Sundarbans ICAR-CIFRI took initiatives for socio-economic protection and upliftment of the rural tribal populace of Sundarbans.

Kultali, Basanti in South 24 Parganas district

Basanti Block of South 24-Parganas district has a total population of 336,717 as per the Census 2011, out of which 35% belongs to Scheduled Caste and 6% belongs to Scheduled Tribe population. To support the livelihoods of the populace of marginalized

Support of ICAR-CIFRI in Amphan affected Sundarbans

Fish seed stocking in water bodies of tribal fishers

community ICAR-CIFRI held hands with Kultali Milan Tirtha, a non-profit organization to reach the unreached of Kultali, Basanti. The Institute distributed 5000 kg lime, 2.5 tonnes fish feed, and 900 kg fish seed to 256 fishers families (SC-196 and ST-60) residing at Kultali, Basanti, Sundarban, West Bengal on 17 August 2020.

Empowering rural women of Kulatali, Basanti

In the post-Amphan period, ICAR-CIFRI took initiatives to help the rural scheduled caste and tribal fisher folk of this block. The Institute imparted off-campus training and demonstrations for establishing home-based ornamental fish culture units to empower the rural womenfolk. The Institute distributed ornamental fish, rearing tanks, blowers, and other accessories, thermostats, fish feeds, medicines among 20 tribal women fishers for setting up ornamental fish culture units in their own houses. After setting up the units CIFRI also monitored their fish culture practice regularly, giving them inputs and clearing their doubts. The women are now able to rear the fish and breed them in their units.

Deltaic Sundarbans : Gosaba Island and Sagar Island

ICAR-CIFRI extended the advisory and fisheries inputs to support the Amphan affected 159 beneficiaries of Gosaba and Sagar Islands, Sundarbans. Due to the COVID-19 pandemic and lock-down situation all the advisory support was given over the telephone. About 1000 kg of lime, 3 tonnes fish feed, and 150 kg seed were distributed among 59 STC beneficiaries of Rangabelia, Gosaba, Sundarban on 2 November 2020; 380 kg fish seed was distributed to 98 tribal fishers along with 1600 kg lime and 5 tonnes fish feed on 16 September 2020 in Sagar Island.

Distribution of submersible pump set at Gosaba

Saltwater ingress is a common problem of deltaic Sundarbans. Amphan triggered heavy tidal waves from coastal rivers and saltwater inundated ponds and other water bodies killing freshwater fish like rohu, catla, and mrigal. To support the tribal fishermen community in their fish farming, ICAR-CIFRI distributed one submersible pump set to the fishermen of Rangabelia, Gosaba, Sundarban belonging to the tribal community on 13 October 2020. This pump set is shared among 120 fisher families living in the locality.

Cast net distribution in Sagar Island

The devastation of Amphan was so intense at Sagar Island that many areas remained inaccessible 48 hours after the cyclone. To support the livelihoods of the tribal fishers 35 cast nets were distributed to the tribal fishermen of Sagar Island through Krishnanagar Swami Vivekanda Youth Cultural Society, Sagar.

STC activities at Birbhum, West Bengal

Palotghat, Kakdwip

About 450 kg of fish seed and 3000 kg of lime were distributed to the 146 ST beneficiaries of Kakdwip block on 07 December 2020 under the Tribal Sub-Plan to support their livelihoods.

Fisheries input distribution to tribal fishers of Purulia District, West Bengal

As per the 2011 census, the total population of the Purulia district is 29,30,115 and Scheduled Caste and Scheduled Tribes constitute 19.38% and 18.45% of the total population, respectively. ICAR-CIFRI has been involved relentlessly in supporting the livelihood and improving the socio-economic status of the fishing community, particularly, belonging to the SC and ST communities of different areas. With this objective, inputs for inland fisheries management such as fish seed and feed were distributed to tribal fishers of Purulia district for stocking in pens and check dam at Pachagora, Purulia, West Bengal. Around 12500 nos. of fish fingerlings and 4000 kg of fish feed were distributed to 30 tribal fishers of the area on 12 October 2020.

Fisheries input distribution to tribal fishers of Birbhum District, West Bengal

Bolpur Sriniketan Block has an area of 334.58 sq. km. As per the 2011 Census of India, Bolpur Sriniketan Block has a total population of 202,553, out of which Scheduled Castes numbered 61,960 (30.59%) and Scheduled Tribes numbered 38,615 (19.06%), the highest amongst all Community Development Blocks in the district. To support the livelihoods of the fishermen community belonging to the scheduled tribe, ICAR-CIFRI arranged a sensitization programme for making them aware of various schemes and projects related to fish farming and distributed the important input for fish farming to the ST under STC on 5 November 2020. On this day, 560 kg of fish seeds, 8000 kg fish feed, and 6000 kg lime have been distributed to 72 tribal fishermen.

STC programmes in Odisha

Inland ornamental fishery to empower tribal women of Mayurbhanj District

Fish seed, fish feed, and medicines were distributed to tribal women fishers of Nalagaja and Badasahi villages of Mayurbhanj district, Odisha on 29 September 2020. ICAR-CIFRI programme on ornamental

Average size of the reared fish at stocking and final harvest

Species	Average length (cm)		Average weight (gm)	
	Initial	Final	Initial	Final
L. gonius	12.01	19.58	18.31	93.05
Amur carp	11.09	25.89	20.40	339.48
Koi carp	10.88	22.88	19.80	258.40

STC activities in Odisha

fish culture has helped 40 nos. of women fishers of Mayurbhanj to culture ornamental fish in their backyard in FRP tanks and to improve their livelihood.

Initiative to empower tribal women of Chunakoli, Khurda District

ICAR-CIFRI distributed 15 FRP tanks and 15 ornamental kits to 15 tribal women of Chunakoli village, Khurda. The initiative was taken to provide an alternative livelihood opportunity to the tribal women so that they can be economically empowered.

Demonstration of pen culture in Balasore District

ICAR-CIFRI demonstrated CIFRI HDPE Pen culture technology in Rishia reservoir situated in Balasore, Odisha for in situ advance fingerling production and stocking in the reservoir. Sri Pratap Chandra Sarangi, Honorable Minister of States for Animal Husbandry, Dairying and Fisheries visited the ICAR-CIFR Pen demonstration site at Rishia reservoir, Balasore on 30 September 2020. The area of the reservoir is 300 ha and the total number of tribal beneficiaries is 150 who are involved in active fishing from the reservoir. ICAR-CIFRI has recommended to stock more than 80-100 mm size of fish seed for higher production from the reservoir. Due to the higher cost of bigger size fish seeds and the unavailability of a large quantity of them in the market, the fishers stock small size fish seeds in the reservoir. For this reason, ICAR-CIFRI has developed a low-cost in situ fish seed production technology through CIFRI HDPE Pen for reservoirs and wetlands. Two pens of 0.1 ha each have been installed in the reservoir and 32,000 fish seed were released in the pens under STC.

Four ICAR-CIFRI pens were demonstrated in Jalaswar wetland in Paikasidha and Keshapura villages in Odisha. The demonstration will help to increase the livelihoods of more than 300 tribal families.

Culture-based fisheries

ICAR-CIFRI released 40,000 fish seed in Sunei dam of Mayurbhanj district of Odisha for culture-based capture fishery benefitting 157 fishers of the reservoir.

Off-campus training

An off-campus training program was organized by ICAR-CIFRI at Kuliana, Bhadrak, on a request from Swami Ashvayananda of RKM, Kuliana for livelihood improvement of 50 tribal (ST) during 25-27 February 2020 at the Ashram venue, Bhadrak. An exhibition was also organized for mobilizing the rural youth and women during the youth festival.

STC programme in Northeast Region

Demonstration of cage culture in Umiam reservoir

The idea of initiating cage

culture in Umiam reservoir, Meghalaya as an option for providing livelihood support to the tribal fishers was mooted by Dr. J. K. Jena, Deputy Director General (Fisheries Science), ICAR while participating in a Ranching-cum-fish fingerling distribution programme organized by the Fisheries Division of ICAR Research Complex for NEH Region, Umiam. ICAR- CIFRI took the initiative and provided a battery of six CIFRI GI Cages and required quantities of CIFRI CageGrow fish feed for demonstration of cage culture in the reservoir with participation of the local fisher community (55 nos.) under the Tribal Sub-Plan programme. Under the collaborative programme, the technical back-stopping for cage culture was provided by the ICAR-CIFRI RC, Guwahati whereas the Fisheries Division of ICAR-RC NEHR provided the fish seed and looked after the day-to-day monitoring and management with the community support.

A battery of six CIFRI GI cages with an area of 100 m^3 per cage (6m x 4m x 4m per cage) was installed in Umiam reservoir. The total areas of the cages are 600 m^3 with an effective water area of 540 m^3 (90 m^3/cage). Fingerlings of gonius (avg. 12.01 cm, 18.31 g), Amur carp (avg. 11.09 cm, 20.4 g) and koi carp (avg. 10.88 cm, 19.8 g) were stocked on 24 September 2019. After five months of rearing, the maximum individual weight of gonius, Amur carp, and koi carp were recorded as 217 g, 660 g, and 665 g, respectively. The average growth of gonius, Amur carp, and koi carp were recorded as 93.05 g (19.58 cm), 339.48 g (22.89 cm) and 258.40 g (22.88cm), respectively. The highest survival was observed in case of Amur carp (80%), followed by koi carp and gonius. No disease incidence was reported during the culture period. The Amur common carp was found to be the most suitable for cage culture in the Umiam reservoir in terms of survival and growth.

The final harvests of the cages directly benefited the 50 fishers families of the Ri-Bhoi Farmers' Union. The

Cage culture in Umiam reservoir, Meghalaya

Distribution of CIFRI-CAGEGROW feed to the tribal fishers of Assam

community also deposited a part of the income generated through the sale of fish in the bank account of the society "Umniuh Khwan welfare fund" at the State bank of India, Umiam for sustaining the activity. Seeing the success of the experiment, the participating fishers are eager to continue the cage culture of fish with technical support from ICAR-CIFRI and ICAR, Umiam.

Demonstration of CIFRI-CAGEGROW feed in derelict waters of Assam

A fish feed distribution programme under 'Demonstration of CIFRI-CAGEGROW feed in derelict water bodies of Goalpara district, Assam' was organized under STC programme of ICAR-CIFRI at Chhatomatia village, Krishnai and Kuchdhowa development block, Goalpara district, Assam in collaboration with O/o. DFDO, Goalpara district, Assam on 19 September 2020. A total of 120 bags (35 kg/bag) of CIFRI CAGEGROW were distributed among tribal fishers Goalpara district. A total of 40 tribal fisher families benefited from the programme.

STC programme in Uttar Pradesh

ICAR-CIFRI conducted an awareness program entitled "Importance of small indigenous fishes for livelihood improvement" at Baghala Bandh situated in the Bundelkhand region on 27 February 2020. More than 40 tribal fishermen participated in the program. During the programme, fishermen were made aware about importance of SIF in nutrition and livelihood and also fisheries management in wetland for productivity enhancement. Mr. Mansa Lal, former pradhan of the village apprised farmers regarding work of CIFRI under STC and requested all to take benefits. The fishermen actively interacted with scientists and promised to make use of SIF for nutrition.

Awareness programme in Gujrat

An awareness programme on "Reservoir fisheries: Scope and opportunities for livelihood and nutritional security" was organized for tribal fishermen of Narmada district at Dr. Ambedkar Bhavan Hall, Rajpipla on 25 January 2020. Eighty-five tribal fishermen attended the programme. Fishermen from village Movi and Boridra have a fishermen cooperative society and the society members are mainly involved in fishing from the reservoir for livelihood.

Pen culture in Vazhani reservoir, Kerela

CIFRI HDPE pens (3 nos.) were installed in Vazhani reservoir under STC programme activity titled 'Demonstration of pen culture of *Etroplus suratensis*'. The activity aimed to build the capacity of tribal fishermen to rear pearl spot seeds using pens, which can be later stocked in the reservoir and would ultimately help to enhance the fishery in the reservoir and improve the livelihood of the tribal fishermen.

STC programme in Uttar Pradesh

The main objective of Scheduled Caste SubPlan is to give a thrust to family oriented schemes of economic development of SCs below the poverty line, by providing resources for filling the critical gaps and for providing missing vital inputs for their livelihood improvement. ICAR-CIFRI is implementing SCSP schemes to empower SC population through the input of fisheries and also imparting knowledge of fisheries technology.

Wetland fisheries enhancement through pen culture and culture-based fisheries

SCSP programme was carried out to improve the socio-economic status of the SC community through the development of inland open water fisheries. Culture-based fisheries for sustainable wetland management and pen culture technologies were successfully demonstrated in five wetlands from West Bengal, namely, Chamordaha, Beledanga, Kumli, Panchita and Chamta beel from West Bengal, and Kespura-Paikasida wetland of Odisha. IMC (catla, rohu and mrigal) and grass carp fish seed were raised in HDEP pen installed in the wetlands for advanced fingerling production which were then stocked in the wetlands for culture based fisheries for the enhancement of fish production. Apart from the stocking of fish through seed raising in pen, fish fingerlings were also provided separately to complement the deficiency of fish seed required to attain the fish yield potential of the six wetlands. Apart from these 6 wetlands, 7 more wetlands of West Bengal were adopted this year for pen culture and culture based fisheries. In all the 7 wetlands pen culture demonstration has been initiated by providing the CIFRI HDPE pen, fish seed, coracle and CIFRI feed.

Few of the pen structures were destroyed during Amphan cyclone in the selected wetlands. New pen, fish seed, feed and fishing boat and other supports were given in the midst of COVID-19 pandemic situation as a post Amphan cyclone support to the fishermen of the wetlands of West Bengal.

Reservoir fisheries production enhancement

ICAR-CIFRI's initiatives in Salia dam, Odisha

ICAR-CIFRI successfully demonstrated the cage culture technology and provided technical inputs to the fishers of Salia dam, Odisha under SCSP programme. Under the species diversification, grow out farming of fish species *viz Puntius sarana*, *Barbonymous gonionotus*, *Labeo rohita* (Jayanti rohu strain) and *Pangasianodon hypophthalmus* were successfully demonstrated in cages. Two CIFRI HDPE Pen nurseries were installed at Salia dam and around 60,000 advance fingerling of IMC were raised in the pen as a stocking material for the reservoir. 1. 5 lakhs of fry was also reared in

Pen culture at Salia dam

Awareness and stocking program at Baghua reservoir

earthen captive nursery for producing advance fingerlings for doubling fish production from the reservoir. In the period of pandemic COVID-19 around 75,000 advanced fingerlings of IMC of more than 30g size were stocked in Salia dam in two phases during May-June 2020 with aim to increase fishers' income in post COVID-19 era. ICAR-CIFRI conducted mass awareness program among the fishermen under SCSP program. Primary fishermen cooperative society (PFCS) members were trained on-field and at ICAR-CIFRI Barrackpore on reservoir fisheries management and enclosure culture.

Stocking in Baghua reservoir with advance fingerling

One lakh and fifty thousand fingerlings of IMC were stocked in pen for raising of stocking material for reservoir. Different fisheries implements like HDPE pen, fish seed, floating fish feed and mechanized FRP boat were distributed to the Primary Fishermen Cooperative Society of Baghua reservoir aiming the production enhancement of the reservoir.

Women empowerment through ornamental fisheries

Ornamental fish culture was demonstrated for livelihood improvement of the fishers of the SC community of Amatali and Kochukali of Sundarbans, West Bengal. Seventy (70) ornamental culture kit and FRP tanks were distributed in the two villages. Another two ornamental fish clusters were developed this year in West Bengal. Twenty five numbers of ornamental culture kit and FRP tanks were provided to the fishers of Khalsi wetland and 35 ornamental culture kit and FRP tanks were provided to the fishers of Kultali, West Bengal. During Amphan cyclone few ornamental kits were destroyed, so new implements were provided to those beneficiaries.

ICAR-CIFRI established an ornamental fish culture cluster at Kulana, Bhadrak, Odisha for SC women to empower them and to make them self-employed by providing alternative source of income under SCSP programme. Twenty five FRP tanks of 350 litre capacity along with all accessories like ornamental fish, plants, medicines, heaters, air blowers and pipes distributed among the SC women. Seven days of field training-cum-demonstration on 'Ornamental fish culture' was conducted at Ramkrishna Sevashram campus, Bhadrak to strengthen the theoretical and practical skill of women on ornamental fish breeding and culture.

Fish production enhancement from rainfed backyard ponds

Fish production enhancements from individual ponds were also

Input supply and training on ornamental fish culture at Ramkrishna Sevashram, Bhadrak

targeted this year under SCSP. The fish farmers were sensitized and provided with fish farming inputs. In Kulutali area of Sunderban, 196 fishers were provided with fish seed, lime and fish feed for their livelihoods improvement. In Santiniketan, Birbhum district of West Bengal, 77 SC families were provided with the inputs like fish seed, fish feed and lime for fish culture in their individual ponds. Sagar island was most affected in Cyclone "Amphan". for the livelihood improvement of the fish farmers. Sensitization for the necessary steps for fish production enhancement was carried out and 250 SC beneficiaries were provided with fish seed, feed and lime.

Prayagraj Regional centre of the Institute organized fish farming related input distribution programme for SC community under SCSP. In this program, 625 kg rice bran, 625 kg mustard oil cake, 250 kg lime, 25 kg mineral vitamin mixture, 25 numbers of gill net and 25 numbers of hand-net were distributed to 25 fish farmers. Due to Covid 19, programme was conducted in three phase (on 02.10.2020, 06.10.2020 and 08.10.2020) and input were distributed either by calling them to institute or at their door steps. Total 25 farmers from Naraina, Karchhana, Handiya, Dubawal villages were benefitted through this programme. Input related to fish farming like 25 kg rice bran, 25 kg mustard oil cake, 1 kg mineral vitamin mixture, 10 kg lime, one gill net and one hand net were distributed to each farmer to support the fish farmers in this pandemic situation.

Capacity building of fishers

Mass awareness on inland fisheries development and fisheries implements distribution cum awareness programmes were conducted for fishers of West Bengal (8 programmes), Odisha (6) and Utter Pradesh (1) and Karnataka (1).

Training programmes on wetland and reservoir fisheries management for the fishers of Salia reservoir, Bagua reservoir and Keshpura-Paikasida wetland of Odisha were conducted at ICAR-CIFRI to improve the management skills on reservoir and wetland fisheries management. Training on ornamental fish culture was conducted at ICAR-CIFRI for the SC fishers of Amtali and Kochukhali, Sunderbans as an alternate livelihood options. On site hands on trainings on ornamental fish culture were conducted at Sunderbans for the SC community of Amtali, Kochukhali, Kulutali, Khasi wetland, and Bhadrak.

Capacity building and senzsitization programme of fisher communities

Scheduled Caste Sub-Plan (SCSP) programme was organized by the Bengaluru Regional Centre on 11 September 2020. Fifty Scheduled Caste fishers from Yallamma Thaayi Meenugaarara Sahakara Sangha, Vaderahalli Village, Thataguni post, Bangalore South Taluk participated in the programme . Fish feed, mask, sanitizers and other disinfectants were distributed to the participants . They were also educated on the importance of physical distancing, use of mask, sanitization & self-hygiene to stay safe during COVID - 19 pandemic.

Garra annandalei Hora, 1921, commonly known as Annandale garra or Tunga garra, under the family Cyprinidae was a new record with new distributional ranges from the middle stretch of river Tapti (Savkheda area, 21.29824499 N, 73.03300358 E). A total of 5 specimens were collected in January 2020 by gill net (10-20 mm mesh size) at a water depth of 1-4 ft. This species was so far reported only from the eastern side of India. The present findings extend its range of distribution in the rivers of the west coast of India.

Garra annandalei

A new exotic fish, trimac cichlid/three spot cichlid, *Amphilophus trimaculatus* (Günther 1867) (Teleostei: Cichliformes: Cichlidae) from the Cauvery River near Bhavani town in Tamil Nadu, India was recorded. The fish, previously known as *Cichlasoma trimaculatum*, is native to Central America (Mexico, El Salvador and Guatemala) and is prevalent in ornamental trade and might have found its way to natural waters through escape or aquarium dumping. Establishment of this fish in the river may impact the local biota negatively.

Amphilophustri maculatus

New Initiatives

Age determination of wetlands using radiotracer techniques

Sustainable management of inland open water resources is one of the major mandates of the Institute. As part of the programme on wetlands ecology in the perspective of changing climate scenario, we have planned to work on determining the age of different wetlands of the country using radiotracer technique. To work on this aspect a joint collaboration has been agreed upon with the ICAR-Indian Institute of Soil Water Conservation (IISWC), Dehradun, Uttarakhand wherein ICAR-IISWC will act as the knowledge partner and also provide technical assistance.

Endocrine disrupting chemicals in the aquatic environment and their effect on fish

A heterogeneous groups of compounds have been identified and detected in inland aquatic environments as potential endocrine disrupting chemicals (EDC). Occurrence of EDCs in the ecosystem is harmful as they accumulate in the food chain and also affect commercially important fish species by interfering with their reproduction, immunity and growth leading to stock depletion and ultimately economic loss. To address this issue, a multi-centric DBT sponsored project on 'Assessment of endocrine disruption in fish reproduction' has been initiated with the main objective of targeted studies of some known EDCs on the reproduction of commercially important fish species and development of biomarkers.

Sustainable management of fisheries resources of Pong reservoir under Indo-German collaboration

A new dimension was initiated by ICAR-Central Inland Fisheries Research Institute (CIFRI) in collaboration with a German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for the development of a sustainable fisheries management strategies of a Ramsar site, Pong reservoir, Himachal Pradesh. Holistic approach was adopted for the development of the fisheries management strategy of Pong reservoir by integrating the relationship of the fisheries resources with the ecological status, climatic variables, water birds use and tourism. Stakeholder perception was also taken into consideration for the development of the management strategy.

Restoration of fishery of river Ganga – a new initiative

As a continuation of tireless effort of ICAR-CIFRI for improvement of fish and fisheries of River Ganga, ICAR-CIFRI has recently initiated a new project on River Ganga, sponsored by NMCG, for enhancing fish stock of selected fish species of river Ganga. Restoration attempt of IMC and Hilsa through river ranching has evoked enough enthusiasm among the fishers and other stake holders involved with river Ganga. Awareness programmes conducted on sustainable fisheries created a beneficial impact on riverine fisheries development. In the first phase of NMCG-CIFRI project (2016-20) the Institute conducted 45 ranching-cum-mass awareness programmes and released more than 35 Lakhs of fish seed in river Ganga to conserve and restoration of IMC & Mahseer fishery in the river. The ranching programs were conducted with active participation of the riverine fishers. However, continuous efforts are essential to extend the present impetus for futuristic development. Hence, more emphasis is given on seed production using riverine germplasm, river ranching, awareness among fishers especially on sustainable fishery in different states like Bihar, Uttar Pradesh and Uttarakhand. Besides, the present project will also aim in identifying riverine stretch/wetland important for sustainable fisheries.

Captive breeding of Hilsa, *Tenualosa ilisha* - Phase II

ICAR-CIFRI has recently been entrusted to lead the ICAR-NASF funded 3-years project on "Captive breeding of Hilsa, *Tenualosa ilisha*-Phase II", with three collaborative partners *viz.*, ICAR-CIFA, ICAR-CIBA and ICAR-CIFE. The project is a follow-up of the project on aquaculture of Hilsa entitled "Stock characterization, captive breeding, seed production and culture of hilsa, (*Tenualosa ilisha*)" lead by ICAR-CIFRI with ICAR-CIFE, ICAR-CIFA, ICAR-CIBA, ICAR-NBFGR, ICAR-CMFRI, and Visva-Bharati University as partners which was operated during 2012-17. Incomplete tasks regarding Hilsa aquaculture i.e. captive maturation is the prime target of the present project. With the study of maturation of brooders in captivity, fine tuning of other components of Hilsa aquaculture will also be performed. Major objectives of the project are development of captive broodstock through nutritional and environmental manipulations, development of hormonal formulation and its delivery system for captive maturation and spawning, and development and refinement of larval rearing technology. The project cost is approximately 5 crores.

Women empowerment through ecosystem based integrated wetland management

Women are actively involved in agriculture, especially in inland fisheries activities in India and SE Asia. As such, fisheries, integrated with other agricultural activities can be an effective way of their empowerment. The DBT-funded project "Introducinge cosystem based integrated wetland management in Lower Gangetic plains of West Bengal: A tool to empower women of fishermen community (Empowering women of wetland-dependent fisherfolk community of Lower Gangetic plain through cost effective technologies) has been initiated by ICAR-CIFRI, in collaboration with Bidhan Chandra Krishi Viswavidyalaya, Kalyani. The components under this project are fisheries through enclosure culture, backyard poultry farming, mushroom cultivation and kitchen gardening. The major goal is to create alternate livelihood opportunities and ensuring nutritional security for women by using technologies that are easily adaptable by rural women. Training and required inputs would be provided to the women beneficiaries during the course of project.

Hilsa fisheries improvement in middle stretch of river Ganga - Phase II

Based on the outputs from the Phase I of the Hilsa improvement programme in river Ganga, NMCG has extended to carry out the activities for improving the Hilsa fisheries in the middle stretch particularly from the Prayagraj to Farakka in the river Ganga during 2020-2023. The major objectives of the project include, i) ranching of 30,000 Hilsa adults/brooders in the upstream of Farakka, which will establish its population in the upper stretches of river Ganga (above Farakka) for self recruitment, ii) creating mass Hilsa conservation awareness with wider participation among the fishermen, Ganga Prahari and state fisheries Departments of West Bengal, Jharkhand, Bihar and U.P., iii) establishing current Hilsa migration across the Farakka barrage through Floy tagging and advanced techniques (e-taggs and sensor based). During first quarter of the project, 5,082 Hilsa adult of average weight of 205 gm have been ranched at the upstream of the Farakka Barrage, West Bengal. The Institute has taken-up initiatives towards Hilsa Fisheries re-establishment in the middle stretches of the river Ganga for livelihood improvement of the fishermen.

State-wise and resource-wise reach of ICAR - CIFRI

State	Resource	Activities
Assam	River	• Assessment of input cost and farm gate prices in fresh and brackish water aquaculture in Bramhaputra
	Wetland	• Vulnerability study in 20 floodplain wetlands (beels) of Dhubri, Morigaon and Kamrup districts • Fisheries development of Borkona beel • Fish stock enhancement in Bamuni, Charan and Saren beels • Cage culture in Samaguri beel • Pen culture demonstration in Borbila and Borkona beels • Assessment of input cost and farm gate prices in fresh and brackish water aquaculture • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Aquaculture farms	• Assessment of input cost and farm gate prices in fresh water aquaculture • Demonstration of CIFRI-CAGEGROW feed in derelict water bodies of Goalpara district
Arunachal Pradesh	River	• Study of ecology and fisheries of river Siang
	Wetland	• Assessment of ecology, fisheries potential and socio-economics in Borbeel, Namsai district. • Pen aquaculture in Borbeel
Andhra Pradesh	Aquaculture farms	• Assessment of input cost and farm gate prices in fresh and brackish water aquaculture
Bihar	Wetland	• Fisheries development in Rulhi, Majharia, Kararia, Sirsa, and Kothia mauns • Assessment of impact of COVID-19 and lockdown on wetland fisheries and giving advisories
Chhattisgarh	Reservoir	• Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
Gujarat	River	• Investigation on habitat characterization, fisheries and socio-economics of river Tapti • Assessment for ecology, biodiversity, ecohydrology of river Narmada • Suggestive measures for fish pass design on the river Narmada • Spatial database on water quality, phytoplankton, zooplankton, hydrologic distance, site characteristics, and fish species richness of river Narmada • Impact assessment of hydro ecological changes on fisheries and socio- economy of fishers downstream of Sardar Sarovar dam in Narmada basin • Input cost and farm gate price of fisheries of Narmada estuary • Input cost and farm gate price of fisheries of Narmada and Mahi rivers • Assessment of input cost and farm gate prices in fishing in Narmada river • Assessment of input cost and farm gate prices in fishing in Narmada estuary
	Reservoir	• Cage culture in different reservoirs • Investigation on ecological status, conservation and enhancement of fisheries in Gujarat part of Sardar Sarovar reservoir
	Aquaculture farms	• Assessment of input cost and farm gate prices in brackish water aquaculture

State	Resource	Activities
Himachal Pradesh	Reservoir	• Ecological studies and assessment of fisheries resources in Pong reservoir • Fish diversity studies and assessment of fisheries potential in Gobind Sagar reservoir
Jharkhand	Reservoir	• Studies on impacts of stocking in Konar, Tenughat, Nalkari and Tilaiya reservoirs • Assessment of impact of cage culture on fish production, economy, and livelihood of reservoir fishers • Cage culture of Amur carp, and *Ompok bimaculatus* • Demonstration of Electronic Data Acquisition System (e-DAS) for fish catch data collection from reservoirs (at Patratu Dam site) • Workshop-cum-Training on "Better health management practices in cage culture" organized at Chandil • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
Karnataka	River	• Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	• Habitat characteristics and fish assemblage of Harangi and Gayathri reservoirs • Study on potential fishery zones in medium and large reservoirs using hydroacoustics in Krishnarajasagar (KRS) reservoir • Pen culture for fingerling raising in Harangi reservoir • NFDB sponsored Skill development programme on "Reservoir fisheries management for employment generation" in Harangi reservoir • Assessment of input cost and farm gate prices in KRS reservoir and fresh water aquaculture systems • Mass awareness campaign on "Inland Fisheries Management" in Vaderahalli, Bangalore under SCSP program • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Protected areas	• Assessment on fish diversity of Cauvery and Nugu Wild Life Sanctuary
	Aquaculture farms	• Input supply and demonstration of fisheries enhancement in tanks of *Yallamma Thaayi Meenugaarara Sahakara Sangha*, Vaderahalli Village, Thataguni post, Bangalore South Taluk
Kerala	River	• Investigation on habitat characterization, fisheries and socioeconomics of river Chaliyar • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Reservoir	• Assessment of ecological and fisheries status of Mangalam reservoir • Demonstration of pen culture of *Etroplus suratensis* in Vazhani reservoir, and Vembanad lake • Assessment of ecosystem health of Vembanad lake
	Wetland/ Backwater	• Study on impact of climate change in inland fisheries and development of adaptation strategies in Vembanad lake • Exploratory surveys conducted in coastal backwaters for ecological assessment in relation to climate change • Assessment of socioeconomic vulnerability of fishers of Vembanad Lake • Demonstration of Climate Resilient Pen Systems (CRPS) for clam culture in Vembanad lake • Pen culture activities with installation of two CRPS pens in Thycauttuserry in the Alleppey District • Assessment of input cost and farm gate prices in Vembanad backwaters and extensive brackish water aquaculture systems associated with Vembanad wetland • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Aquaculture farms	• Assessment of input cost and farm gate prices in fresh and brackish water aquaculture

State	Resource	Activities
Madhya Pradesh	Reservoir	• Study of ecology and fisheries in Madhya Pradesh part of Sardar Sarovar reservoir. • Final report of the status of fish diversity, abundance and population dynamics of tilapia in Halali reservoir has been submitted.
Manipur	Wetland	• Demonstration of cage culture of *Osteobrama belangeri* in Loktak lake • Development of region-specific pen design using ITK in Takmu pat
Meghalaya	Reservoir	• Demonstration of cage culture in Umiam reservoir
Odisha	River	• Assessment of input cost and farm gate prices in fishing in Mahanadi estuary • IBI study of ecosystem health of river Kathjodi
	Reservoir	• Impact of lockdown due to COVID-19 on fisheries of Derjang reservoir and giving advisories • Cage culture experiments and demonstration in Salia dam • Pen culture demonstrations in Rishia, Salia and Baghua reservoirs • Assessment of input cost and farm gate prices in reservoir fishing • Study of fish disease and water quality in Angul reservoir
	Wetland, Lagoon	• Assessment of input cost and farm gate prices in fishing in Chilika lagoon • Demonstration of culture-based fisheries and pen culture technologies in Kespura-Paikasida wetland of Odisha
	Aquaculture farms	• Assessment of input cost and farm gate prices in fresh and brackish water aquaculture systems • Input supply and demonstration of fish culture in Mayurbhanj and Khurda districts
	Ornamental Fisheries	• Input supply and demonstration of ornamental fish culture in Bhadrak, Chunakoli (Khurda), Rishia (Balasore), Baripada (Mayunbhanj)
Tamil Nadu	River	• Investigation on habitat characterization, fisheries and socioeconomics of river Cauvery
	Reservoir	• Studies on impacts of stocking in 54 reservoirs of Tamil Nadu • Assessment of ecological and fisheries status in Mettur, Krishnagiri and Poondi reservoirs • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Protected areas	• Assessment on fish diversity of Cauvery Wild Life Sanctuary
Telangana	Reservoir	• Demonstration of species diversification for table fish production in cages in Palair reservoir, Khammam • Studies on fish assemblage structure and implications of cage culture in Palair reservoir, Khammam • Assessment of impact of COVID -19 and lockdown on reservoir fisheries and giving advisories
Tripura	Reservoir	• Studies on impacts of stocking in Dumbur reservoir • Training to 47 Tribal fishers involved in cage culture and fishing in Dumbur reservoir.
Uttar Pradesh	Reservoir	• Impact of lockdown due to COVID-19 on reservoir fisheries of Rihand reservoir • Assessment of input cost and farm gate prices in reservoirs
	Wetlands	• Assessment of input cost and farm gate prices for wetland ecosystems of Uttar Pradesh state. • Fisheries and ecological studies in Loni wetland in Rawa district of Bundelkhand region • Assessment of input cost and farm gate prices in fishing in wetlands
	Aquaculture systems	• Assessment of input cost and farm gate prices in aquaculture systems of Prayagraj, Jaunpur and Chitrakoot district • Input supply and demonstration of fisheries enhancement in tanks of Naraina, Karchhana, Handiya, Dubawal villages
	River	• Assessment of input cost and farm gate prices in Ganga and Tons river systems. • Ranching of river Ganga with wild-bred IMC seeds • Assessment of fish and fisheries of the Ganga river system • Assessment of water quality of river Ganga during lockdown

State	Resource	Activities
Uttarakhand	River	• Study on the impact of heat waves in a stretch of Ganga River • Study of fish diversity and migration in Tons river • Metagenomic study of sediments of river Ganga, Yamuna, Bhagirathi and Alakananda at different locations • Assessment of fish and fisheries of the Ganga river system
West Bengal	River	• Assessment of input cost and farm gate prices in fishing in Ganga • Assessment of input cost and farm gate prices in fishing in Hooghly-Matlah estuary • Assessment of pollution status of the river Teesta • Ranching of river Ganga with wild-bred IMC seeds • Hilsa tagging and ranching in river Ganga at Farakka • Assessment of efficacy of fish pass at dams on river Teesta • Assessment of water quality and fishing activity of river Hooghly during lockdown • Assessment of impact of COVID-19 and lockdown on reservoir fisheries and giving advisories
	Canal	• Fisheries development in Kostala canal, Sundarbans
	Wetland	• Assessment of environmental variables and biotic community interactions in wetlands Nayachara and Sahebganj in Teesta-Torsa basin, and Katiganga and Bishnupur in Ganga basin. • Fish yield estimation of 21 wetlands of Teesta -Torsa and Ganga basins, with highest yield in Chaltia wetland, Murshidabad • Vulnerability assessment based on stakeholder perception in 15 wetlands of Maldah and Murshidabad districts • Study on the impact of heat waves in Bhomra wetland • Assessment of pollution status in Borti beel, Raja beel, East Kolkata wetlands • Carbon sequestration studies in Raja, Borthy (Beraberia), Bhomra, and Borthy (Tetulia) wetlands • Assessment of climate induced risks of Mathura wetland, North 24 Parganas district • Assessment of input cost and farm gate prices in fishing in stocked wetlands • Pen culture demonstration in Beledanga wetland • Ecosystem based integrated development and management of Khalsi wetland • Demonstration of culture-based fisheries and pen culture technologies in Chamordaha, Beledanga, Kumli, Panchita and Chamta beels of West Bengal • Study of fish diseases, including TiLV, in Moyna and East Kolkata wetlands • Study of microplastic-attached heavy metals in East Kolkata wetlands • Stakeholder meeting cum awareness program was organized at Media beel • Assessment of impact of COVID-19 and lockdown on wetland fisheries and giving advisories
	Aquaculture systems	• Assessment of input cost and farm gate prices in fresh and brackish water aquaculture systems of Purba Medinipur, Hooghly, N 24 Pgs districts • Advisory and input distribution in Amphan-ravaged Sundarbans and Kakdwip • Input supply and demonstration of fisheries enhancement in backyard ponds of Sundarbans, Purulia and Birbhum • Input supply and demonstration of ornamental fish culture in Sundarbans, and Khalsi wetland

Helping the Sundarbans fishers ravaged by super cyclone 'Amphan'

The super cyclone "Amphan" made its landfall between Sagar Island, Sundarbans, and Kakdwip, West Bengal on 20 May 2020. The monstrous cyclone unleashed high-speed winds, heavy rainfall, and storm surge that ravaged the Sundarbans causing tenfold devastation than "Aila" did. It was the strongest tropical cyclone to strike the Ganges Delta causing over US$13 billion of damage, and is also the costliest cyclone ever recorded in the Gangetic Plain.

Damages caused by Amphan at Rangabelia, Gosaba

Amphan mauled telecommunication systems, uprooted trees and electric poles, destroyed thousands of dwellings and ravaged roads, bridges and river embankments across North and South 24 Parganas districts of West Bengal. A large number of kachha houses in Gosaba, Sagar Island, Kalitala, and Amtoli areas of Sundarbans were damaged. Several river embankments in Sundarbans were washed away or breached inundating vast areas of houses, ponds, and agricultural fields. In the North 24 Parganas the coastal areas of Sandeskhali, Hingalganj, Hemnagar, and Kalitala were severely damaged. High tidal waves damaged several dams over the Ichamati, Raimangal, and Sahebkhali rivers on the coastal belt close to Sundarbans. The devastation was so intense at Sagar Island, Kalitala, and Gosaba of Sundarbans that many areas remained inaccessible even 48 hours after the cyclone, making the disaster management difficult.

People attached to fisheries and aquaculture suffered huge losses in several areas of North 24-Parganas and South 24-Parganas as salt water gushed into the freshwater areas. The salt water not only killed freshwater fish varieties like Indian major carps, minor carps, puti etc. but also affected agriculture production. The tribal beneficiaries of Gosaba were in severe despair from their loss due to high tidal waves that inundated ponds and other water bodies. In Basanti area all ponds were submerged with salty water. The cyclone also deposited a vast amount of leaves and tree branches in the water bodies soiling the water quality.

ICAR-CIFRI extended supports to the ravaged population including tribal fishers through supply of inputs and relief materials, and by giving advisories.

Supports extended by ICAR-CIFRI	Place and Number of fishers benefitted
Water quality analysis of the water bodies and advisories	159 fishers of Kultali, Sagar Island, Gosaba
Distribution of 5000 kg lime, 2.5 tonnes fish feed and 900 kg fish	256 fishers of Kultali, Basanti
Distribution of backyard ornamental fish tanks and ornamental fish kit	80 fisher women of Kultali Basanti
Distribution of 1000 kg of lime, 3 tonnes fish feed and 150kg seed	59 fishers of Gosaba
Distribution of fish seed, lime, fish feed	348 fishers of Sagar Island
Distribution of a submersible pump	120 fisher family of Rangabelia, Gosaba

COVID-19 pandemic, lockdown, and response by ICAR-CIFRI to minimize its impacts on fisheries

COVID-19 pandemic, caused by the novel coronavirus, has severely impacted human activities and livelihood across the globe with more than 8.5 crores people were affected, and more than 18 lakh people died; in India, more than 1.3 crores people were infected while 1.6 lakh died till 31 Dec. 2020. To contain the pandemic, unprecedented lockdown measures were adopted by several countries, including India.

During the COVID 19 pandemic, many countries implemented restrictions to contain its adverse effect on human health. The entire range of activities in the fisheries sector from seed production, stocking, fishing, transportation, storage and marketing, value addition, etc. were adversely affected due to the enforced lockdown, severely affecting the livelihood. These measures have caused an enormous impact on the livelihood and nutritional security of a large section of the population especially the poor fishers.

Assessment of impact of COVID-19 and lockdown on inland fisheries

The institute attempted to assess the impact by rapidly surveying the fishers and fish markets. It was observed that the fishing activities operated at a 30% level of the normal in medium reservoirs of Tamil Nadu. In medium reservoirs, marketing was found to be the major issue for fishermen, hence only 10% of fishers were involved in fishing activities and the catch was sold mainly for local consumption. The impact of fisherman in small reservoirs was minimal during the lockdown period because of high local demand. The fish prices increased by around Rs. 10-20/kg in the state. While in Karnataka, fishing in reservoirs, tanks, ponds, etc. stopped completely during lockdown. Fishing operation in large reservoirs like Krishnarajasagar was at only 25% of the normal fishing season. Fishes were sold locally only. In riverine fisheries fishing was carried out at Kushalnagar and T. Narasinghpur stations of Cauvery river, but not on a full-fledged basis in the state. Only 10 fishers (normal time) from each station carried out fishing daily, as compared to 35-40 fishers during normal time, and the catch was sold only to the local people. Fishers, fish vendors, ice distributors, intra- and inter-state dealers were also badly affected. The reduced fish catch and high demand for fish has resulted in higher (30-65%) selling price for various important fish groups.

In Kerala, the lockdown caused disruptions in the fish food supply chain but fish farming and allied activities such as transportation and distribution of fish seeds, fish seed production, hatchery operations, cold storage facilities, and processing plants were granted relaxations by district administration in consultation with district fishery officers. Fishing by artisanal boats was allowed, however the catch was

Fish vendors taking token for fish purchase in Kerala maintaining social distance

assigned to be sold in local markets avoiding auction sales and maintaining social distancing. The widening gap between demand and supply of fish that was observed during the initial lockdown phase brought in a price hike to the tune of 100%. Similarly, in the second phase of lockdown, the fishing, fish marketing, hatchery operations, and the subsequent transportation have been excluded from restrictions without obstructing social distancing. In reservoirs, the pre-COVID catch ranged from 20-100 kg/day whereas, during the lockdown it had decreased to 5 kg/day.

In Telangana, a fishing ban in reservoirs used to be imposed up to 5 May every year. Hence there is no significant impact of the lockdown on fishers. Cage culture in Palair reservoir was still operational and 500-600 kg/day was harvested from the cage. However, the daily sale of fish in the Hyderabad area had come down to 10-15 tonnes from 100-150 tonnes.

The Fishermen Cooperative Societies (FCSs) of studied wetlands of West Bengal did not harvest the stocked fishes because of lesser opportunity and options of selling the due to closer of markets. A survey in two villages of Sundarbans, West Bengal revealed that only local fish species were available in local markets during the lockdown period. The retail price of fish was down by 25-30% due to the supply side pressure, as no transportation was available to send the fish to cities like Kolkata, etc. Surveys of Howrah wholesale fish market and retail fish markets of Kolkata during the lockdown period revealed that the supply was down by almost 60%. The wholesale price of fishes increased by 25-30% in the Howrah fish market. The retail price of fishes was 40-50% higher as compared to normal times.

In the wetlands of Bihar, the fish harvest was completely stopped from 24 March to 15 April. The fishing was started only after 15 April at a 30% level due to low demand for fish and supply chain disruption. With easing up of lockdown after 3 May 2020, the intensity was increased to 50% of normal time, but 75% of people were not opting for fish purchase due to financial stress. A fish market survey of Motihari revealed that the supply of fish was down by almost 50%. Farmgate price of Indian major carps increased to Rs. 280-300/kg as compared to 220-230/kg before the lockdown period. Through ICAR-CIFRI technological intervention fish catch recorded at Kararia and Kothiamaun in East Champaran district of Bihar were 5.0 and 4.0 metric tonnes respectively during the lockdown period. Fishers have earned Rs. 7 and Rs. 5 lakhs respectively. CIFRI technological intervention has enhanced their earning during this lockdown period.

Fish marketing at Chiklihole reservoir, Karnataka maintaining the mandatory protocols of safety

Survey of Sundarbans fishers maintaining social distsnce

In Assam, the farm gate price of IMC was Rs. 250-300/kg during the lockdown period as compared to Rs. 150-180/kg during normal time. The supply of fish was only 40% of the normal times. The fish supply from other states had completely stopped. In retail markets of Guwahati IMC prices increased by about 40%. The retail price of catfish increased by 25% of normal times. Similarly in the west of Gujarat state the COVID-19 has severely hampered the fishing activities in the inland fisheries sector. Farmgate of freshwater fishes such as IMC increased to Rs 270-300/kg as compared to Rs. 120-150/kg before the lockdown period.

In Derjang reservoir, Odisha the fishing effort and the fish catch were reduced by 50% and the fishing days has reduced to 5 days from 6 days. As the entry of consumers to landing places was restricted during lockdown, only the wholesaler (commission agents) was allowed to buy the fish directly from the landing centres and the agent was selling the fish only in a specified isolated place. The selling price of fish had increased by 20% due to disparity in supply and demand.

In Rihand reservoir, the fishing activity was completely stopped with disruption in transport system to markets of West Bengal and NE states. The supply of ice was also suspended. There was no fishing activity in Patratu and Panchet reservoirs, Jharkhand. Fishing activities were obstructed initially for few days in Maithon reservoir. In wholesale markets, price of the local fish was 75-80% higher during lockdown than usual and in retail markets, the price was more than double even for medium-sized fish.

However, relaxation in lockdown restrictions and subsequent opening of economic activities have brought near normalcy in fish harvest and marketing in most of the reservoirs in various parts of the country.

Impact on aquatic ecosystem

During the lockdown period, an improvement in the quality of water was reported by the fishermen in almost all the inland water bodies. At Prayagraj, Sangam the Ganga water carbonate (CO_3), bicarbonate ($BiCO_3$) and chloride (Cl_2), specific conductivity, total dissolved solid, and total hardness (TH) decreased from last year. Some chemical parameters such as calcium (Ca), magnesium (Mg), phosphate (PO_4) and silicate (SiO_2) decreased from last year indicate the improvement in the water quality. Similar improvements in water quality were also recorded at Barrackpore. As a result the fish catch from rivers also increased. At Daspara and Nawabganj stretch of river Ganga in Barrackpore, Hilsa landing was recorded 13 kg and 4.9 kg respectively during post lockdown period.

Advisories issued by ICAR-CIFRI to combat COVID-19

ICAR-CIFRI took lead in developing and issuing advisories, for the safety of the workers and in preventing the spread of the disease. The Institute prepared advisories for the stakeholders involved in fishing activities in rivers, estuaries, reservoirs, and wetlands in 7 different regional languages, besides in English and Hindi. These advisories were popularized through print & electronic media, circulated to State Fisheries Departments, developmental agencies, NGOs, and SHGs, and also through social media. The advisories were also sent to progressive fish Farmers /hatchery owners/ fish seed, feed, aqua chemical providers/wetland fishers/FCS/ Market intermediaries-functionaries/Transport supporters/fishers fishing in inland open water waters including pond systems of West Bengal, Bihar, Tripura, Odisha, UP, MP, Jharkhand, Telangana, Andhra Pradesh, HP directly and through DoFs of different States across India.

Such efforts have been appreciated by various national and international agencies. Recognizing the importance of these timely advisories issued by ICAR-

CIFRI, the Food and Agricultural Organization (FAO), Rome had recommended these advisories to include as Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries under the Asia-Regional initiatives for the benefit of fisheries sector across the globe (Webpage: http://www.fao.org/3/ca8959en/ca8959en.pdf). The global fishery sector is expected to benefit from these efforts of the institute.

Advisories issued to fisheries sector by the Institute to combat hardship during COVID-19 pandemic

In 2020 the Institute conducted technology demonstrations in the following areas/resources

Sl. No.	Technology / protocol	Water resource / Place
1	Cage culture of high value fish species *Ompok bimaculatus*	Maithon reservoir, Jharkhand
2	Cage culture of Amur carp	Samaguri beel of Assam, and Maithon reservoir, Jharkhand
3	Grow out culture of *Labeo rohita*	Timbi reservoir, Gujarat
4	Cage culture of high value *Puntius sarana*	Salia dam, Odisha
5	Cage culture of carps	Umiam reservoir, Meghalaya
6	Cage culture of *Osteobrama belangeri*	Loktak lake, Manipur
7	Species diversification for table fish production of *Pangasianodon hypophthalmus, L. rohita, L. rohita* (Jayanti variety), *L. catla* and *Macrobrachium* sp.	Palair reservoir, Telangana
8	Region-specific climate-friendly pen design using ITK	Takmu pat, Manipur
9	Pen culture for fingerling raising	Harangi reservoir, Karnnataka
10	Pen culture	Borbila and Borkona beels, Assam
11	Pen culture	Borbeel, Arunachal Pradesh
12	Pen culture	Rishia, Salia and Baghua reservoirs, Odisha
13	Culture of *Etroplus suratensis* in ICAR-CIFRI HDPE pens	Vazhani reservoir, Kerala
14	Culture of *E. suratensis* in Climate Resilient Pen Structure(CRPS)	Vembanad lake, Kerala
15	Culture-based fisheries and pen culture technologies	Kespura-Paikasida wetland, Odisha
16	Pen culture demonstration	Beledanga wetland, Wet Bengal
17	Culture-based fisheries and pen culture technologies	Chamordaha, Beledanga, Kumli, Panchita,Chamta beels of West Bengal
18	Fish stock enhancement	Bamuni, Charan, Saren beels of Assam
19	Demonstration of CIFRI-CAGEGROW feed	Derelict water bodies of Goalpara district, Assam
20	Fisheries development of wetlands	Rulhi, Majharia, Kararia, Sirsa, and Kothia mauns of Bihar
21	Cage culture activity	Different reservoirs of Gujarat
22	*e-Matsya* for fish catch data collection from reservoirs	Reservoirs of Karnataka, Kerala, and Odisha

Awards and Recognitions

Awards

- Indian Council of Agricultural Research awarded the ICAR-CIFRI Annual Report, 2018-19 the Best Annual Report Award in Large Institute Category. It added a feather to the cap of ICAR-CIFRI. This news was published in various leading newspapers such as Dainik Jagran (Hindi), The Samaja (Odiya) and Bartaman (Bengali).

- ICAR- CIFRI Guwahati Centre bagged the third best stall award in the Farmers Fair on the theme "Farmers prosperity through doubling farmers income" organized by ICAR-ATARI, Zone-VI, Guwahati at Horticultural Research Station (HRS), AAU, Kahikuchi, Guwahati during 26-27 February 2020.

- Dr. B. P. Mohanty was awarded with the coveted Fellowship of the National Academy of Agricultural Sciences (FNAAS), India.

Dr. B. P. Mohanty receiving the NAAS Fellowship

ICAR-Central Institute of Fisheries Education
(University under Sec.3 of UGC act 1956)
Indian Council of Agricultural Research
Panch Marg, Off Yari Road, Versova, Andheri(W), Mumbai - 400 061

Certificate of Appreciation

Certified that
Archisman Ray, Akanshya Das and Nabanita Chakraborty
participated in the IDEATHON Poster Competition held as part of
the National Webinar on
'Artificial Intelligence and IoT for Smart Aquaculture'
organized by ICAR-CIFE, Mumbai during 11-12 November 2020
under the National Agricultural Higher Education Project -
Centre for Advanced Agricultural Science and Technology (NAHEP-CAAST)
project on "Development of Energy Efficient and Environment
Protective Aquaculture Technologies for Degraded Soils".

We are pleased to award
Second Prize
to their poster titled
Robotic Fish Shepherd TRINETRA

(Ananthan P.S.)
Organizing Secretary

(Gopal Krishna)
Director/Vice Chancellor

Certificate of appreciation conferred to A. Roy and the group

Dr. B. K. Behera was awarded Dr. Hiralal Chowdhury Gold Medal

- Sh. Archisman Ray, Ms. Akankshya Das and Ms. Nabanita Chakraborty got the 2nd Prize in the 'Ideathon' at ICAR-CIFE, Mumbai for designing robotic fish.
- Dr. B. K. Behera was awarded the Dr. Hiralal Chowdhury Gold Medal in AEHMS 12 organized at Pantnagar, Uttarakhand during 17-19 February 2020.
- Ms. Canciyal J. got the Best Oral Presentation award in the theme 'Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation', in AEHMS 12 organized at Pantnagar, Uttarakhand during 17-19 February 2020.
- Dr. Dibakar Bhakta was awarded the Best Doctoral Research Award-2020 by Society for Biotic and Environmental Research (SBER), Khowai, Tripura, India in recognition of outstanding research of PhD thesis.
- Dr. Dhruba Jyoti Sarkar was awarded the International Best Scientist for his work on environment pollution research by RULA AWARDS in Association with World Research Council and United Medical Council, 2020 at Trichy Tamilnadu, India.

Dr. D. J. Sarkar was awarded in the 4th IUPAC Conference

- Dr. Dhruba Jyoti Sarkar was awarded the Prof. A. P. Sharma Young Scientist Gold Medal Award by the in AEHMS 12 organized at Pantnagar, Uttarakhand during 17-19 February 2020.
- Dr. Dhruba Jyoti Sarkar received the third Best Oral presentation award in 4th IUPAC International Conference on Agrochemicals Protecting Crops, Health and Natural Environment held during 7-10 January 2020.

Mr. H. S. Swain receiving the Prof. A. P. Sharma Gold Medal

- Dr. H. S. Swain bagged the Dr J.K. Jena Best Young Scientist Award by IFSI in AEHMS 12 organized at Pantnagar, Uttarakhand during 17-19 February 2020.

- Presentation by Lohith Kumar, Aparna Roy, R. K. Manna, S. Samanta, B.K. Das was awarded the third position for concept presentation in the India International Science Festival under the domain Nav Bharat Nirman - Building self-reliant SMART Villages for Inclusive Growth', organised by the Ministry of Science and Technology, Ministry of Earth Sciences & Vijnana Bharati (VIBHA), Govt. of India during 22-25 December 2020.

L. Kumar and others were awarded in the IISF

- Presentation by Roshith CM, Suresh VR, Manna RK, Sibina Mol S, Kumar L, Sharma SK, Roy Choudhury A, Vijaykumar, ME and Das BK bagged the Best Oral Presentation (First Position) Award in the category “Ecosystems of Inland Waters” in AEHMS 12 organized at Pantnagar during 17-19 February 2020.

- Dr. S. Borah was awarded the Best Oral Presentation award in AEHMS 12 organized by IFSI, PFGF, ICAR-CIFRI, GBPUAT and AEHMS at Pantnagar, Uttarakhand during 17-19 February 2020.

- Sh. S. K. Sahu received the Best Oral presentation award in National Conference on Geospatial Technologies in Agriculture, organized at ICAR-NAARM, Hyderabad during 20-21 February 2020.

- Dr. Soma Das Sarkar was awarded the International Best Scientist for environmental pollution research by RULA AWARDS Research leadership award of the year 2020 in Association with World Research Council and United Medical Council, 2020 at Trichy, India.

- Dr. U. K. Sarkar, Dr. Soma Das Sarkar, Sh. Mishal P and Ms. Gunjan Karnatak got the Best Poster award in AEHMS 12 organized by IFSI, PFGF, ICAR-CIFRI, GBPUAT and AEHMS at Pantnagar, Uttarakhand during 17-19 February 2020.

Recognitions

- Dr. A. K. Das delivered an invited lecture in the Youth Club Development Convention organized by Nehru Yuva Kendra Sangathan at Ramakrishana Mission Institute of Culture at Golpark, Kolkata on 9 Feb. 2020.
- Dr. A. K. Das delivered an invited lecture in a five-day webinar on 'COVID-19 and Fisheries: Potential impacts, mitigation and management' organized by College of Fisheries, CAU, Lembucherra, Tripura on 18 June 2020.
- Dr. A. K. Das delivered an invited lecture on in a webinar on 'Developing Atmanirbhar Madhya Pradesh' on 11 August 2020 organized by Dept. of Agriculture, Govt. of MP.
- Dr. A. K. Das was a resource person in a webinar on 'Entrepreneurship opportunities in agriculture and allied sectors' organised by Nehru Yuva Kendra, Kolkata on 16 September 2020.
- Dr. A. K. Yadav was elected as a Member of Executive Committee, Society of Statistics, Computer and Applications (SSCA).
- Dr. Archana Sinha delivered theme lecture in the workshop on Ornamental Fisheries Entrepreunership Development organized by NCDC in collaboration with NFDB and W.B. Fisheries Department at Kolkata on 25 January 2020.
- Dr. Arun Pandit was a Reviewer of Ph.D. thesis of Fisheries Economics of ICAR-CIFE, Mumbai.
- Dr. B. K. Das, Director was elected as a Member of the Syllabus Commitee of the Neotia University.
- Dr. B. K. Das was elected as a Member of Executive Council, Indian Science Congress Association.
- Dr. B. K. Das was elected as a Member, Expert Committee on Inland Fishery Resources (ECIFR), Ministry of Fisheries, Animal Husbandry & Dairying.
- Dr. B. K. Das was elected as an External Member, Board of Management, ICAR-Central Institute of Fisheries Education, Mumbai.
- Dr. B. K. Das was elected as a Member, Expert Committee for program under the School of Agriculture and Allied Sciences, Neotia University.
- Dr. B. K. Das was elected as a Member, NASI Council (Biological Sciences).
- Dr. B. K. Das was elected as a Member, Monitoring Committee of NMCG-WII Sponsored Project “Planning and Management for Aquatic species conservation and maintenance of Ecosystem service in the Ganga river basin for a clean Ganga”.
- Dr. B. K. Das was elected as a Member, Central Standing Committee on Pradhan Mantri Matsya Sampada Yojana (PMMSY), Ministry of Fisheries, Animal Husbandry and Dairying, Department of Fisheries.
- Dr. B. K. Das was elected as a Member of Advisory Committee of the project “Development of

biosensors for detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies".

- Dr. B. K. Das was elected as a Member, National Advisory Committee of the International Symposium "Transforming Coastal Zone for Sustainable Food & Income Security, organized by Indian Society of Coastal Agricultural Research.
- Dr. B. K. Das was elected as a Member of the Technical Advisory Committee (TAC) of Farakka Barrage Project.
- Dr. B. K. Das was elected as a Special Invitee by the CPCB in the matter of Manoj Mishra Vs Uol.
- Dr. B. K. Das was elected as a Coordinator of Member Institute of the Consortium of Science & Technology Institutes (CSTI) led by IIT Kanpur to deliver the mandate of clean Ganga, supported by Ministry of Jal Shakti, Govt. Of India.
- Dr. B. K. Bhattacharjya served in the Honorary Board of Directors, Assam Fisheries Development Corporation Ltd., Guwahati.
- Dr. B. K. Bhattacharjya, Dr. D. Debnath and Dr. Pronob Das have been elected as Members of selection committee of Assam Public Service Commission (APSC) for recruitment of Fishery Development Officer on 20 & 21 March 2020.
- Dr. B. K. Bhattacharjya, Dr. S. Yengkokpam and Dr. Pronob Das were External reviewers of M.F.Sc thesis of College of Fisheries, AAU, Raha.
- Dr. Kavita Kumari acted as a Moderator for the DToL 2 session and the Conservation Genomics session for the Biodiversity Genomics 2020 Conference organized by Welcome Sanger Institute, London.
- Dr. M. A. Hassan delivered lecture in the National Webinar oraganized by Asutosh College, Kolkata during 17-18 August 2020.
- Ms. Manoharmayum Shaya Devi was awarded Ph.D. degree by ICAR-Central Institute of Fisheries Education, Mumbai on 31 January 2020.
- Sh. N. S. Singh was awarded Ph.D. degree by ICAR-Indian Agricultural Research Institute, New Delhi.
- Dr. Pronob Das was acted as the Editorial board member of Acta Scientific Agriculture.
- Dr. Pronob Das was a Panelist during seminar on "Farmers prosperity through doubling farmers income" for the state of Assam during 26-27 February, 2020, organized by ATARI, Zone-VI, Guwahati at HRS, AAU, Kahikuchi, Guwahati.
- Sh. S. Borah was elected as a Member of the District Level Committee of Nalbari district, Assam for PMMSY.
- Dr. S. Dam Roy was a RAC Member of ICAR-Directorate of Coldwater Fisheries Research, Bhimtal and attended the first meeting of RAC during 20-21 May 2020.
- Dr. S. Dam Roy was as a Member of Department of Biotechnology Monitoring Committee and attended the virtual Meeting on 20 November 2020.

- Dr. S. Dam Roy was Advisory Board Member of two Ph. D programmes in CIFE Mumbai and attended their viva-voce examinations on 17 July 2020 and 4 August 2020.
- Dr. S. Dam Roy was an External Evaluator of a project submitted by an Emeritus Professor for ICAR funded project during October 2020.
- Sh. Shyamal Chandra Sukla Das was awarded Ph.D. degree by ICAR-Central Institute of Fisheries Education, Versova, Mumbai.
- Ms. Sibina Mol S. was awarded the Ph. D. degree by ICAR- Central Institute of Fisheries Education, Mumbai.
- Dr. S. K. Manna was elected as a Member of the Core Committee for drafting Rules for the Aquatic Animal Disease and Health management Bill, 2019.
- Dr. Suman Kumari was a Resource Person in the Training on 'Sustainable Agriscapes for the Futures' organised by IUCN, during 27-28 August 2020.
- Ms. Suvra Roy was awarded PhD degree by the Ghent University, Belgium on 21 September 2020.
- Dr. U. K. Sarkar delivered guest lecture in webinar on “Strategies of small-scale aquafarming during Covid 19” on 10.07.2020.
- Dr. U. K. Sarkar delivered an invited lecture in a five day webinar on 'COVID-19 and Fisheries: Potential impacts, mitigation and management' organized by College of Fisheries, CAU, Lembucherra, Tripura on 19-06-2020.
- Dr. U. K. Sarkar reviewed UGC SAP programme of Dept. of Zoology, Guru Nanak Dev University, Punjab on 12-03-2020.
- Dr. U. K. Sarkar acted as the external examiner for PhD viva voce in Guru Nanak Dev University, Amritsar on 05 October 2020.
- Dr. U. K. Sarkar acted as external examiner for PhD viva voce in West Bengal University of Animal & Fisheries Sciences on 16 October 2020.
- Dr. U. K. Sarkar acted as External Examiner in viva voce of Ph.D. thesis in the West Bengal University of Animal and Fishery Science on 14.12.2020.
- Sh. Vaisakh G, Scientist was awarded Ph. D degree by ICAR-Central Institute of Fisheries Education, Versova, Mumbai.
- Sh. Vikash Kumar was awarded PhD degree by the Ghent University, Ghent, Belgium on 25 August 2020.

On and Off-campus training programs for fishers and fish farmers

Title	Venue	Duration	No. of participants
Inland open water fisheries management and development	CIFRI, Barrackpore	3-9 January, 2020	31 fishers of Darbhanga district, Bihar
Ornamental fish culture under SCSP	CIFRI, Barrackpore	9-11 January, 2020	27 (17 fisherman and 10 fisherwomen, Sundarbans)
Inland open water fisheries management and development	CIFRI, Barrackpore	17-23 January, 2020	30 Fishers of Samastipur district, Bihar
Inland open water fisheries management and development	CIFRI, Barrackpore	4-10 February, 2020	31 fishers of Katihar, Bihar
Training programme on Inland fisheries management for livelihood improvement under SCSP	CIFRI, Barrackpore	7-9 February, 2020	100 fishermen from South 24 Parganas
Inland open water fisheries management and development	CIFRI, Barrackpore	11-17 February, 2020	29 fish farmers of Nawada, Bihar
Inland open water fisheries management and development	CIFRI, Barrackpore	18-24 February, 2020	31 fish farmers of Bhagalpur, Bihar
Development and management of cage and pen culture in Tripura	CIFRI, Barrackpore	25-29 February, 2020	44 fish farmers of Tripura
Inland open water fisheries management and development	CIFRI, Barrackpore	28 February to 5 March, 2020	31 fish farmers of Munger, Bihar
Wetland & reservoir fisheries management for livelihood improvement under SCSP	CIFRI, Barrackpore	12-14 March, 2020	45 fish farmers of Odisha
Inland open water fisheries management and development	CIFRI, Barrackpore	12-16 March, 2020	30 fish farmers and 4 officers of Mayurbhanj Odisha
On farm training on Ornamental fishery under SCSP	KhalsiBeel, West bengal	20-12 September, 2020	25 women beneficiaries
Ornamental fish farming for women fishers of Odisha under TSP	Nalagaja and Badasahi villages of Mayurbhanj district	29 September 2020	45 women fishers
Ornamental fish culture under TSP	Bhadrak, Odisha	18 -24 October, 2020	25 women fishers

Training programs for Officials

Name of the training	Venue	Duration	Number of participants
Enclosure culture (Cage & Pen) towards livelihood and nutritional security	CIFRI, Barrackpore	14-18 January, 2020	25Officials ofdifferent state departments
Inland Fisheries Management	CIFRI, Barrackpore	3-5 February, 2020	25 Fisheries Inspectors of Madhya Pradesh
Field Experience Training (FET) for 110th FOCARS ARS Scientist Probationers	CIFRI, Barrackpore	25 February – 16 March, 2020	6 Scientists from ICAR-NAARM

NFDB Sponsored Skill Development programmes

Name of the training	Date	Participants	Venue
Ornamental fish culture for livelihood improvement	6-8 February, 2020	100	Sundarban, South 24 Parganas
Training programme on Inland Fisheries Management for livelihood improvement	7-9 February, 2020	100	Amtali and Kochukhali South 24 Parganas
Wetland fisheries management' in collaboration with Directorate of Fisheries, Manopur	10-12 February, 2020	50	ICAR-CIFRI RRC, Guwahati
Culture based fisheries for improving livelihood of inland fishers	17-19 March, 2020	50	ICAR-CIFRI, Barrackpore

Off-campus training programmes

Online training programmes (Webinars)

Name of the training	Date	Participants	Venue
Online training programme on e-Matsya, a fish catch recording android software	17 June, 2020	17 officials of Odisha	ICAR-CIFRI, Barrackpore
Exploring the impact of COVID-19 on the ecosystem health of rivers and its dolphin population: Present status and future strategy for conservation in India-Bangladesh-Myanmar-Nepal	24-25 August, 2020	600 Participants from India, Nepal, Bangladesh, Indoneshia, Myanmar	ICAR-CIFRI Barrackpore
Small scale fisheries in inland open waters: Status and opportunities	09-10 September, 2020	1190 Participants from India, Nepal, Bangladesh, Malaysia, Italy, Canada, Belgium, Netherlands	ICAR-CIFRI Barrackpore
Knowledge empowerment of youth on inland fisheries management: A way towards Atmanirbhar Bharat	29 September, 2020	120 youths	ICAR-CIFRI Barrackpore
Women empowerment and Gandhian perspective	1 October, 2020	75 women	ICAR-CIFRI Barrackpore
Enhancing conservation of river dolphins	24 November, 2020	1000 participants	ICAR-CIFRI Barrackpore
Production enhancement through pen culture in inland open waters	27 November, 2020	55 fish farmers from Assam	ICAR-CIFRI, RRC Guwahati
Production enhancement through pen culture in inland open waters	04 December, 2020	72 fish farmers from West Bengal	ICAR-CIFRI Barrackpore
Production enhancement through cage culture in inland open waters	11 December, 2020	63 fish farmers from Bihar, UP, MP, Maharashtra	ICAR-CIFRI Barrackpore
Production enhancement through pen culture in inland open waters	18 December, 2020	122 fish farmers from Odisha	ICAR-CIFRI Barrackpore

Seminar / Symposium / Workshop/Winter School

Seminar/Symposium/Workshop/Training	Date	Venue
ICAR-Central Inland Fisheries Research Institute, Barrackpore has organised ICAR -sponsored Winter School on "Advances in Management of Inland Open - water Ecosystem Health"	21 January – 10 February, 2020	ICAR-CIFRI, Barrackpore
National Conference on Ecosystem Health & Fisheries of Indian Inland Waters: Multiple Stressor, Management & Conservation (AEHMS 12), jointly organised by IFSI, Barrackpore, CoF, GBPUAT, Pantnagar& AEHM Society, Canada, ICAR -CIFRI, Barrackpore & PFGF, Mumbai.	17-19 February, 2020	GBPUAT, Pantnagr, Uttarakhand

Exposure / Educational Visits

Particulars of visitors	Date of visit	Venue
70 nos. of B.F.Sc. 2nd year students from CoF, Chhattisgarh Kamdhenu University	8 January, 2020	ICAR-CIFRI, Barrackpore
28 nos. of B.F. Sc. Students from CoF, CAU, Lembuchera, Tripura	9 January, 2020	ICAR-CIFRI, Barrackpore
48 nos. of trainee farmers from DDF, FFRTC, Kulia, Kalyani	16 January, 2020	ICAR-CIFRI, Barrackpore
89 nos. of students (class VII to XI) from Bhatpara Taraknath Balika Vidyamandir, Bhatpara, 24 PGS (N).	17 January, 2020	ICAR-CIFRI, Barrackpore
28 nos. of students (UG & PG) & 2 nos. of faculty In-charge from Vidyasagar College, Kolkata	28 January, 2020	ICAR-CIFRI, Barrackpore
19 nos. of farmers from Digapahandi block, Ganjam district, Odisha	29 January, 2020	ICAR-CIFRI, Barrackpore
24 nos. of trainees from WBUAFS, Belgachia, Kolkata under Skill Development Certificate course on "Aqua clinics &Aquapreneurship Development Program (AC & ABC)	7 February, 2020	ICAR-CIFRI, Barrackpore
114 nos. of students (Class VII to XI) from Umasashi High School, Barrackpore	13 February, 2020	ICAR-CIFRI, Barrackpore
30 nos. of B.Sc. students from Anandaram Baruah College, Barpeta, Assam	2 March, 2020	ICAR-CIFRI, Barrackpore

Exhibitions/Mela

Date	Particulars	Place
27 December 2019 -3 January, 2020	Naihati Utsav 2019-20	Naihati
15-17 January, 2020	BajarpurGraminProdarshani O Mela organised by AlukaranbarhSeva Sangha.	Purba Medinipur
11-14 February, 2020	International Conference (ClimFishCon 2020) organized by CUST-School of Industrial Fisheries, Kochi &DoF, Govt. of Kerala at Kochi.	Kochi
17-19 February, 2020	National Conference on Ecosystem Health & Fisheries of Indian Inland Waters: Multiple Stressor, Management & Conservation (AEHMS 12), jointly organised by IFSI, Barrackpore, CoF, GBPUAT, Pantnagar & AEHM Society, Canada, ICAR-CIFRI, Barrackpore & PFGF, Mumbai.	GBPUAT, Pantnagr, Uttarakhand

Different on-campus training activities

Institute Projects (April 2017- March 2020)

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

Institute Projects (April 2020- March 2023)

Sl. No.	Project Code	Project Title
1	REF/20-23/11	Temporal assessment of estuarine fisheries resources for sustainable management
2	REF/20-23/12	Assessment of ecological impacts of dams and barrages in selected rivers with special references to fisheries
3	REF/20-23/13	Fish catch assessment of the Rivers Mahanadi, Krishna, Barak, Tapti and Kosi
4	REF/20-23/14	Exploration and assessment of fisheries and livelihoods of protected inland water bodies
5	REF/20-23/15	Eco-variability and impact study of river Yamuna on river Ganga with special emphasis on fisheries
6	REF/20-23/16	Assessment of environment variability, nutrient fluxes and biotic community interactions of a few mangrove stands of Indian mangrove eco-region
7	RWF/20-23/10	Understanding spatio-temporal variations of reservoir ecosystem and developing improved fisheries management strategies for different eco-regions: A new perspective
8	RWF/20-23/11	Eco-orientation approach for fisheries enhancement of floodplain wetlands in diverse eco-regions of India
9	FREM/20-23/16	Ecosystem health risks and food safety assessment in relation to chemical contaminants in inland aquatic environment
10	FREM/20-23/17	Evaluation and management of environmental health through omics technologies
11	FREM/20-23/18	Fisheries Resource Assessment and predictions in Inland Open-water under AI and BigData Platform
12	FSE/20-23/04	Achieving Sustainable Development Goals (SDGs) through inland fisheries
13	NEH/20-23/03	Refinement of management strategies for openwater fisheries of Norteastern Region through location and ecosystem-based approaches

Externally Funded Projects

Sl. No.	Project Title	Funding Agency
1	National surveillance programme for aquatic animal diseases	NFDB
2	Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan	Ministry of Water Resources, River Development & Ganga Rejuvenation
3	Impact of climate change in inland fisheries and development of adaptation strategies	DARE, Ministry of Agriculture (through ICAR-CRIDA)
4	Microbiome meta-transcriptomics assessment of Indian River basins for eco system health monitoring	ICAR (through ICAR-IASRI)
5	All India network project on fish health	ICAR (through ICAR-CIBA)
6	Hilsa fisheries improvement in middle stretch (Farakka to Prayagraj) of the river Ganga	National Mission for Clean Ganga
7	Fisheries development in Majhariamaun of Bihar through refinement of site specific fisheries enhancement technology – an innovative project	DAHD&F
8	Fisheries development in Sirsa wetland of Bihar through in-situ fish feed rearing and fisheries enhancement techniques for tapping fish production potential – an innovative project	DAHD&F
09	Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholder participation for capacity building and improved livelihood – an innovative project	DAHD&F
10	Fisheries development in Rulhi wetland of Bihar through stakeholders' participatory fisheries management model (co-management) in a sustainable manner- an innovative project	DAHD&F
11	Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India	National Mission on Himalayan Studies
12	Fisheries development in Kothiamaun of Bihar - A pilot project	NFDB
13	Cage culture in reservoirs as collaborative programme between Department of Fisheries, Telangana state and ICAR-CIFRI during 2018-2020	DoF, Telangana
14	Collaborative research project with WorldFish Centre under Window-3 Program	ICAR-WorldFish
15	Study on input costs and farm-gate prices of inland fisheries in India	Ministry of Statistics Programme Implementation
16	Assessment of endocrine disruption in fish reproduction	DBT
17	MEAN: Measuring Endocrine Disrupting Chemicals (EDC) and Aquatic diagnostics through Bio-Sensory Network with a special reference to North East India	Ministry of Electronics and Information Technology
18	Development of biosensors for detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies	NASF, ICAR
19	Introducing 'Ecosystem based integrated wetland management' in lower Gangetic plains of West Bengal: A tool to empower women of fishermen community	DBT
20	National Agricultural Innovation Fund (NAIF) Component-1 ITMU	ICAR

Consultancy Projects

Sl. No.	Project Title	Funding Agency
1	Assessment and Management of Fisheries Resources of Pong Reservoir, Himachal Pradesh" (Project no: 16.9020.5-001.00)	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
2	Assessment and impact study on bio -diversity, eco-hydrology, fish population dynamics and livelihood of fishers in Narmada river with special focus on downstream of Sardar Sarovar Dam and Bhadbhut Reservoir	Narmada Water Resources, Water Supply & Kalpasar Department, Govt. of Gujarat
3	Assessment of Efficacy of Fish Pass/Fish Ladder at Teesta Low Dam -III & Teesta Low Dam- IV Power Stations, Distt. Darjeeling, West Bengal	National Hydroelectric Power Corporation Limited (NHPC)
4	Study on viable and feasible alternative on the blocked migratory movement of fish species due to construction of the Naitwar Mori -Hydro-electric Project	Satluj Jal Vidyut Nigam Limited (SJVN)
5	Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar Reservoir	Madhya Pradesh Fisheries Federation
6	Investigation on ecological status, conservation and enhancement of fisheries in Gujarat part of Sardar Sarovar Reservoir	Sardar Sarovar Narmada Nigam Limited (SSNL)
7	Impact assessment of hydro-ecological changes of fisheries and socio-economy of fishers downstream of Sardar Sarovar Dam in Narmada Basin	Sardar Sarovar Narmada Nigam Limited (SSNL)

WorldFish project review meeting

A review meeting under the World Fish Window-3 project was held on 4 January 2020 at the institute headquarters, Barrackpore. Dr. J. K. Jena, DDG (Fy.Sc.), ICAR, New Delhi chaired the meeting. He gave a brief overview of the project, following which detail achievements were presented by the respective institute. Dr. Bindu R. Pillai and Dr. P.C. Das from ICAR-CIFA, Bhubaneswar; Dr. Suseela Mathew and Dr. A. K. Mohanty from ICAR-CIFT Cochin and Dr. B.K. Das and other staff from ICAR-CIFRI attended the meeting.

Review meeting of the WorldFish project

Conference on Ecosystem Health and Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation

Aquatic ecosystems, their biotic communities and fisheries are highly stressed all over the world, including in India. Inland Fisheries Society of India (IFSI), ICAR - Central Inland Fisheries Research Institute (ICAR-CIFRI), G. B. Pant University of Agriculture and Technology (GBPUAT), Aquatic Ecosystem Health & Management Society (AEHMS), and Professional Fisheries Graduate Forum (PFGF) joined hands to convene the conference "Ecosystem Health and Fisheries of Indian Inland Waters: Multiple stressors, Management and Conservation" at GBPUAT, Pantnagar, during 17-19 February 2020.

Dr. Joykrushna Jena, Deputy Director General (Fisheries Science) ICAR inaugurated the Conference in presence of Dr. Tej Pratap, Vice-Chancellor, GBPUAT, and many other dignitaries. Dr. Gopal Krishna and Dr. M. Munawar delivered keynote addresses. The lead lectures were given by Dr. Sandeep Behera, Chief Consultant, NMCG, Dr. Dilip Kumar, Former Director & VC, ICAR-CIFE, Dr. V.V. Sugunan,

Inauguration of the AEHMS12 Conference

A few glimpses of the Conference

Former ADG (Inland Fisheries), ICAR, Dr. B. K. Das, Director, ICAR-CIFRI, and Dr. Debajit Sarma, Director, ICAR-DCFR. The keynote session was chaired by Dr. J. K. Jena and Dr. S. D. Tripathi, and lead lecture session chaired by Dr. Gopal Krishna and Dr. V.V. Sugunan.

The three day mega-event comprised of various events including inauguration, keynote and lead lecture session, technical sessions, gold medal presentations, poster presentations, exhibitions, satellite sessions for farmers, plenary sessions and valedictory programme. More than 200 researchers, academicians including scientists from Canada and Bangladesh along with 150 farmers of Uttarakhand, Uttar Pradesh and West Bengal participated in the conference. The oral presentations were conducted in four regular sessions, viz., Ecosystems of inland waters; Impact of multiple stressors; Ecosystem assessment, monitoring, tools and techniques; Ecosystem based management besides two Special Sessions on Climate change adaptations: Tools & techniques; and Towards developing blue economy in India.

The valedictory ceremony was held on 19 February with Dr. Tez Pratap, Vice Chancellor, GBPUAT as the chief guest of function. Dr. B. K. Das, Dr. M. Munawar, Dr. Dilip Kimar, Dr. S. D. Tripathi, Dr. V. V. Sugunan and Dr. A. P. Sharma made their remarks in the ceremony and appreciated everyone for the grand success of the Conference with special emphasis on the well attended, deliberated and

Group photograph of Winter School Participants

active sessions of the Conference.

ICAR Winter School on "Advances in management of inland open-water ecosystem health"

The Institute organised the ICAR-sponsored winter school on "Advances in Management of Inland Open-water Ecosystem Health" during 21 January - 10 February 2020. Scientists, University Faculty and Subject Matter Specialist from Krishi Vigyaan Kendras (KVKs) and Post-docs from Assam, Chattisgarh, Madhya Pradesh, Odisha, Tamil Nadu, Tripura and West Bengal participated in the Winter School. Some of the important topics covered were: Recent approaches in aquatic ecosystem health assessment, Emerging contaminants in open water, Fish health management in inland open waters, Geospatial technology in inland aquatic resource management, Metagenomics, Aquatic ecosystem health for ensuring food safety and nutritional security, Impact assessment of barge movement, Water quality assessment tools, Ecosystem vulnerabilities toclimate change, Nanotechnology in ecosystem health assessment, Nutrigenomics, AI, Big data and IoT in aquaculture and fisheries, Environmental Management issues in wetlands and reservoirs, Economic valuation of ecosystem services, Economic valuation of ecosystem services, EDCs in open water ecosystems, 2-D electrophoresis, immunoblotting, PCR, fatty acid, amino acid, pesticide and heavy metals analysis by HPLC, GCMS, AAS, etc.

Workshop on Pen aquaculture at Namsai district, Arunachal Pradesh

A workshop on 'Pen aquaculture technology for improved livelihood' was organized by the Guwahati Regional Centre, in collaboration with the Directorate of Fisheries, Govt. of Arunachal Pradesh at Jona III village on the banks of Bor Beel on 04 Feb 2020. It was organized for capacity building of the local beel users community on various aspects of pen aquaculture technology. Fish culture in pen enclosures has been initiated in Bor Beel by ICAR-CIFRI RC, Guwahati under the project sponsored by the National Mission on

Workshop on 'Pen aquaculture technology for improved livelihood'

Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD), Almora, Uttarakhand. A total of 35 fishers from the village (including 6 women and 4 youth) participated in the day-long programme. Shri BijayTalukdar, Deputy Commissioner, Namsai district, District Officers of Fishery, Agriculture; Veterinary, Horticulture, Textile & Handicrafts and staff of Krishi Vigyan Kendra and ICAR-CIFRI were present in the workshop. The Heads of agriculture and allied departments also discussed various Govt. schemes and urged the participants to avail them.

Workshop on e-Office

Workshop on e-office

A training-cum-workshop on e-Office was conducted by ICAR at ICAR-CIFRI, Barrackpore during 11-12 Feb, 2020. Total 23 Administrative and Technical staff of ICAR-CIFRI, Barrackpore and its' Regional Centres have participated in the workshop. Staff of ICAR-ATARI, Kolkata Regional Centre and ICAR-NBSS&LUP, Kolkata Regional Centre also attended the training programme. Shri S.K.Sahu, Scientist & In-Charge, AKMU, ICAR-CIFRI was the Nodal Officer of the said training programme. Shri Rakesh Kr. Saini, Chief Technical Officer (IT), ICAR-IASRI, Pusa, New Delhi along with his team trained the staff. This training workshop was co-ordinated by Shri Rajeev Lal, CAO, ICAR-CIFRI.

Workshop-cum-training programme on Better health management practices in cage culture

A two-days Workshop-cum-Training programme on "Better health management practices in cage culture" was organized at Chandil, Jharkhand during 4-5 March 2020 under the All India Network Project on Fish Health. The programme was inaugurated by the august presence of Sh. Ashis Kumar Sarai, Deputy Director of Fisheries, Ranchi, other officials and local Fishers' representative. A total of eighty five cage fish farmers from Jharkhand participated

Workshop-cum-Training programme at Chandil reservoir

RAC Meeting

in this workshop. Pamphlets prepared by CIFRI in English and Hindi languages on "Better health management practices in cage culture" were unveiled and distributed among the participants.

Research Advisory Committee (RAC) Meeting

The Research Advisory Committee (RAC) Meeting of the Institute was held on 18 May 2020 in video conferencing mode. This is the first meeting of newly constituted RAC (2020-2022) of the Institute. The Chairman Prof. (Dr) Baskaran Manimran along with other RAC Members viz. Dr. K.G. Padmakumar, Dr. Sharad Kumar Jain, Dr. S. C. Pathak and Dr. B. P. Mohanty (ADG, I. Fy.), ICAR participated in the meeting. Dr. J. K. Jena, DDG (Fy. Sc.), ICAR took special interest and participated in the meeting and requested the committee to recommend advisories for the progress of research activities of the Institute. Dr. B.K. Das, Director requested the RAC to guide the research activities of the Institute so as to deliver and translate research into actionable recommendations to address food, livelihood and nutritional security of this country. Heads of Divisions/sections, Head of the Regional Centres and Stations presented their respective research and other achievements.

IRC meeting

Institute Research Committee Meeting for the year 2019-20 started on 8th June 2020 at the Institute headquarters both in on-line and off-line mode. The meeting was started with a welcome address by Dr. Arun Pandit, Member Secretary IRC. Dr. B.P. Mohanty, newly joined ADG (I. Fishery) also joined the meeting. The IRC mourned to the untimely death of Ms. Sukanya Som, Scientist and observed 2 minutes silence in honour of the departed Soul. Following this Scientists presented their achievements and future work plan. New project proposals were also presented in the IRC.

IRC Meeting

Webinar on river dolphin conservation

International webinar for Enhancing conservation of river dolphins through sub-regional cooperation

The indiscriminate and illegal fishing has resulted in catching juvenile fishes and accidental/illegal catching of dolphins from inland waters. A two-days International Webinar on "Exploring the impact of COVID-19 on the ecosystem health of rivers and its dolphin population: Present status and future strategy for conservation in India-Bangladesh-Myanmar-Nepal" was inaugurated by Shri Rajiv Ranjan Mishra, IAS, Special Secretary and Director General, National Mission of Clean Ganga (NMCG), Ministry of Jalashakti, Government of India on 24 August 2020. This Webinar aimed at the conservation of river dolphins in the South East Asian region through regional strategy and partnership. Experts on dolphins from various countries viz. India, Nepal, Myanmar, Bangladesh and Indonesia participated and shared their experience in this Webinar. More than 1000 participants from various Research Organizations, Colleges, Universities of India and other countries registered for this Webinar. A total 22 experts represented their country paper in this virtual seminar.

Global webinar on Small scale fisheries in inland open water: status and opportunity

A Pan-Asia webinar on "Small Scale Fisheries in Inland open water: Status and opportunity" was held on 9 September 2020 with virtual participation of experts, academicians and institutions from India, Bangladesh, Srilanka, Nepal, Malaysia along with the experts from Canada, FAO, and Belgium. The webinar was inaugurated by Dr. J. K. Jena, DDG (Fisheries Science), ICAR, New Delhi. Experts like Dr. B. K. Das, Director, ICAR-CIFRI, Dr. Dilip Kumar, Former Director, ICAR-CIFE, Dr. C. V. Mohan of WorldFish centre, Penang Malaysia spoke on this occasion. This

Webinar on Small scale fisheries

webinar, organized jointly by ICAR-CIFRI, IFSI, and PFGF India made a review of the present situation and formulated future strategies for enhancing small–scale fisheries management with the objective to fulfill five major Sustainable Development Goals (SDGs) through national and sub-regional cooperation. More than 30 research papers were presented in different technical sessions. More than 1700 participants including policymakers, scientists of India and abroad registered and participated through web platforms, out of which 65% were scholars and students, 22% were academicians, 11 % were entrepreneurs and self employed and 2% were fishers.

Webinar on International freshwater dolphin day for "enhancing conservation of river dolphins"

Realizing the vulnerability of freshwater dolphins and its importance for conservation, a one-day International webinar on "Enhancing conservation of river dolphins" coinciding with International Freshwater Dolphin Day was organised by ICAR-CIFRI in collaboration with NMCG (National Mission for Clean Ganga), IFSI (Inland Fisheries Society of India), and PFGF (Professional Fisheries Graduates Forum) on 24 November 2020. The webinar was inaugurated by Dr. Rajiv Ranjan Mishra, IAS, Special Secretary and Director General, National Mission of Clean Ganga (NMCG), Ministry of Jalshakti, Government of India. Experts on dolphins from various countries viz., India, Nepal, and Bangladesh participated and shared their experience. Dr. B. C. Choudhury, well-known dolphin expert, emphasised on 6 Es for conservation which includes Ecological maintenance, Exploitation of the resources judiciously, E-flow, Empathy of community involvement, Exchange of scientific information and Education and awareness. More than 800 participants participated in this webinar through virtual mode.

Webinar on International freshwater dolphin day

Stakeholder's meet and distribution of inputs for climate smart wetland fisheries

A stakeholder meeting-cum-awareness program was organized by the Institute at

Stakeholder's meet at Media beel

Media beel, North 24 Parganas on 16 December 2020 to create awareness on climate change and its deleterious impacts on wetland fisheries under the project "National Innovations on Climate Resilient Agriculture (NICRA)". Dr. B. K. Das, Director, ICAR-CIFRI presided over the meeting. The meeting was attended by 100 fishers and project investigators from the Institute. The program was inaugurated with the release of 45000 fish fingerlings of Indian major carps, bata (*Labeo bata*), punti (*Puntius sarana*) and tengra (*Mystus* sp.) by the Director. He stated that the Institute is committed to lend technological support to the inland fishers of the country and motivated them to build their capacities on scientific management practices and climate-resilient tools for sustainable fisheries. Addressing the gathering Dr. U. K. Sarkar, Head of Reservoir and Wetland Fisheries Division and Principal Investigator, NICRA briefed about the programme and explained the various climate-smart adaptation strategies. The office-bearers of co-operative societies and fishers of Media and Panchpota wetlands expressed the difficulties and challenges faced in managing the wetland fisheries in the changing scenario. The program also involved an interaction session between the fishers and scientific staff of the Institute.

Awareness programme and participatory rural appraisal vis-a'-vis agro-aqua ecosystem analysis

The Beledanga beel in North 24 Parganas district provides livelihood to the people living in the adjoining villages. Physical degradation of the wetland is quite visible and it has important implications for sustainable development. PRA was conducted on 22 December 2020 to identify the threats perceived by the beel dependent community. Matrix ranking was done with active participation of the beel dependent community and it was found that encroachment, weed infestation, lack of technical knowhow, lack of capital in the hand of the FCS, lack of willingness of the management of the FCS, local politics, intensive poaching, etc. are the major issues affecting fish production as well as the livelihoods of the beel dependent community.

PRA activity at Beledanga beel

Annual Sports

ICAR-CIFRI organized Annual Sports on 25 and 27 January 2020 at Barrackpore Head Quarter. In the inauguration, Dr. B.K. Das, Director urged all the staff including contractual and research scholar to involve in the two days different sports events with true sportsman spirit and develop kinship among others. The staff participated enthusiastically in various events like 100 m race, kick the football, hit the wicket, cricket, volleyball, tug of war, in addition to various indoor games like TT, carom, chess, badminton.

Republic Day

The Institute celebrated the Republic Day with great enthusiasm on 26 January 2020. Dr. B. K. Das, Director hoisted the tri-colour and paid rich tribute to the nation. He remarked that India gained freedom after lot of struggle by the freedom fighters. Hence, preserving the unity of our nation is our sacred duty. In his speech, he also recounted the achievements of CIFRI during the last one year. He remarked that a good working atmosphere and team spirit are the key to success. All the CIFRI staff and their family members were present on the occasion.

River ranching programmes on different occasions

Ranching on the eve of 71st Republic Day

On the occasion of 71st republic day, ICAR-CIFRI conducted a ranching programme by releasing 50,000 fingerlings of Indian major craps in River Ganga at Gandhi Ghat with an aim of sustaining and conserving the biodiversity in the river under Namami Gange Program. The programme was organized in collaboration with Vivekananda State Police Academy, West Bengal. Shri Deepankar Bhattacharya, IPS and DIG of Vivekananda State Police Academy, graced the event as the guest of honour. Trilingual pamphlets were distributed among the fishermen and public present. More than 150 officials of the Police Academy, NMCG project staffs and ICAR-CIFRI members were present during the river ranching.

Ranching in Prayagraj 'Sangam' during Magh Mela

A total of 20,000 fingerlings of Indian major carps were released in the Ganga river at Sangam nose, Prayagraj on 11 February 2020 during Magh Mela. The Programme was organized by ICAR-CIFRI Allahabad under Namami Gange to restore and conserve the depleting fish stock in the river. Mr. Atharvraj from NMCG, Delhi was the chief guest in the occasion who briefly described the role of NMCG and work undertaken in Namami Gange Programme. He also sensitized the audience about pollution free Ganga and

importance of Ganga for the existence of civilization. On this occasion he released a leaflet titled "Matsya Jaiv Vividhata." The event was attended by officials from Ganga Task force, Ganga Prahari, Ganga Vichar Manch Ganga, the pilgrimage of Magh Mela, students of university, WII, Fisheries Dept. of Uttrar Pradesh, NGOs, fishers of nearby villages, fish traders and local people living on the bank of the Ganga.

River ranching on 74th Foundation Day of ICAR-CIFRI

On 17 March 2020, ICAR-CIFRI celebrated its 74th Foundation day at the Institute headquarter, Barrackpore. The grand ceremony culminated with ranching of 50,000 advance fingerlings of Indian major carp seed in River Ganga at Barrackpore ghat in presence of the honourable guests, Dr. Ashok Kumar Saxena, Former President of Indian Science Congress Association and Dr. (Smt.) Vijayalakshmi Saxena, General President (Elected) of Indian Science Congress and Chief Guest of the function.

A series of five river ranching and dolphin awareness programmes

ICAR-Central Inland Fisheries Research Institute, Barrackpore, conducted a series of five river Ranching programmes and Dolphin Awareness during 11-16 June

2020 as a part of 'NAMAMI GANGE' programme during the post-lockdown situation. The ranching programmes extended over four districts (Burdwan, Nadia, Hooghly and North 24 Parganas) of West Bengal. As a part of the campaign, a total of 2.0 lakh advance fingerlings had been released during the entire ranching week at different stretches of river Ganga namely Nabadwip, Kalna, Balagarh, Tribeni and Barrackpore. The program focused on replenishing IMC (Labeo rohita, Labeo catla, Cirrhnus mrigala and Labeo calbasu) fish resource in severely stressed areas of the river. River ranching programme can pave a way for stock enhancement in open water resources and is vital for restoration, conservation and upliftment of this declined fish fauna. Local fishermen and stakeholders present in the program were sensitized about various factors behind declining fish biodiversity as well as total fish catch from river Ganga such as indiscriminate destruction of brooders and juvenile fishes by use of zero mesh destructive fishing gears and also asking for their active cooperation towards success of river ranching program. An awareness programme was also organized on Dolphin conservation along the Ganga coast from Nabadwip to Barrackpore. The efforts made by the Institute under its National Mission for Clean Ganga Project (NMCG) was highly appreciated by both local authorities and fishers communities.

Ranching of advanced fingerling in the river Ganga at Prayagraj

A total of 5,000 advanced fingerling seeds of Indian major carps were released in the Ganga river at Sangam nose, Prayagraj on 20 June 2020. The Programme was organized by Allhabad regional Centre of ICAR-CIFRI under Namami Gange to restore and conserve the depleting fish species. Irafannulh Khan, Fishery Inspector from Fishery Department, Uttar Pradesh was the chief guest on the occasion. He briefly described about the fish and fishes of the Ganga river and government scheme related to fishermen. Special guest of the function Shri Rajesh Sharma, Co-ordinator, Ganga Vichar Manch / Namami Gange highlighted the role of NMCG and work undertaken in Namami Gange Programme. Mr. R. K. Tiwari alias Dukanji, brand ambassador of Swachchhata of Nagar Nigam was present who sensitized the audience about pollution free Ganga and importance of Ganga for the existence of civilization. The event was attended by officials from Ganga Vichar Manch. Wildlife Institute of India, the pilgrimage of Sangam, WII, Fisheries Dept. of Uttrar Pradesh, students of nearby colleges, fishers of nearby villages, fish traders and local people living on the bank of the Ganga participated in the programme.

Ranching during celebration of Ganga Utsav

ICAR-Central Inland Fisheries Research Institute, Barrackpore fervently celebrated Ganga Utsav 2020

initiated by National Mission of Clean Ganga (NMCG). On the third day of the celebration, a carp ranching was organized at Barrackpore Gandhi Ghat. A total of 50,000 fish fingerlings and advanced fingerlings of Rohu, Catla and Mrigal were released in the river. Police officials and their family members from Barrackpore Police Commissionerate have actively participated in the ranching program.

River ranching on the occasion of 'World Fisheries Day' celebration

ICAR-CIFRI, Prayagraj celebrated 'World Fishery Day' by organising a ranching cum mass awareness programme at Diha village. A total of 15,000 fingerlings were released into the Ganga River. About 50 fishermen participated in the programme.

Fish harvest mela at Rulhi wetland, Bihar

The Institute organized a fish harvest mela at Rulhi maun, a seasonally open ox-bow lake with 80 ha water spread area at Motihari, East Champaran, Bihar on 9 February 2020. The mela was attended by the District Fisheries Officer, local officials along with different stakeholders and more than 100 fishers. This is one of the wetlands where the Central Sector Scheme (CSS) on Blue Revolution is being successfully demonstrated employing the ICAR-CIFRI's technologies for sustainable exploitation of under-exploited wetlands of Bihar with financial assistance from NFDB Hyderabad. Technological interventions by ICAR-CIFRI during the last two years at Rulhi maun have led to increase in fishing days from 35 days to 93 days and fish yield from 60 to 153 kg/ha. Extended fishing period has also reduced migration of fishers for non-fishing jobs to other cities.

मछुआरों की आय बढ़ कर हुई तीगुनी

Workshop on stress management

The Institute organized a four-days workshop on Art of

Living, especially stress management for staff members of the institute during 6-9 March 2020 at the Institute HQ. The course helped cleaning the mind and the practice of Yoga and pranayama aided in better fitness and stress free mind. The course created a positive vibe among the participants and ensured their well being.

74th Foundation Day of ICAR-CIFRI

ICAR-Central Inland Fisheries Research Institute, Barrackpore Celebrated its 74th Foundation Day on 17 March 2020 at the Institute headquarter, Barrackpore. Dr. B. K. Das, Director congratulated all CIFRIans, progressive fish farmers, fisheries industries, etc. who were part of the momentous 73 years of epic journey of ICAR-CIFRI. Dr. Ashok Kumar Saxena, Former President of Indian Science Congress Association and Guest of Honour in his address congratulated officers and staffs of CIFRI for its 74th foundation day. He thanked the scientists for creating awareness among farmers for second green revolution and doubling farmers' income through enhancing fish production. Dr. (Smt) Vijayalakshmi Saxena, General President of Indian Science Congress and Chief Guest of the function congratulated the Director and all the staff members of ICAR-CIFRI on this momentous occasion. She hoped that ranching efforts taken up by the Institute would pave the way for improved fish diversity in river Ganga. On this occasion two publications, namely, "Eurihaline fishes of river Ganga" and Hindi magazine "Nilanjali" were released by the dignitaries. About, 100 fish participated in the foundation day ceremony.

संसदीय राजभाषा समिति का आगमन

संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा दिनांक 26–28 फरवरी 2020 तक वडोदरा के 21 कार्यालयों का राजभाषा कार्यान्वकयन में हुई प्रगति का निरीक्षण किया। इसी क्रम में भाकृअनुप–केन्द्री य अंतर्स्थकलीय मात्स्यिकी अनुसंधान संस्थारन, क्षेत्रीय केन्द्रे, वडोदरा का दिनांक 27 फरवरी, 2020 को राजभाषा कार्यान्व्यन में हुई प्रगति का निरीक्षण किया ।निरीक्षण बैठक दिनांक 27 फरवरी, 2020

को पूर्वाह्न शुरु की गई जिसमें संसदीय राजभाषा समिति की दूसरी उपसमिति के गणमान्यन सदस्यों के अतिरिक्तर निरीक्षण कार्यालय की ओर से डॉ. बि. के. दास, निदेशक, भारतीय कृषि अनुसंधान परिषद (भाकृअनुप), नई दिल्ली के प्रतिनिधि के रूप में डॉ. प्रवीण कुमार, सहायक महानिदेशक (समुद्री मात्स्यिकी), श्रीमती सीमा चोपड़ा, निदेशक (राजभाषा), श्री राजीव लाल, मुख्य् प्रशासनिक अधिकारी, केन्द्रू के प्रभारी अधिकारी डा. एस. पी. काम्बाले, उपस्थित थे। संसदीय समिति के गणमान्यि सदस्यों ने बड़ी ही उत्सुकता के साथ प्रदर्शित सामग्रियों को देखा तथा विभिन्न तकनीकी तथा प्रशासनिक प्रकाशनों के बारे में जानकारी ली।

International Womens' Day

International Women's Day (IWD) is a global day celebrating the social, economic, cultural and political achievements of women - while also marking a call to action for accelerating gender equality. The institute celebrated the International Women's Day on 7 March 2020 at the headquarters, Barrackpore. The theme of this year's IWD was "I am Generation Equality: Realizing Women's Rights" by the UNO. Gender equality is essential for economies and communities to thrive. A gender equal world can be healthier, wealthier and more harmonious. On the occasion Dr. B.P.Mohanty, ADG (Inland Fy) and Dr. B.K. Das, Director and few women staff spoke about women's contribution in our nation building. Cultural programme and food court were also arranged on the occasion.

International Yoga Day

The 6th International Yoga Day was celebrated on 21 June 2020 with great enthusiasm. In spite of the COVID-19 pandemic, all the staffs made it a point to perform yoga fervently at homes. There were around 380 participants from the Institute including the Centres. Dr. B. K. Das, Director advised that yoga should be a daily part of our lives, especially in pandemic situation to keep ourselves fit and healthy.

National Fish Farmers' Day

To commemorate the first success of induced breeding by Prof. Hira Lal Chaudhary, the Government of India has declared 10 July of every year to be celebrated as National Fish Farmers Day. ICAR-CIFRI celebrated National Fish Farmers' Day on virtual platform on 10 July 2020. The virtual event witnessed a gathering of more than 300 fish farmers, entrepreneur, students and fish production groups from 14 states including West Bengal, Bihar, Gujarat, Odisha, Assam, Kerala, Tripura, Meghalaya, Manipur and Arunachal Pradesh, Uttar Pradesh and Punjab. Shri Pratap Chandra Sarangi, Honourable Minister of State of Fisheries, Animal Husbandry & Dairying and MSME of Govt. of India graced as Chief Guest of the Programme. Dr. M. R. Sinha, Dr Joykrushna Jena, DDG, (Fisheries Science), ICAR and Prof. A. P. Sharma, Dr. B.K. Das were also present. The Chief Guest paid gratitude to Late Hira Lal Choudhury for his remarkable invention. He desired India should become the largest fish producer country in the world and that should be the target of all farmers, scientists and other stakeholders. Dr. Ravishankar, C. N., Director, ICAR-CIFT, Cochin, Dr. A Gopalakrishnan, Director, ICAR-CMFRI, Cochin, Dr. Gopal Krishna, Director & Vice-Chancellor, ICAR-CIFE, Mumbai, Dr. Dilip Kumar, Former Director, ICAR-CIFE, Mumbai also addressed the gathering.

केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसन्धान संस्थान, बैरकपुर में हिंदी सप्ताह का उद्घाटन

हिंदी दिवस के अवसर पर केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसन्धान संस्थान, बैरकपुर में हिंदी सप्ताह के वर्चुअल आयोजन का उद्घाटन मुख्य अतिथि भारतीय विज्ञान कांग्रेस संस्था, कोलकाता की निर्वाचित अध्यक्षा डॉ श्रीमती विजया लक्ष्मी सक्सेना जी के द्वारा किया गया । इस अवसर पर अन्य विशिष्ट अतिथि डॉ अशोक कुमार सक्सेना, पूर्व अध्यक्ष, भारतीय विज्ञान कांग्रेस, डॉ विमल मोहन्ती, सहायक महानिदेशक भारतीय कृषि अनुसन्धान परिषद, दिल्ली, संस्थान के निदेशक डॉ वसंत कुमार दास, एवं संस्थान के सभी विभागाध्यक्ष एवं वैज्ञानिक मौजूद थे । डॉ विमल मोहन्ती, सहायक महानिदेशक भारतीय कृषि अनुसन्धान परिषद, दिल्ली ने अपने वक्तव्य में कहा की यह संस्थान

विगत तीन वर्षो से प्रतिवर्ष भारतीय विज्ञान कांग्रेस संस्था , कोलकाता के साथ हिंदी दिवस का आयोजन करता रहा है ।

मुख्य अतिथि भारतीय विज्ञान कांग्रेस संस्था, कोलकाता की निर्वाचित अध्यक्षा डॉ श्रीमती विजया लक्ष्मी सक्सेना ने संस्थान के निदेशक एवं कर्मचारिओं को हिंदी दिवस के आयोजन की बधाई दी । उन्होंने कहा की 14 सितम्बर १९५३ को पहली बार हिंदी दिवस का आयोजन हुआ था । हिंदी जन संवाद की भाषा है, और बोलचाल की भाषा के रूप में यह भारत के अनेक प्रदेशो में सुदृढ़ है । संस्थान के निदेशक डॉ वसंत कुमार दास ने अपने अध्यक्षीय वक्तव्य में कहा की इस साल कोरोना महामारी के कारण हिंदी सप्ताह का आयोजन वर्चुअल प्लेटफार्म पर किया जा रहा है इसमें संस्थान के सभी क्षेत्रियो केन्द्रों के साथ साथ भारतीय विज्ञान कांग्रेस संस्था, कोलकाता के सभी पदाधिकारीगण जुड़े हुए है ।

Independence Day

The 74th Independence Day of the Nation was celebrated at the Institute on 15 August 2020. The day began with the disciplined march past carried out by the Security Guards followed by flag hoisting by Dr. B. K. Das, Directior. Due to COVID-19 pandemic the programme was held maintaining physical distance and all other precautions. Director congratulated all the staff for the great achievements made by the Institute during the last one year and also appealed to all staffs to follow Covid guidelines and remain cautious.

Hon'ble Minister of State for Fisheries, AH D & MSME visits CIFRI Pen demonstration site at Rishia reservoir

Shri Pratap Chandra Sarangi, Hon'ble Minister of State for Fisheries, AH D & MSME Visited the ICAR-CIFRI Pen demonstration site at Rishia reservoir, Balasore on 30 September 2020. ICAR-CIFRI is demonstrating CIFRI Pen HDPE® culture technology in Rishia reservoir for in situ advance fingerling production and stocking in the reservoir. ICAR-CIFRI's low-cost in situ fish seed production technology through CIFRI Pen HDPE for reservoirs and wetlands were being demonstrated in the reservoir. Two pens of 0.1 ha each has been installed in the reservoir and 32,000 fish seed were released in the pens by honourable Minister. He also distributed CIFRI CAGEGROW® fish feed to the fishers for feeding in pen culture. Honourable Minister in his address emphasized on the cooperation and unity among the fishers for their livelihood development. Dr. B. K. Das, Director, CIFRI briefed him about the activities carried out by CIFRI in Odisha. He assured the fishers of technical support from ICAR-CIFRI and also the whole hearted support to make the demonstration successful for expansion of the same to produce more fish seed from pen culture.

150th Gandhi Jayanti Saptah

To commemorate the 150th Birth Anniversary of Bapu Mahatma Gandhi, the Institute organized 150th Gandhi Jayanti saptah from 26 September to 2 October 2020 with wide array of programmes. On 26 September, Swachh Bharat programme was undertaken, on 27 and 28 October painting competition was organized where school children and staff members participated. On 29 September 2020 capacity building programme

on “Knowledge empowerment of youth on inland fisheries management: A way towards Atmanirbhar Bharat” was organized for rural youth in virtual platform. On 30 September 2020, Prof. Shankar Kumar Acharya delived lead lecture on “Relevance of Gandhian Philosophy on Agriculture”. On 1 October, Webinar on Women empowerment was organized with lectures by Nikita Gopal, Dr. Nandini Salaria, IFS, and Archana Kak Kumar, followed by panel discussion. The week-long celebration was culminated on 2 October 2020 with Webinar-cum-stakeholders meet on “Reinventing Gandhian Philosophy in improving fishers' livelihood”. More than 300 fishers from Northern, Eastern, Southern, Western and North-Eastern states of India participated in this programme through virtual platform.

Dr. V. V. Sugunan, Former ADG (Inland Fisheries), ICAR, Dr. J. K. Jena, DDG (Fisheries Science), Dr. Dilip Kumar, Former Director & VC, ICAR-CIFE, Fishers, fishermen cooperative society members and farmer entrepreneurs from Manipur, Assam, Meghalaya, Karnataka, Kerala, Odisha, West Bengal, Bihar, Uttar Pradesh, and Gujarat participated and gave their opinions.

Vigilance Awareness Week

The Institute observed "Vigilance Awareness Week” during 27 October to 2 November 2020 focusing on the theme area" Vigilant India – Prosperous India” maintaining the COVID-19 safety protocols. The week-long observance started with administration of pledge to the officials and staff on 27 October by the Director. Many of the staff also took e-pledge. Large numbers of posters, banners, placards were displayed at the campus premises showing the ill effects of corruption and the commitment of CIFRI toward zero tolerance on corruption.

The walkathon arouse much interest of the locals and commuters. Quiz, extempore competition, in-house seminar were also organized. The week-long celebration was culminated through a concluding ceremony on 2 November in which Shri Dhrubajyoti De, IPS, Joint Commissioner of Police, Barrackpore Police Commissionerate was the Chief Guest. He delivered a thought-provoking lecture for upholding the highest standards of ethical conduct, honesty and integrity. Dr. B.K. Das, Director discussed the importance of transparency and preventive vigilance for a corruption-free organization. Dr. Arun Pandit, Vigilance Officer of the institute presented the activities carried out during the vigilance awareness week.

Ganga Utsav 2020

The Ganga Utsav 2020, initiated by National Mission of Clean Ganga (NMCG), was fervently celebrated by ICAR-CIFRI during 2-4 November 2020. The inaugural programme was graced by Mr. Dhrubajyoti Dey, IPS, Joint Commissioner of Police (Barrackpore Police Commissionerate). Ranching of more than 300 numbers of Hilsa (Tenualosa ilisha) was conducted in upstream of Farakka stretch. The prized species was also tagged. A cultural event was organized in the CIFRI campus. A blissful Ganga Arati followed

by a carp ranching program (50,000 fish) was organized at Barrackpore Gandhi Ghat.

World Antibiotic Awareness Week (WAAW-2020)

World AMR awareness week under the "Indian Network for Fisheries and Animal Antimicrobial Resistance (INFAAR)" programme was organised by ICAR-CIFRI, Barrackpore during 18-24 November 2020. The main objective of the programme was to create awareness among the fish farmers, fishermen, animal rearing farmers to reduce the use of antibiotics in the rearing and growing period of the fish and animals. In this connection, an awareness programme was created at Farakka, West Bengal on 18 November 2020. Dr. A. K. Sahoo, PI of the project, described the importance of the week (18-24 November 2020) for creating wider awareness on the antibiotic uses and consequences of the over- and under-use of antibiotics towards developing antibacterial resistance. A pledge was taken by all the participants to stop misuse of antimicrobial products in animals and fisheries and in Inland open waters, particularly in ponds, rivers and wetlands. As a part of the awareness programme, more than 40 students from Digsui Sadhana Banga Vidyalaya, Hooghly Dist, West Bengal participated in a virtual platform on the topic "

Antibiotics: Handle with Care" on 21 November 2020.

World Fisheries day

World Fisheries Day was celebrated on 21 November, 2020 at Chamta wetland, Bongaon, West Bengal through a 'field day' with the on-field events like sensitization programme, demonstrations, etc. The programme aimed at generating awareness among the beel dependent communities regarding the importance of climate-resilient

beel fisheries management and also to empower rural youth through climate-resilient small-scale beel fisheries management. Dr. B.K.Das, Director inaugurated the programme by stocking the fingerlings in the pens installed in Chamta wetland. The issues raised by fishers and fish farmers were compiled by the scientists. Fishers from Kholsi beel, Beledanga beel, Chamardaha beel and Panchita beel were also present in the programme.

Communal Harmony Campaign Week and Flag Day

To foster and reinforce the spirit of communal harmony and national integration, ICAR-CIFRI observed the Communal Harmony Campaign Week and Flag Day during 19-25 November 2020. The week long campaign commenced on 19 November with the Pledge taking ceremony on Communal Harmony and National Integration. The Institute was decorated with display of posters and banners spreading messages of brotherhood and integrity. On 25 November 2020 the Flag Day of National Foundation of Communal Harmony was observed by collection of voluntary donations and distribution of flag stickers.

Constitution Day

The Constitution Day Pledge taking ceremony was observed at ICAR-CIFRI to commemorate the adoption of the Constitution of India on 26 November, 2020 by joining the Hon'ble Prime Minister in reading of the Preamble, telecast live through the Govt. of India portal india.gov.in at the Institute Meeting Room. All staff members fervently observed the occasion.

Memorandum of Understanding between ICAR-CIFRI and CSB-CSRTI for utilization and diversification of silkworm pupae products for fish feed

ICAR-Central Inland Fisheries Research Institute, Barrackpore and CSB-Central Sericultural Research and Training Institute, Mysore signed a memorandum of understanding for research proposal on "Utilization and diversification of silkworm pupae products for human & animal consumption and composting" on 8 December 2020. The MOU was signed by Dr. B. K. Das, Director on behalf of ICAR-CIFRI and Dr. Pankaj Tewary, Director on behalf of CSB-CSRTI. Under this collaborative project, ICAR-CIFRI will work on formulation and development of fish feed using silkworm pupae and their testing, trials and validation.

Union Minister of Jalshakti visits Hilsa ranching station of ICAR-CIFRI

Shri Gajendra Singh Shekhawat, Honourable Union Minister of Jal Shakti, visited ICAR-Central Inland Fisheries Research Institute (CIFRI) Hilsa ranching station at Farakka, West Bengal on 18 December 2020. Shri U. P. Singh, IAS, Secretary, Department of Water Resources, River Development and Ganga rejuvenation, Ministry of Jal Shakti, Shri A. K. Jain, Commissioner, Flood Control Management, Ministry of Jal Shakti, and Shri Saibal Ghosh, General Manager, Farakka Barrage Authority (FBA) and staff of FBA, Inland Waterways Authority (IWAI), Central Water Commission (CWC), and ICAR-CIFRI were present on this occasion. Dr. B. K. Das, Director and Co-ordinator and Dr. A.K. Sahoo, Sr. Scientist briefly explained the objectives and ongoing activities of the project with technical interventions for improving Hilsa fisheries in the river Ganga. Honourable Minister released tagged Hilsa in River Ganga at Farakka.

Fish harvest mela at Beledanga

ICAR-CIFRI is working on the production enhancement strategy in wetlands under SCSP and WorldFish – W-3 project in various wetlands of West Bengal. ICAR-CIFRI has adopted the Beledanga

wetalnd in North 24 Parganas of West Bengal and started pen culture demonstration last year with a target of increasing the fish production up to 1000 kg/ha/year in three years. Four numbers of CIFRI Pen HDPE® of 0.1 ha were installed in the wetland and fingerlings of Indian major carp were stocked in 3 pens and Grass carp was stocked in one pen. ICAR-CIFRI has provided technical support and guidance apart from the support in terms of fish feed, fish seed, coracle and boat to the fisheries society. The fish harvest mela was organized in this wetland during 14-18 December 2020. In last one year, the production of the wetland has crossed 30,000 kg with productivity of 500 kg/ha. In the 1st year of intervention of ICAR-CIFRI, 42% increase in fish production has been achieved. It is anticipated that by the year 2022 the production will be doubled with productivity of 1000 kg/ha/year from this wetland.

ICAR-CIFRI provides livelihood support to wetland fishers of Borkona beel, Assam

The institute has been implementing a project titled, "Small scale fisheries in wetlands for livelihood and nutritional security," headed by Dr. B. K. Das, Director, in collaboration with WorldFish, Penang, Malaysia. As part of

the project activities, Borkona beel, a seasonally open floodplain wetland located near Sarthebari in Barpeta district, Assam was selected for technology demonstration. The beel is managed by Bampara Fishery Co-operative Society having 65 active members belonging to scheduled caste community and a total of 350 fisher families depend on the beel for livelihood support. ICAR-CIFRI initiated supplementary stocking with fingerlings of major and minor carps (40,000 nos.) in the beel for the first time on 28 December, 2020. An awareness program was also organised on the occasion.

Agriculture, with its allied sectors, is unquestionably the largest livelihood provider in India, more so in the vast rural areas. “Lab to land" approach is ideal to increase farm productivity as it helps to disseminate technologies to farmers in a simple and acceptable manner. ICAR-CIFRI is torch bearer of the flagship programme 'Mera Gaon Mera Gourav (MGMG)' and always in touch with the fishers, farmers with the objective to propagate scientific know-how for their socio-economic development without disrupting the ecosystem. Under MGMG programme the institute

The summery of the annual progress under MGMG programme

Linkages developed to facilitate the villagers of MGMG adopted villages

organized demonstrations, field days, training programmes, etc. This year due to COVID-19 pandemic ICAR-CIFRI issued guidelines in local languages and provided advisories to the fishers of the MGMG villages. The institute has also provided technical literatures to the farmers of the MGMG adopted villages. Advisories were also extended on impact of climate change in inland waters, pen culture technology, fish as health food, etc.

For successful implementation of the MGMG programmes linkages were developed with sister institute concerns.

Successful demonstrations of CIFRI technology/protocols in MGMG villages

Beledanga village, 24 Pargana (N) district of West Bengal is one of the MGMG adopted villages situated by the side of Beledanga beel. Demonstration of pen culture with Grass carp in CIFRI HDPE pen was carried out to produce in situ carp fingerlings. Fish seed, feed, fishing gears were provided by the institute to the fishermen community of the village. It took only 3 months to grow fry to advanced fingerling stage and the mortality of the released fingerlings in the wetland was also negligible.

"Ecosystem-based integrated wetland management" was demonstrated in Uttar Bramhapur, Khalsi, Mathpara, Kanapukur Danga villages to empower the rural women of the beel dependent community.

Swachh Bharat Abhiyan

The ICAR-CIFRI whole heartedly participated in the Swachh Bharat Mission since its inception on 2nd October 2014. Earlier cleanliness activities were restricted within the institute. But in recent years it crossed the institute's boundary since the institute is directly involved with the farmers, especially the poor fishers. In the year 2020, the institute has initiated 'swachhata' activities in multiple dimensions that have further been propagated. Other than regular cleanliness activities, ICAR-CIFRI specially celebrated 'Swachhata Pakhwara' during 15-31 December 2020. More than 300 staff members of this institute, including contractual and research scholars, actively participated in various events during the program. Activities undertaken under 'Swachhata Pakhwara' got particular dimension, especially in terms of diversity, starting from in-house cleaning to carry the message to the remotest corner of a village. Various Swachh Bharat activities undertaken in 2020 were:

1. Digitization of office records and installation of e-office
2. Basic maintenance of the office campus
3. Sanitization and Solid Waste Management
4. Cleaning and beautification of the surrounding areas
5. Vermicomposting—a Waste to Wealth activity
6. Special drive towards plastic-free India
7. Swachhta Awareness at local levels
8. Organizing Swachhta Workshops
9. Fostering Healthy Competitions

Some of the significant activities deserve mentioning, as described below.

Combating disaster

Amphan, the strongest super cyclone of this century, hit West Bengal on 18 May 2020 during COVID pandemic, which affected ICAR-CIFRI campus worst. An extensive cleaning program was undertaken in the aftermath of the cyclone, where all the institute staff members took active participation. An inventory of uprooted trees was also created, and the institute planted an equivalent number of trees to fulfil the loss, envisioning the future.

Waste to wealth—a green initiative by ICAR-CIFRI

The ICAR-Central Inland Fisheries Research Institute has generously participated in the waste-to-wealth activity under the Swachh Bharat

Clearing Amphan affected uprooted trees

Tree plantation for health of the future

Vermicompost unit of ICAR-CIFRI

Abhiyaan and established a Vermicompost manufacturing unit at its residential campus. It is worth mentioning that, beside regular sale of the compost, the institute has filed a patent (Patent application No. 202031049308) on the entire vermicomposting procedure!

Towards plastic free India—a seminal work by ICAR-CIFRI

Towards plastic-free India, ICAR-CIFRI has gone up to micro-level and unravelled plastic pathway from home to an aquatic system and published a seminal research article (https://doi.org/10.1016/j.scitotenv.2019.133712). The results and key findings have been translated into lucid layman's language, and the message has been carried forward to common men under the swachh Bharat activities. Thus, ICAR-CIFRI has initiated a mission mode awareness drive to reduce, recycle and reuse plastic in the educational institutions, local village community level and a boating drive to the mighty river Ganga.

As prevention and awareness measures in view of the COVID situation, masks and

Awareness campaigning for plastic, microplastic free river

sanitizers were distributed in the nearby areas' low-income residential colonies. Simultaneously, they were also made aware of maintaining proper hygiene and precaution during the pandemic.

Distribution of mask and sanitizer, led by the Director, ICAR-CIFRI

Cleaning activity at the Allahabad Center

Mass awareness programme organized by the Bangalore Center

Cleaning activity at the Vadodara Center

Cleaning activity at the Kochi Center

भाकृअनुप–केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान, बैरकपुर तथा इसके क्षेत्रीय केन्द्रों में हिंदी सप्ताह (ऑनलाईन मोड में) समारोह

कोरोना महामारी (कोविड–19 वायरस संक्रमण) के कारण वर्ष 2020 में भाकृअनुप–केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान, बैरकपुर तथा इसके क्षेत्रीय केन्द्रों में हिंदी सप्ताह समारोह का आयोजन ऑनलाईन मोड में किया गया। सप्ताह के समस्त कार्यक्रम बैरकपुर मुख्यालय तथा इसके क्षेत्रीय केन्द्रों (प्रयागराज, गुवाहटी, बेंगलूरू तथा वडोदरा) में संयुक्त रूप से आयोजित किये गये। इस अवसर पर (वर्चुअल तौर पर) मुख्य अतिथि डॉ. (श्रीमती) विजयालक्ष्मी सक्सेना, (निर्वाचित) महाध्यक्ष, भारतीय विज्ञान कांग्रेस संस्था, कोलकाता; विशिष्ट अतिथि डॉ. अशोक कुमार सक्सेना, पूर्व महाध्ययक्ष, भारतीय विज्ञान कांग्रेस संस्था कोलकाता; डॉ. अरूण कुमार पाण्डे, सहायक कार्यकारी सचिव, भारतीय विज्ञान कांग्रेस संस्था, कोलकाता; डॉ बी. पी. मोहान्ति, सहायक महानिदेशक (अंतर्स्थलीय मात्स्यिकी), भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली; संस्थान के निदेशक, डॉ बसंत कुमार दास; संस्थान के सभी विभागाध्यक्ष/वैज्ञानिक एवं समस्त क्षेत्रीय केन्द्रों के अधिकारी व कर्मचारी उपस्थित थे।

कार्यक्रम का शुभारंभ भारतीय कृषि अनुसंधान परिषद् के स्वागत गीत से हुआ। हिंदी कक्ष के सर्वकार्यभारी, डॉ. श्रीकान्त सामंता ने समारोह के मुख्य अतिथि, विशेष अतिथि, निदेशक, सभी प्रभागाध्यक्षों, केन्द्रों के प्रभारी अधिकारियों तथा समस्त अधिकारियों व कर्मचारियों का स्वागत किया। साथ ही उन्होंने संस्थान की राजभाषा हिंदी की प्रगति की रिपोर्ट भी प्रस्तुत की। उन्होंने राजभाषा विभाग द्वारा तय किये गए निर्देशों के पालन का उल्लेख करते हुए संस्थान के समस्त अधिकारियों व कर्मचारियों का इस कार्य में सहयोग के लिए धन्यवाद दिया।

डॉ विमल प्रसन्ना मोहन्ती, सहायक महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने संस्थान के निदेशक को विगत तीन वर्षो से लगातार भारतीय विज्ञान कांग्रेस संस्था, कोलकाता के साथ इस तरह के हिंदी कार्यक्रम का आयोजन करने के लिये धन्यवाद दिया। उन्होंने कहा कि निदेशक महोदय के मार्गदर्शन में संस्थान में हिंदी कार्यों में काफी प्रगति हुई है और हिंदी प्रकाशनों की संख्या में बढ़ोतरी हुई है।

मुख्य अतिथि, डॉ (श्रीमती) विजयालक्ष्मी सक्सेना, महाध्यक्ष (निर्वाचित) ने संस्थान के निदेशक एवं कर्मचारियों को हिंदी दिवस के आयोजन की बधाई दी। उन्होंने कहा कि हिंदी जनसंवाद की भाषा है और इस रूप में यह भारत के अनेक प्रदेशों में सुदृढ़ है। हिंदी भारतीय जनमानस की भाषा के रूप में भारतीय विज्ञान की वाहक होनी चाहिए। हिंदी के प्रसार के लिए हमारी सरकार का भी अत्यधिक योगदान है। माननीय प्रधानमंत्री के साथ साथ देश के अन्य वरिष्ठ नेतागण अंतर्राष्ट्रीय सभाओं में हिंदी में अपना अभिभाषण देते है। उन्होंने अपील की कि हिंदी में लिखित वैज्ञानिक पुस्तकों को शिक्षण संस्थानों के पाठ्यक्रम में मान्यता मिलनी चाहिए। डॉ. अशोक कुमार सक्सेना, पूर्व महाध्यक्ष ने अपने वक्तव्य में कहा कि आज इंटरनेट पर हिंदी भाषा में नयी सामग्री का सृजन बहुत तेज गति से बढ़ रहा है। उन्होंने कहा कि उच्च शिक्षा के लिए, उच्च स्तर की शिक्षण सामग्री हिंदी भाषा में उपलब्ध होना चाहिए। इससे हिंदी भाषा में मौलिक ज्ञान–विज्ञान, काम–काज और व्यापार को बढ़ावा मिलेगा। इसलिए हिंदी भाषा को बढ़ावा देने के लिए विज्ञान की पुस्तकों एवं शोध पत्रों का अधिकाधिक प्रकाशन हिंदी माध्यम में करने की आवश्यकता है।

संस्थान के निदेशक, डॉ बसंत कुमार दास ने अपने अध्यक्षीय वक्तव्य में कहा कि इस वर्ष कोरोना महामारी के कारण हिंदी सप्ताह का आयोजन वर्चुअल प्लेटफार्म पर किया जा रहा है इसमें संस्थान के सभी क्षेत्रीये केन्द्रों के साथ साथ भारतीय विज्ञान कांग्रेस संस्था, कोलकाता के सभी पदाधिकारीगण जुड़े हुए है। उन्होने इस अवसर पर संस्थान के समस्त कर्मियों विशेषकर हिंदी कार्य से जुड़े सारे वैज्ञानिको और कर्मचारियो को बधाई दी। उन्होने कहा कि विगत तीन वर्षो से हम हिंदी मासिक समाचार पत्रिका प्रकाशित कर रहे है। संस्थान की सभी तकनीकों को जन–जन तक पहुंचाने के लिए हिंदी भाषा में पुस्तिकाओं एवं पत्रक (लीफलेट) का प्रकाशन हुआ है और इनको मत्स्य कृषको तक पहुँचाया जा रहा है ताकि वो अधिक से अधिक लाभान्वित हो सकें।

डॉ. यू. के सरकार, प्रभागाध्याक्ष और डॉ. बि. के. बेहरा, प्रभागाध्यक्ष ने अपने अपने वक्तव्य में हिंदी के महत्व पर प्रकाश डाला तथा कार्यालयीन कार्य में हिंदी के अधिकाधिक प्रयोग पर बल दिया। डॉ. सुबीर कुमार नाग, प्रभागध्यक्ष ने समस्त अधिकारियों व कर्मचारियों को हिंदी में अधिक से अधिक कामकाज करने का आग्रह किया। डॉ. एम. ए. हसन, प्रभागाध्यक्ष ने राजभाषा और राष्ट्रभाषा के महत्व पर जोर दिया। उन्होंने कहा कि हिंदी विश्व की प्रमुख भाषाओं में से एक है क्योंकि यह अधिकांश लोगों द्वारा बोली और समझी जाती है। मुख्य प्रशासनिक अधिकारी श्री राजीव लाल ने अपने वक्तव्य में कम्प्यूटर पर उपलब्ध ऐप के द्वारा हिंदी अनुवाद करने की शैली पर प्रकाश डाला।

हिंदी सप्ताह का समापन समारोह संस्थान मुख्यालय तथा इसके क्षेत्रीय केन्द्रों के साथ संयुक्त रूप से (ऑनलाइन मोड में) दिनांक 20 सितम्बर, 2020 को आयोजित किया गया। हिंदी सप्ताह के दौरान कई हिंदी प्रतियोगिताओं का आयोजन किया गया। मुख्यालय तथा इसके क्षेत्रीय केन्द्रों में कार्यरत कर्मचारियों ने बड़ी संख्या् में ऑनलाईन मोड में इन प्रतियोगिताओं में भाग लिया। प्रतियोगिताओं में विजयी कर्मियों और शोध छात्रों को निदेशक महोदय के करकमलों द्वारा पुरस्कार प्रदान किये गये। क्षेत्रीय केन्द्रों में कार्यरत अधिकारियों व कर्मचारियों को निदेशक महोदय की ओर से वहां के प्रभारी अधिकारियों द्वारा पुरस्कार वितरण किया गया। अंत में निदेशक महोदय ने सर्वप्रथम भारतीय विज्ञान कांग्रेस संस्था, कोलकाता के सहयोग के लिए समस्त कर्मचारियों, शोध छात्रों और उनके पारिवारिक सदस्यों को धन्यवाद दिया जिन्होंने हिंदी सप्ताह के दौरान अपना सहयोग दिया। हिंदी सप्ताह आयोजन समिति के सदस्यों को हिंदी सप्ताह के सुचारू ढ़ंग से संचालन के लिए धन्यवाद दिया। इस अवसर पर सितम्बर माह की सिफरी मासिक समाचार का विमोचन संस्थान के निदेशक, डॉ. बि. के. दास द्वारा ऑनलाईन मोड में किया गया। इस मौके पर आदरणीय निदेशक महोदय ने समस्त अधिकारियों व कर्मचारियों को अपनी नैतिक जिम्मेदारियों का निर्वाह करते हुए अपने कार्यालय का कामकाज हिंदी में करने के निर्देश दिए।

संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा इस संस्थान के क्षेत्रीय केन्द्र, वडोदरा का निरीक्षण

संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा दिनांक 26–28 फरवरी, 2020 को वडोदरा क्षेत्रीय केन्द्र समेत 21 कार्यालयों के राजभाषा कार्यान्वयन प्रगति का निरीक्षण किया। इसी क्रम में भाकृअनुप–केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान, क्षेत्रीय केन्द्र, वडोदरा का दिनांक 27 फरवरी, 2020 को राजभाषा कार्यान्वयन में हुई प्रगति का निरीक्षण किया गया।

इस बैठक का उद्देश्य वडोदरा केंद्र के राजभाषा हिन्दी कार्यो की समीक्षा करना था। इस समिति के संयोजक प्रो. रीता बहुगुणा जोशी, संसद सदस्य (लोकसभा) थे। समिति के अन्य सदस्यों में श्री प्रदीप टमटा, संसद सदस्य (राज्यसभा); श्री सुशील कुमार गुप्ता, संसद सदस्य (लोक सभा); श्रीमती रंजनबेन धनंजय भट्ट संसद सदस्य (लोकसभा), श्री बी. एल. मीना, सचिव (समिति), श्री कमल स्वरूप, अनुसंधान अधिकारी और श्री किरण पाल सिंह, समिति रिपोर्टर इस बैठक में उपस्थित हुये। इस बैठक में संस्थाान के निदेशक डा. बि. के. दास, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के प्रतिनिधि डा. प्रवीण कुमार, सहायक महानिदेशक (समुद्री मात्स्यिकी), श्रीमती सीमा चोपड़ा,

संस्थान के निदेशक और संसदीय राजभाषा समिति की संयोजक माननीया प्रो. रीता बहुगुणा जोशी

निदेशक (राजभाषा), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली तथा वडोदरा केन्द्र के प्रभारी अधिकारी डा. एस. पी. काम्बले उपस्थित हुये।

निरीक्षण कार्यक्रम को देखते हुए वडोदरा केन्द्र द्वारा राजभाषा हिन्दी में किए गए कार्यों की एक प्रदर्शनी आयोजित की गई। संसदीय समिति के गणमान्य सदस्यों ने बड़ी ही सहर्ष रूप से प्रदर्शित सामग्रियों को देखा और विभिन्न तकनीकी तथा प्रशासनिक प्रकाशनों के बारे में जानकारी ली। समिति के संयोजक माननीया प्रो. रीता बहुगुणा जोशी ने संस्थान की गृह पत्रिका नीलांजलि के प्रकाशन कार्यों की सराहना की। इस अवसर पर वडोदरा अनुसंधान केन्द्र की राजभाषा हिंदी की गतिविधियों एवं उपलब्धियों पर एक संकलित प्रलेख का प्रकाशन किया गया।

उपरोक्त कार्यकलापों के अलावा संस्थान में निम्नलिखित राजभाषा हिन्दी संबंधी कार्यों का निष्पादन सफलतापूर्वक किया गया –

1. संस्थान की वार्षिक गृह पत्रिका, "नीलांजलि" अंक 10 वर्ष 2019 का प्रकाशन।
2. मत्स्य रोग पर मोबाइल ऍप (हिन्दी रूपांतरण) : मत्स्य रोग संबंधी सलाह
3. हिन्दी में वृत्तचित्रः अंतर्स्थलीय पिंजरा पालन में प्रजाति विविधता
4. हिन्दी में वृत्तचित्र : गंगा नदी में जैव विविधता पुनर्स्थापन हेतु वाइल्ड मछलियों का जर्मप्लाज्म प्रजनन
5. देशव्यापी कोरोना महामारी (कोविड 19) के कारण लॉकडाउन के समय नदी, ज्वारनदमुख, मुहाने और नहरों पर निर्भरशील मछुआरों के लिये परामर्शी दिशानिर्देश
6. देशव्यापी कोरोना महामारी (कोविड 19) के कारण लॉकडाउन के समय जलाशय और आर्द्रक्षेत्रों पर निर्भरशील मछुआरों/ मछुआरा सहकारी समितियो के लिये परामर्शी दिशानिर्देश

माननीय संसदीय राजभाषा समिति द्वारा संस्थान के क्षेत्रीय केन्द्र, वडोदरा का निरीक्षण

Library and Informatics, the 'knowledge bank' of the Institute, presently stores 12,416 books, 5030 issues of journals and a number of other valuable documents in the field of inland fisheries and relevant supportive subjects in its rich collection.

The year 2020 saw the unprecedented COVID-19 pandemic worldwide and the nation-wide lockdown, yet the library has added 408 numbers of documents, comprised of 145 numbers of books, 32 leaflets/pamphlets and others to its existing stock. A number of ICAR-CIFRI publications are also being kept in the library, which serve as rich source of information in both theoretical and practical aspects of inland fisheries. Besides the headquarters, library units situated at the regional centres and stations of ICAR-CIFRI were also strengthened with new books and journals.

For the convenience of management, Library and Informatics section is divided into four segments, *viz.*, Scientific books, Journals, ICAR-CIFRI publications and Hindi books. The cataloguing system of library is digitized and managed through KOHA Open Source Library Management Software and available for online search through ICAR-CIFRI website and also through AGRICAT, a Union catalogue available to all NARS institutes. This year the library had scanned 25 numbers of documents and uploaded in ICAR-CIFRI website. ICAR-CIFRI library is an active member of CeRA consortium and has sent 35 documents to different NARS institutes through Document Delivery Request (DDR). The Library and Informatics section also conducted an webinar on 2 November 2020 at ICAR-CIFRI headquarters, where the officials of J-Gate explained the advantages of new J-Gate platform to the participants. In 2020 more than 100 books in relevant fields, including motivational and Hindi books, were ordered for purchase.

Staff Information

Staff position as on 31.12.2020

Category	Sanctioned Strength	Filled up	Vacant
R.M.P	1	1	-
Scientist	88	84	4
Technical	81	50	31
Administrative	67	35	32
Skilled Support Staff	65	41	24
TOTAL	302	211	91

Head Office & Centre–wise staff position

Name of the Centre	RMP	Scientist	Technical	Administrative	Skilled Support Staff	Total
Barrackpore	1	53	37	30	23	144
Kolkata	-	3	1	-	1	5
Vadodara	-	3	3	1	6	13
Allahabad	-	7	5	1	5	18
Bengaluru	-	7	1	2	3	13
Guwahati	-	9	2	1	2	14
Kochi	-	2	1	-	1	4
TOTAL	1	84	50	35	41	211

Financial Up-gradation under MACP

Sl. No.	Name of the staff with designation	Next higher grade pay (as per 7th CPC Pay Scales)
1	Sh. Ratan Das, SSS	1st MACP w.e.f. 13.01.2020 in the Pay Level-2 of 7th CPC (Rs.19990 - Rs. 63200)
2	Sh. Debasis Singha, SSS	2nd MACP w.e.f. 08.02.2020 in the Pay Level-3 of 7th CPC (Rs. 21700 - Rs. 69100)
3	Sh. M. Pennappa, SSS	3rd MACP w.e.f. 30.03.2020 in the Pay Level-4 of 7th CPC (Rs.25500 - Rs. 81100)
4	Sh. S. C. Tadvi, SSS	2nd MACP w.e.f. 16.10.2020 in the Pay Level-3 of 7th CPC (Rs.21700 - Rs. 69100)
5	Sh. Sureshbhai Chimanbhai Machhi, SSS	2nd MACP w.e.f. 06.10.2020 in the Pay Level-3 of 7th CPC: Rs.21700 - Rs. 69100.
6	Sh. M.Mari, SSS	3rd MACP w.e.f. 23.11.2020 in the Pay Level-4 of 7th CPC (Rs.25500 - Rs.81100)

Personnel as on 31.12.2020

Headquarter, Barrackpore
Director
Dr. B.K. Das
Head of Division
Dr. S . Samanta
Dr. U. K. Sarkar
Dr. M. A. Hassan
Dr. S. K. Nag
Dr. B. K. Behera
Principal Scientist
Dr. Malay Naskar
Dr. S. K. Manna
Dr. A. K. Das
Dr. R. K. Manna
Dr.(Md.) Aftabuddin
Dr. Sanjay Kumar Das
Dr. Arun Pandit
Dr. Hemanta Chowdhury
Dr. A. K. Bera
Senior Scientist
Dr. A. K. Sahoo
Scientist
Sh. P. Maurye
Sh. Ganesh Chandra
Dr. D. Das
Dr. (Mrs) Aparna Roy
Sh. S.K. Sahu
Dr. Sajina A.M
Dr. Soma Das Sarkar
Dr. P.K. Parida
Ms. Prajna Ritambhara Swain
Sh. Roshith C.M
Dr. Raju Baitha
Ms. Suvra Roy
Ms. Kavita Kumari
Sh. S. K. Koushlesh
Sh. M. H. Ramteke
Ms. Thangjam Nirupada Chanu
Dr. D. K. Meena

Scientist (contd.....)
Ms. Suman Kumari
Sh. Vikash Kumar
Dr. Lianthuamluaia
Ms. Gunjan Karnatak
Sh. Mishal P.
Sh. Himanshu Sekhar Swain
Sh. Tasso Tayung
Ms. Pritijyoti Majhi
Ms. Anjana Ekka
Ms. Tanushree Bera
Ms. J. Canciyal
Dr. Dhruba Jyoti Sarkar
Ms. Piyasi Debroy
Sh. Rahul Das
Sh. Dibakar Bhakta
Ms. Tanuja Abdulla
Ms. Chayna Janna
Sh. K. Lohith Kumar
Ms. Sangeetha M Nair
Ms. Manoharmayum Shaya Devi
Sh. Santhana Kumar V
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Ms. Keya Saha
Sh. Raban Chandra Mandi
Md. Quasim
Sh. Sujit Chowdhury
Ms. Sunita Prasad
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Sh. Abhijita Sengupta
Dr. Khaja Syed Shahul Hameed
Sh. Yousuf Ali
Sh. Manabendra Roy
Sh. Asish Chakraborty
Sh. Rabiul Sk.
Sh. Subhendu Mondal
Sh. Bablu Kumar Naskar
Sh. T.K. Halder
Sh. Giridhari Paramanick
Sh. Sanjay Kumar Das

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Sh. Arun Kumar Mondal
Sh. Sudarsan Bandopadhyay
Sh. Debasis Saha
Sh. Suvra Saha
Sh. Subrata Das
Sh. Atanu Das
Sh. Arijit Ghsoh
Sh. Lokenath Chakraborty
Sh. Anjon Kumar Talukder
Ms. Sumedha Das
Ms. Sadrupa Bhowmick
Ms. Sangeeta Chakraborty
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Sh. Avishek Saha
Sh. Rakesh Pal
Ms. Ambily M.N.
Md. Naim

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Sh. Subir Das
Sh. Ashwini Kumar
Ms. Jolly Saha
Sh. Santosh Sarkar
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Sh. Kishore Shaw
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Sh. Chandan Chakraborty
Ms. Swapna Chattopadhyay
Ms. Mousumi Banerjee (Nan)
Sh. Bijoy Roy
Sh. Pradipta Sen
Sh. Suranjan Singh
Sh. Fazal Khan
Sh. B. L. Dhanuk

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Sh. Somenath Banerjee
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Sh. Syed Abol Kabi
Ms. Ankita Ghosh
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Sh. Aritra Datta

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Sh. A.N. Prasad
Sh. U.S Ram
Sh. Gopal Ch. Roy
Sh. M.L. Sarkar
Sh. Sukhen Das
Sh. Manabendra Dutta
Sh. Shibani Bhattacharya
Sh. P.R. Mahata
Sh. Shabbir Ahmed
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Sh. Ravi Kumar Sonkar
Sh. B.K. Sahani
Sh. Ratan Das
Sh. Debshish Singha
Sh. B. Shankar Reddy
Sh. Tapan Kumar Bhattacharjee
Ms. Anita Ganesh Gawate
Sh. Ashok Kumar Nishad
Sh. Ajay Kumar Nishad
Sh. Jayanta Pramanick
Sh. Niranjan Kumar
Sh. Divakar R

Regional Centre of ICAR-CIFRI, Allahabad
Scientist
Dr. Dharm Nath Jha, Scientist-in-Charge Md. Absar Alam, Scientist Sh. Jeetendra Kumar, Scientist Sh. V. Ramrao Thakur, Scientist Sh. Vikas Kumar, Scientist Sh. Monika Gupta, Scientist Sh. Shravan Kumar Sharma, Scientist
Technical
Sh. S.K. Srivastava,CTO Dr.(Mrs.) Kalpana Srivastava,CTO Sh. Vijay Kumar, STA Sh. Jitendran Kr. Singh,STA Sh. Ram Sajiwan,TO (Driver)
Administrative
Sh. Manish Kumar Singh, UDC
Skilled Support Staff
Sh. Gopal Chand,SSS Smt. Laxmi Devi,SSS Sh. Munshi Ram Rana, SSS Sh. Anil Kumar,SSS

Regional Centre of ICAR-CIFRI, Vadodara
Scientist
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Sh. R.K. Sah, Technical Officer Sh. Solanki Jayesh K., Senior Technical Assistant Sh. Ram Prasad, Senior Technical Assistant
Administrative
Sh. C. D. Parmer, Assistant
Skilled Support Staff
Sh. R. N. Kantibhai, SSS Sh. H.J. Chetanbhai, SSS Sh. Machi Suresh Bhai Chimanbhai, SSS Sh. Tadvi Santibhai Chandubhai , SSS Sh. Dangar Arjan Valabhai, SSS Ms. Harshaben A. Joshi, SSS

Regional Centre of ICAR-CIFRI, Guwahati
Scientist
Dr. B. K. Bhattachariya, Principal Scientist & Acting Head Ms. Sona Yengkokpam, Senior Scientist Dr. Depesh Debnath, Senior Scientist Sh. Anil Kumar Yadav, Scientist Sh. Pranob Das, Scientist Ms. Niti Sharma, Scientist Sh. Simanku Borah, Scientist Sh. N. S. Singh, Scientist Sh. S.C. Sukla Das, Scientist
Technical
Sh. Bipul Ch. Ray, Senior Technical Officer Sh. Amulya Kakati, Senior Technician
Administrative
Sh. Ganesh Bhanja, UDC
Skilled Support Staff
Sh. S. Kalita, SSS Sh. Hemanta Das, SSS

Regional Centre of ICAR-CIFRI, Bangalore
Scientist
Dr. (Mrs.) Preetha Panikkar, Principal Scientist & Officer-in-Charge Sh. M. Feroz Khan, Scientist Sh. M. Karthikeyan, Scientist Ms. Ramya V. L., Scientist Ms. Sibina Mol, Scientist Dr. Ajoy Kumar Saha, Scientist Sh. Jesna P K, Scientist
Technical
Sh. Vijay Kumar M.E., Technical Officer
Administrative
Ms. G. Vinodalaxmi, Personal Assistant Ms. S. Sumithra Devi, Assistant
Skilled Support Staff
Sh. M. Pennappa, SSS Sh. M. Mari, SSS Sh. R. Nagrrajan, SSS

Research Station of ICAR-CIFRI, Kolkata
Scientist
Dr. Sibnarayan Dam Roy, Principal Scientist & Scientist-in-Charge Dr. Archana Sinha, Principal Scientist Sh. Pronob Gogoi, Scientist
Technical
Sh. Arunava Mitra, Technical Officer
Skilled Support Staff
Ms. Kalyani Biswas, SSS

Research Station of ICAR-CIFRI, Kochi
Scientist
Dr. Deepa Sudheesan, Scientist-in-Charge Dr. Thankam Theresa Paul, Scientist
Technical
Sh. S. Monoharan, CTO
Skilled Support Staff
Sh. P.V. Shajil, SSS

Transfer

Name of the staff	From	To
Dr. Archana Sinha, Principal Scientist	ICAR-CIFRI, Barrackpore	ICAR-CIFRI Research Centre, Kolkata
Dr. Debrabata Das, Scientist	ICAR-CIFRI Research Centre, Kolkata	ICAR-CIFRI, Barrackpore
Sh. K. Lohith Kumar, Scientist	ICAR-CIFRI Research Centre, Kolkata	ICAR-CIFRI, Barrackpore
Sh. Ganesh Bhanja, UDC	ICAR-CIFRI, Barrackpore	ICAR-CIFRI Regional Centre Guwahati
Sh. Rakesh Pal, Technical Assistant	ICAR-CIFRI Barrackpore	Maithan Research Station of ICAR-CIFRI

Promotion

Sl.No.	Name & Designation	Promoted to
1	Sh. Roshith C. M. , Scientist	Scientist with Pay Level-11 w.e.f. 15.12.2014
2	Dr. Pronob Das, Scientist	Scientist with Pay Level -11 w.e.f. 15.09.2015
3	Dr. S.C. Sukla Das, Scientist	Senior Scientist with Pay Level -12 w.e.f. 15.09.2016
4	Dr. T. T. Paul, Scientist	Scientist with Pay Level -11 w.e.f. from 15.12.2016
5	Dr. Suman Kumari , Scientist	Scientist with Pay Level-11 w.e.f. 04.06.2018
6	Dr. Kavita Kumari, Scientist	Scientist with Pay Level-11 w.e.f. 01.01.2018

Probation clearance of administrative staff

Name of the official	Designation	Date of completion of probationary period 2(years)	Posting
Sh. C.D. Parmer	Assistant	21.07.2017	Vododara
Ms. Divya Jain	Assistant	21.07.2017	Allahabad
Ms. Ruma Ghosh	Assistant	31.08.2017	Barrackpore
Sh. Raushan Kumar	Assistant	26.09.2019	Barrackpore
Ms. Mousumi Banerjee Nan	Assistant	27.05.2020	Barrackpore
Sh. Bijoy Kumar Roy	Assistant	27.05.2020	Barrackpore
Sh. Pradipta Sen	Assistant	27.09.2020	Barrackpore

Superannuation

Name of the Official	Designation	Date of Retirement/Superannuation
Sh. T.V. Velayudhan	SSS	01.01.2020 (VR)
Sh. Nabajit Deka	SSS	31.01.2020
Ms. Usha Unnithan	STO	31.05.2020
Ms. Sefali Biswas	AAO	30.11.2020
Sh. Ashis Roy Chowdhury	TO	30.11.2020
Ms. K. Sucheta Majumder	CTO	31.12.2020
Sh. Ram Prasad	STA	31.12.2020
Sh. Jai Ram Prasad	SSS	31.12.2020
Ms. Divya Jain	Assistant	30.11.2020 (VR)

Demise

Name of the Official	Designation	Date of death
Sh. S. R. Meena	ACTO	20.03.2020
Ms. Sukanya Som	Scientist	17.05.2020
Sh. Kamlesh Kumar	SSS	30.10.2020

Publications

Research paper

Alam A, Jha DN, Verma SK, Verma HO, Mishra SK, Das SCS, Kumar J, Thakur VR, Gupta M and Das BK (2020). Length–weight relationships of four small indigenous freshwater fishes from the subtropical Ganga River, India. *Lakes & Reservoirs: Research & Management*, https://doi.org/10.1111/lre.12337.

Alam A, Chadha NK, Kumar AP, Chakraborty SK, Joshi KD, Sawant PB, Das SCS, Kumar J and Kumar T (2020). DNA barcoding and biometric investigation on the invasive *Oreochromis niloticus* (Linnaeus, 1758) from the River Yamuna of Uttar Pradesh. *Indian Journal of Animal Research*, 54(7): 856-863.

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Alam A, Gopinath V, Jha DN, Joshi KD, Kumar J, Das SCS, Thakur VR, Gupta M and Das BK (2020). Food and feeding biology of commercially important freshwater eel, *Mastacembelus armatus* (LACEPÈDE, 1800) from the Ganga River, India. *Oceanography & Fisheries Open Access Journal*, 11(4): 555819. DOI: 10.19080/OFOAJ.2020.11.555819.

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Behera BK, Patra BKB, Chakraborty HJ, Sahu P, Rout AK, Sarkar DJ, Parida PK, Raman RK, Rao AR, Rai A and Das BK (2020). Metagenome analysis from the sediment of river Ganga and Yamuna: In search of beneficial microbiome. *PLoS One*, 15(10): p.e0239594.

Behera BK, Chakraborty HJ, Patra B, Rout AK, Dehury B, Das BK, Sarkar DJ, Parida PK, Raman RK, Rao AR and Rai A (2020). Metagenomic analysis reveals bacterial and fungal diversity and their bioremediation potential from sediments of river Ganga and Yamuna in India. *Frontiers in Microbiology*, 11: 226136. doi.org/10.3389/fmicb.2020.556136.

Behera BK (2020). Metagenomics as tool for river health monitoring, *Journal of the Inland Fisheries Society of India*, 52(1): 16-20.

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Bhakta D, Das SK, Das BK,Nagesh TS and Samanta R (2020). Growth, mortality and exploitation status of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuary of West Bengal, India. *Regional Studies in Marine Science*, https://doi.org/10.1016/j.rsma.2020.101451.

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beel (Ramsar site no. 1207), Brahmaputra valley, Assam. *Journal of Applied and Natural Science*, 12(2):202-206. https://doi.org/10.31018/jans.vi.2288.

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Documentary Films :

1. Canal Fisheries Development in Sundarbans by ICAR-CIFRI (English)
2. Wild Fish Germplasm Breeding of River Ganga for Biodiversity Restoration (English)
3. Species Diversification in Inland Cage Culture (English)
4. High Value Species for Cage Culture in Reservoirs (English)
5. गंगा नदी में जैव विविधता पुनर्स्थापन हेतु वाइल्ड मछलियों का जर्मप्लाज्म प्रजनन (Hindi)
6. अंतर्स्थलीय जलक्षेत्रों के पिंजरे में मछली पालन हेतु प्रजाति विविधता (Hindi)

Patent Filed

- Patent application on "Development of nanoemulsifiable concentrate formulations of hydrophobicbioactive molecules and method of preparation thereof" has been filed on 28 September 2020 to Indian Patent Office, Kolkata. The application number is 202031042037.

- Patent application on "Culture media from vermicompost for enhancing the growth and lipid productivity of Chlorella spp" has been filed on 11 November 2020 to Indian Patent Office, Kolkata. The application number is 202031049308

Trademark filed

- Trademark application for "CIFRI ARGCURE" has been filed on 18 August 2020 in the Trade Mark Registry of Government of India, Mumbai. The application was filed under class 5 with application number 4614213

Memorandum of Understanding signed

MoU signed with Government Department/Public Institution/Public Sector unit

- MoU was signed between ICAR-CIFRI, Barrackpore and Assam Fisheries Development Corporation Ltd., Guwahati on 6 November 2020 for providing land for setting up a field station of ICAR-CIFRI Regional Centre at Ghorajan Beel, Amingaon.

- MoU was signed on 16 December 2020 between ICAR-CIFRI, Barrackpore and Brahmaputra Board, Ministry of Jalshakti, Guwahati for scientific collaboration in Brahmaputra Rafting expedition and awareness campaign.

- MoU was signed between Govt. of Himachal Pradesh State Fisheries Dept. and ICAR- CIFRI on 4 September 2020 for ecological assessment of Gobind Sagar reservoir, Himachal Pradesh.

MoUs signed for Research Collaboration

- MoU was signed between ICAR-CIFRI, Barrackpore and CSB-CSRTI, Mysore on 8 December 2020 for Utilization and diversification of silkworm pupae for the development of fish feed.

- MoU was signed between ICAR-CIFRI, Barrackpore and CDAC, Kolkata on 1 December 2020 for development of research collaborations in the field of sensors for monitoring of pollutions in aquatic bodies, disease occurrence, physiochemical parameters estimation, etc. and lay out plan for establishing IOT (Internet of Thing) based inland fisheries management.

MoUs signed for Academic Collaboration

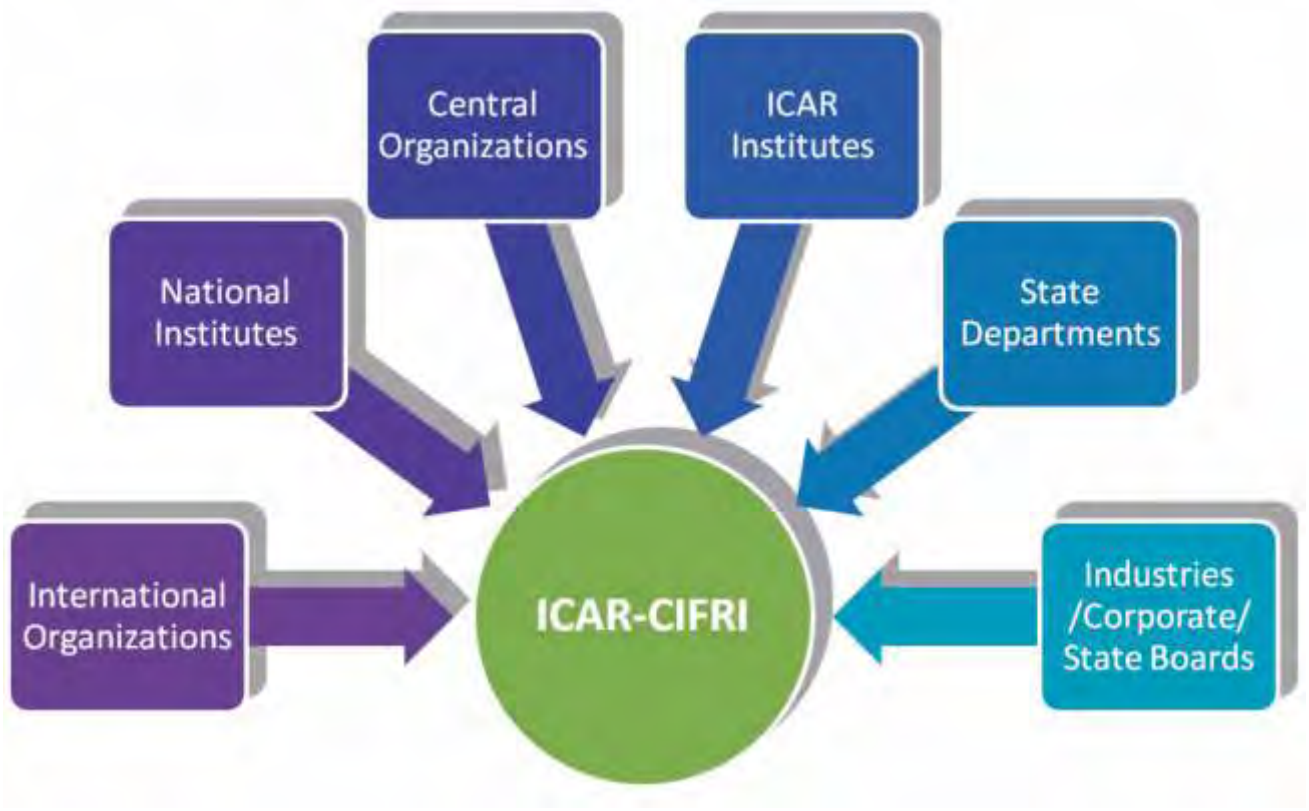
- MoU was signed between ICAR-CIFRI, Barrackpore and Nehru Gram Bharti (deemed to be university), Prayagraj on 7 February 2020 for Academic and research collaboration in the field of inland fisheries.

- MoU was signed between ICAR-CIFRI, Barrackpore and Maharaja Agrasen University, Solan on 25 February 2020 for Academic and research collaboration in the field of inland fisheries.

Mou with Murshidabad Wetland Secretaries

Linkages Developed

Linkages are important in the spread and diffusion of stocks of knowledge, which not only act as building blocks for new knowledge, innovation and developmental activities. Several organizations are involved in fisheries research and development in India and abroad and have intimate linkages with ICAR-CIFRI. Beside research and development, the Institute has established its linkages through collaboration with several organizations for extension, outreach activities, seminars, workshops, publications, etc.



International Linkages and Collaboration

International Multilateral Organizations

- Food and Agriculture Organization, UN
- Bay of Bengal Programme Inter-Governmental Organization
- International Union for Conservation of Nature, Indonesia
- Network of Aquaculture Centres in Asia-Pacific, Bangkok
- South Asian Association for Regional Cooperation (SAARC), Kathmandu, Nepal
- SAIC, Bangladesh
- World Fish Centre, Malaysia
- World Bank
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany

Foreign Universities

- Agriculture and Forestry University, Nepal
- Bangladesh Agricultural University, Mymensingh , Bangladesh

- Carleton University, Canada
- Centre for Natural Resource Studies, Bangladesh
- Ghent University, Ghent, Belgium
- RMIT university, Melbourne, Australia
- Tribhuwan University, Nepal
- University of Manitoba, Canada
- University of Ottawa, Canada
- University of Waterloo, Canada
- Wageningen University, Netherlands

Government Departments of Foreign Nations

- Department of Fisheries, Bangladesh
- Department of Fisheries, Myanmar
- Department of Fisheries, Nepal
- Department of Forest, Bangladesh

International Societies and Humanitarian organizations

- Aquatic Ecosystem Health & Management Society, Canada
- Deep Sea Fishers Ltd & ASAP Healthy Food Ltd., Bangladesh
- Rotary International
- International Collective in Support of Fishworkers
- South East Water, Melbourne
- Wetlands International South Asia
- World Wide Fund for Nature, India

Linkages within India

Central Departments, Boards and Authorities

- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Department of Biotechnology, New Delhi
- Ministry of Environment, Forest & Climate Change, Govt. of India, New Delhi
- National Fisheries Development Board, Hyderabad
- National Mission for Clean Ganga, Department of River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Govt. of India, New Delhi
- Bureau of Indian Standards, New Delhi
- Central Water Commission, New Delhi
- Inland Waterways Authority of India
- Narmada Control Authority, Department of River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Govt. of India, Indore
- Farraka Barrage Authority, Murshidabad
- National Bank for Agriculture and Rural Development
- National Biodiversity Authority
- Nehru Yuva Kendra Sangathan, West Bengal
- AkashVani, Kolkata
- Indian Science Congress Association, Kolkata

National Universities & Institutes

- Assam Agricultural University, Jorhat
- Assam Fisheries Development Corporation Ltd., Guwahati
- Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia
- Bihar Animal Science University, Patna
- C-DAC, Kolkata
- Central University of South Bihar, Patna
- College of Fisheries, Central Agricultural University, Lembucherra, Agartala
- Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur
- Department of Zoology, University of Calcutta, Kolkata
- Dibrugarh University, Assam
- F. M. University, Balasore
- G.B. Pant University of Agriculture & Technology, Pantnagar
- Indian Institute of Technology, Kharagpur
- Indian Institute of Technology, Hyderabad
- Indian Institute of Science Education and Research, Kolkata
- Indian Statistical Institute, Kolkata
- Maharaja Agrasen University, Solan
- Manipur University, Imphal
- School of EBES, Central University of South Bihar, Gaya
- Tilka Manjhi Bhagalpur University (TMBU), Bhagarlpur
- University of Kalyani, Kalyani
- Utkal University, Bhubaneswar
- Chaudhury Charan Singh National Institute of Agricultural Marketing, Jaipur
- Vidyasagar University, Midnapore
- National Water Academy, Pune
- Visva-Bharati University, Santiniketan
- West Bengal University of Animal and Fisheries Sciences, Kolkata
- Azim Premji University, India
- National Centre for Disease Control
- Wildlife Institute of India, Chandrabani, Dehradun

ICAR Organizations

- ICAR Research Complex for NEH Region, Umiam
- ICAR-Agricultural Technology Application Research Institute, Umiam
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Central Institute of Fisheries Education, Mumbai
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar
- ICAR-Central Marine Fisheries Research Institute, Kochi
- ICAR-Central Research Institute of Jute & Allied Fibre, Barrackpore
- ICAR-Directorate of Coldwater Fisheries, Bhimtal
- ICAR-National Academy of Agricultural Research Management, Hyderabad
- ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
- ICAR-National Bureau of Fish Genetic Resources, Lucknow

- ICAR-National Institute of Animal Nutrition & Physiology, Bengaluru
- ICAR-National Research Center on Pig, Rani

State Departments, Boards and Authorities

- Department of Fisheries, Govt. of Gujarat
- Department of Fisheries, Govt. of Manipur
- Department of Fisheries & Aquatic Resources, Nagaland
- Department of Fisheries, Govt. of Tripura
- Department of Fisheries, Govt. of Uttarakhand
- Directorate of Fisheries, Govt. of Assam
- Directorate of Fisheries, Govt. of Bihar
- Directorate of Fisheries, Govt. of Chattishgarh
- Directorate of Fisheries, Govt. of Himachal Pradesh
- Directorate of Fisheries, Govt. of Jharkhand
- Directorate of Fisheries, Govt. of Karnataka
- Directorate of Fisheries, Govt. of Kerala
- Directorate of Fisheries, Govt. of Odisha
- Directorate of Fisheries, Govt. of Uttar Pradesh
- Directorate of Fisheries, Govt. of West Bengal
- Department of Forest, Govt of Gujarat, Ukai
- Narmada Water Resources, Water Supply and Kalpasar Department, Gandhinagar
- Chilika Development Authority, Bhubaneswar
- Assam Rural Infrastructure and Agricultural Services Society (ARIAS)
- Assam Fisheries Development Corporation Ltd.
- Swami Vivekananda State Police Academy, Barrackpore
- Gujarat Maritime Board, Bharuch
- Sundarban Development Board, West Bengal

Central Public Sector Units

- North Eastern Electric Power Corporation (NEEPCO) Limited
- Satluj Jal Vidyut Nigam (SJVN) Limited
- National Hydroelectric power corporation (NHPC) Limited

State Public Sector Units, Federation

- Comprehensive Area Development Corporation, Howrah
- Madhya Pradesh Apex Fisheries Cooperative Federation
- Sardar Sarovar Narmada Nigam Limited

Other Humanitarian Organizations/ NGO

- Hotel & Restaurant Association of Eastern India
- NIRMAN, Odisha
- Ramakrishna Mission, Bhadrak and Sargachhi
- Sundarban Dreams

ICAR-CIFRI in Media

Training and Capacity Building of ICAR-CIFRI Employees

The Annual Training Plan (ATP) of all categories employees of the Institute for the year 2020-2021 was prepared based on the training need assessment and submitted through TMIS. The number of persons attended training for the period (April 2020 - December 2020) was less due to restrictions imposed to cope with the COVID-19 pandemic since the expected training programmes could not be conducted by training organizing institutes. Few staff members could attend some of online training/capacity building programmes.

Annual Physical and Financial Targets and Achievements (April - December 2020)

A. Physical Targets and Achievements

Sl. No.	Category	Total No. of Employees*	No. of trainings planned for each category during 2020-21 as per ATP	Total No. of employees undergone training during April 2020 to December 2020
1	Scientist	84	13	06
2	Technical	50	09	02
3	Administrative & Finance	35	05	-
4	SSS	41	06	-
	Total	210	45	

B. Financial Targets and Achievements (April - December 2020)

BE 2020-21 for HRD (Rs in lakhs)	Actual Expenditure up to 31st December, 2020 for HRD	% Utilization of allotted budget
1.00	Nil	0

Meetings / Workshops / Seminars Attended

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
1.	Ecological observations and channel cross-sectional studies on the River Ramganga (Uttarakhand) under the India – European Union Partnership Programme	1 – 7 January 2020	Roshith C. M	GIZ (Germany) New Delhi
2.	107th Indian Science Congress	3-7 January 2020	B. K. Das, Preetha Panikkar, M. Feroz Khan, Ajoy Saha, Ramya V. L., Jesna P. K., Sibina Mol S., Thankam Theresa Paul, B. K. Behera, Santhana Kumar V., Md. Aftabuddin, Soma Das Sarkar, Ranjan K. Manna, Ganesh Chandra	UAS, Bangalore
3.	International Conference on Functional Materials (ICFM 2020)	6-8 January 2020	B. K. Behera	Material Science Centre at IIT, Kharagpur
4.	MECOS-3	7-10 January 2020	T. T. Paul	ICAR-CMFRI, Kochi
5.	Workshop on Methodology for fish catch assessment survey and online data collection in Kerala	10 January 2020	M. Karthikeyan	Kerala University of Fisheries and Oceanic Sciences
6.	World Fish Project Meeting	11 January 2020	B. K. Das	Bhubaneswar
7.	Meeting with CHSE+2	12 January 2020	B. K. Das	Bhubaneswar
8.	Meeting with World Bank in Central Water Commission for finalization of World Bank Project	13 January 2020	B. K. Das	CWC, New Delhi
9.	Meeting with DDG, NMCG	14 January 2020	B. K. Das	NMCG, New Delhi
10.	National Conference on "Science and Technology: Rural Development"	20 January 2020	B. K. Das	ISCA Surendranath College, Kolkata
11.	Inaugural function of the Professional Skill Development Certificate Course on "Aqua Clinics and Aquapreneurship Programme	20 January 2020	B. K. Das	WBUAFS, Kolkata
12.	Meeting with CDA regarding eco-labelling certification of some of fish resources of Chilika Lake	21 January 2020	B. K. Das	Chilika Development Authority (CDA). Bhubaneswar

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
13.	3rd International Symposium on Genomics in Aquaculture	21-23 January 2020	B. K. Das, B. K. Behera	ICAR-CIFA, Bhubaneswar
14.	Meeting with SJVNL to work out fish pass design	31 January 2020	B. K. Das	Shimla, Himachal Pradesh
15.	National Conference on "Trends and progress of Animal Sciences"	6 February 2020	B. K. Das	Fakir Mohan University, Balasore, Odisha Organized by Zoological Society of Orissa, Utkal University, Bhubaneswar
16.	Inauguration programme of 2-days Workshop on e-Office implementation	11-12 February 2020	Md. Aftabuddin	Virtual mode
17.	ClimFishCon 2020	11-15 February 2020	B. K. Das, T. T. Paul, Kavita Kumari, S. K. Nag	Le Meridian, Kochi
18.	Training of Trainers (ToT) of ASCI at ATARI-Kanpur	13-15 February 2020	S. K. Manna, D. K. Meena	ATARI-Kanpur
19.	Conference on *Ecosystem Health & Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation*(AEHMS 12)	17 – 19 February 2020	B. K. Das, Preetha Panikkar, M. Feroz Khan, M. Karthikeyan, Ajoy Saha, Ramya V. L., Jesna P. K., Sibina Mol S., Vijaykumar M.E., D.N. Jha, Absar Alam, Jeetendra Kumar, V.R.Thakur, Monika Gupta, Kalpana Srivastava, Vijay Kumar, B. K. Bhattacharjya, S. Yengkokpam, Pronob Das, S.C. S. Das, S. Borah,Thankam Theresa Paul, S. Dam Roy, Pranab Gogoi, Dhrubajyoti Sarkar, M. Shaya Devi, Santhana Kumar V., Hassan MA, Manna S. K. Raju Baitha, Gunjan Karnataka, Swain HS,S. K. Sahu, Md. Aftabuddin, Soma Das Sarkar, Asit Kumar Bera, Malay Naskar, Ganesh Chandra, Arun Pandit, Srikanta Samanta, Sanjoy K. Das, Ranjan K Manna, Dibakar Bhakta, Roshith, C.M.	IFSI, ICAR-CIFRI, GBPUAT, AEHMS, PFGF at Pantnagar

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
20.	NSO project meeting with Shri Ramana Murthy, DDG and other staff of NAD	19 February 2020	Arun Pandit	National Accounts Division, National Statistical Office, Min of Stat. and Prog.Implementation Govt of India
21.	National Conference on "Geospatial Technologies in Agriculture"	20-21 February 2020	S. K. Sahu	ICAR-NAARM, Hyderabad
22.	Workshop on "Hands-on Training on Fish Disease Management in Aquaculture"	22 February 2020	B.K. Das	Siliguri Fisheries Research and Training Centre, Department of Zoology, NBU
23.	Rajbhasha Sansadiya Committee Inspection	25 – 27 February 2020	B.K. Das, S.P. Kamble, Anand Meetei, Visakh G., Rajeev Lal, Md. Quarim, J.K. Solanki, C.D. Parmar	Hotel Welcome, Vadodara
24.	Meeting with CDA for SCSP Project at Chilika	13 March 2020	B. K. Das	Chilika Development Authority, Bhubaneswar
25.	Meeting on National Sample survey organization project review	29 April 2020	B. K. Das	Online
26.	Video conference on impact of COVID 19 on fisheries sector with the Deputy Director General (Fisheries Sc.), ICAR	3 May 2020	Arun Pandit, Aparna Roy, Ganesh Chandra	Online
27.	Meeting called by DG, ICAR regarding the ICAR-World fish collaborative projects	4 May 2020	B. K. Das	Online
28.	Meeting with Director, Inland fisheries, Department of Fisheries, Government of India	6 May 2020	B. K. Das	Online
29.	Meeting called by DDG, Fisheries regarding the World fish projects	8 May 2020	B. K. Das	Online
30.	One day online Workshop on "Training Management Information System (TMIS) for HRD Nodal Officers of ICAR"	8 May 2020	S. K. Nag, Aparna Roy	Online ICAR, New Delhi
31.	Executive Council Meeting of Namami Gange	12 May 2020	B. K. Das	Online NMCG, New Delhi

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
32.	National policy workshop through webinar on Riverine and Marine Plastic litter in India	12 May 2020	B. K. Das	Online UNEP and National Productivity Council
33.	Webinar on Post-covid era: mainstreaming biodiversity and nature in development agenda	22 May 2020	Preetha Panikkar	Online International Biodiversity Congress
34.	National Webinar on status of marketing and breeding management of ornamental fishes for an invited talk	29 May 2020	B. K. Das	Online
35.	Webinar series on "Quantitative Methods for Social Sciences"	1-20 June 2020	Ganesh Chandra, Arun Pandit, A.K. Yadav	Online ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi
36.	Webinar on "Opportunities in fisheries sector post lockdown"	4 June 2020	Pronob Das	Online Agrovision Foundation, Nagpur
37.	Launch event of UN-FAO's State of World Fisheries and Aquaculture (SOFIA) 2020	8 June 2020	B. K. Das	Online
38.	1st meeting of the Expert Committee on Inland Fishery Resources (ECIFR)	10 June 2020	B. K. Das	Online
39.	Meeting called by DDG (Fisheries Sciences)	11 June 2020	B. K. Das	Online
40.	Webinar on "Challenges, opportunities, and future of Inland fisheries",	12 June 2020	B. K. Das, Ganesh Chandra, Pronob Das	Online Agrovision Foundation, Nagpur
41.	Webinar on "Entrepreneurship Opportunities in Indian Fisheries Sector - A crisis management support to overcome the impact of COVID-19 pandemic"	12 June 2020	Ganesh Chandra	Online Zonal Technology Management Centre, ICAR-CIFT, Cochin
42.	National Webinar on Strategies & Policy Interventions for Agricultural Development in North East India during COVID 19 era	13 June 2020	B. K. Das	Online CAU, Imphal and AIASA, New Delhi
43.	Executive Committee meeting of Indian science congress association	15 June 2020	B. K. Das	Online Indian Science Congress Association

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
44.	ICAR-NIAP Webinar on "Agriculture During COVID-19, Economic Package and Reforms	16 June 2020	Ganesh Chandra	Online ICAR-NAIP, New Delhi
45.	International webinar on strategies against the Covid 19 pandemic	18 June 2020	Monika Gupta	Online Dept. of Biotechnology, Kumaun University, Nainital
46.	Arising Aquaculture Opportunities Amidst COVID-19	19 June 2020	Monika Gupta	Online World Aquaculture Society Asian Pacific Chapter
47.	CSTFA Webinar on Models and methods for sustaining tropical fisheries in a changing climate	21 June 2020	Preetha Panikkar	Online CSIRO Oceans & Atmosphere, Brisbane, Australia
48.	RSA-India BRICS Collaboration Meeting	23 June 2020	B. K. Das	Online
49.	Meeting on Implementation of e-office	23 June 2020	B. K. Das	Online AS(D) & Secretary, ICAR
50.	Web Meeting on Blue IT Project with officials from CDAC	25 June 2020	B. K. Das	Online
51.	Meeting on Cost Committee Meeting on proposed NASF project 'Captive Breeding of Hilsa, *Tenualosa ilisha* : Phase II' with ADG, NASF and other members	1 July 2020	B. K. Das	Online
52.	Webinar on Rapid Rural Community Response to COVID-19 (RCRC) on with DG, ICAR	3 July 2020	B. K. Das	Online
53.	46th Meeting of Board of Management of ICAR-CIFE, Mumbai	4 July 2020	B. K. Das	Online
54.	V2V Inception Meet	6 July 2020	B. K. Das	Online
55.	Webinar on "Development of status paper for FAO on small scale fisheries"	7 July 2020	B. K. Das, U. K. Sarkar	Online ICAR-CIFRI, Barrackpore
56.	46th Meeting on Dry fish matter project	9 July 2020	B. K. Das	Online
57.	International Web Conference on "Climate smart agriculture for food and nutritional security"	10-11 July 2020	Ganesh Chandra	Online Society for Rural Upliftment, Varanasi
58.	Director Meeting of Fisheries Institute called by DDG (Fisheries Sciences)	15 July 2020	B. K. Das	Online Fisheries Science Division, ICAR

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
59.	Webinar on 'Innovative biosecurity approaches for a healthier aquaculture industry'	15 July 2020	Pronob Das	Food and Agriculture Organization of the United Nations
60.	Web Meeting on the occasion of ICAR Foundation Day	16 July 2020	B. K. Das	Online
61.	Webinar on Aquaculture and Value Chains	17 July 2020	B. K. Das, Ganesh Chandra, V.R. Thakur	Online NEDAC Training Centre, Bangkok in collaboration with AIT, Bangkok
62.	Web talk on Inland Fisheries: Way Forward for the faculty and students of Mahatma Gandhi Central University	18 July 2020	B. K. Das	Online Organized by Mahatma Gandhi Central University
63.	Felicitation of Dr. Rattan Lal, World Food Prize Winner and lecture by Dr. Lal on Soil Science Research in the context of food security and climate change	21 July 2020	S. K. Nag	Online ICAR-Indian Institute of Soil Science, Bhopal, ICAR-National Academy of Agricultural Sciences - Bhopal Chapter and ICAR-Indian Society of Soil Science - Bhopal Chapter
64.	Meeting with Hon. Minister for Environment, Forest and Climate Change regarding EAC	24 July 2020	B. K. Das	Online
65.	Webinar on "Stakeholders Dialogue on Current Challenges and Way Forward for Pesticides Management"	24July 2020	S. K. Nag	Online Organised jointly by Trust for Advancement of Agricultural Sciences (TAAS), Society of Pesticide Science India (SPSI), Indian Phytopathological Society (IPS), Entomological Society of India (ESI)
66.	Meeting the EAC (River Valley Hydro Electric Projects)	25 July 2020	B. K. Das	Online

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
67.	International Conference cum Webinar on 'Research Frontiers and Prospects in Biosciences and Biotechnology'	28-29 July 2029	B. K. Das	Online PG Department of Biosciences and Biotechnology, Fakir Mohan University, Balasore, Odisha
68	Virtual Dialogue: Building Forward Better with Aquatic Foods	29 July 2020	Aparna Roy	Online World fish
69.	International Webinar on 'Rainbow revolution project'	1 August 2020	U. K. Sarkar	Online BCKV, Kalyani
70.	Consultation meeting on "Project River Dolphin: Development of Conservation Action Plan"	7 August 2020	T. N. Chanu	Online Wildlife Institute of India, Dehradun
71.	Meeting called by DDG (Fy. Sc.) and other Senior Officers of SMD	11 August 2020	B. K. Das	Online
72.	Meeting on the progress of the Project 'Study on input cost and farm gate prices in inland fisheries of India' with Director, NAD-Agriculture Unit, CSO	12 August 2020	B. K. Das	Online
73.	Meeting with the Joint Commissioner of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying to discuss on the data related to Inland Fisheries Resources for drafting of report on Inland fisheries Potential from various inland water bodies	13 August 2020	B. K. Das	Online
74.	Video lecture on NABL Accreditation of ICAR Laboratories	13 August 2020	S. K. Nag	ICAR, New Delhi
75.	International webinar on Covid-19 pandemic: Sustainable fishery sector and global trade	17 August 2020	Preetha Panikkar	Online Vikrama Simhapuri University, AP
76.	National Webinar on "Doubling of income of Fish Farmers of Chhattisgarh"	18 August 2020	B. K. Das	Online College of Fisheries, Chhattisgarh Kamdhenu Visvidhyalaya
77.	Six monthly meeting of Town Official Language Implementation Committee TOLIC (Rajbhasha)	19 August to 25 Septembe r 2020	D. N. Jha	Online Office of the Chief Commissioner of Income Tax, Prayagraj.
78.	NICRA Technical Programme Finalization Workshop	20 August 2020	U. K. Sarkar S. K. Nag	Online ICAR-CRIDA, Hyderabad

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
79.	Statutory e- meeting of the Executive Committee,	22 August 2020	B. K. Das	Online Indian Science Congress Association
80.	Webinar on 'Entrepreneurship opportunities in the fishery sector'	22-23 August 2020	A. K. Das	APC College, New Barrackpore, West Bengal
81.	Webinar on Enhancing Conservation of river dolphins through Sub-Regional Cooperation: Exploring the impact of COVID-19 on the ecosystem health of rivers and its dolphin population: Present status and future strategy for conservation in India-Bangladesh-Myanmar-Nepal	24 -25 August 2020	B. K. Das, Preetha Panikkar, M. Feroz khan, M. Karthikeyan, Ajoy Saha, Ramya V. L., Jesna P. K., Sibina Mol S., D.N.Jha, Absar Alam, Jeetendra Kumar, V.R. Thakur, Monika Gupta, B. K. Bhattacharjya, S. Yengkokpam, D. Debnath, Pronob Das, S. C. S. Das, A.K. Yadav, S. Borah, N. Sharma, N.S. Singh, Staff & Young Professionals of Bengaluru Centre, S.P. Kamble, W. Anand Meetei, P. Maurye, Dhrubajyoti Sarkar, Kavita Kumari, P. K. Parida, Tanushree Bera, Ganesh Chandra, M. Shaya Devi, Santhana Kumar V., Hassan MA, Manna SK, Raju Baitha, Gunjan Karnataka, Swain HS, T. Tayung, Meena DK, Srikanta Samanta, Sanjoy K. Das, Ranjan K Manna, A.K. Sahoo, Dibakar Bhakta, Roshith, C.M., Srikanta Samanta,Sanjoy K. Das, Ranjan K Manna, A.K. Sahoo, Dibakar Bhakta, Lohith Kumar, Aparna Roy, Arun Pandit	Online ICAR-CIFRI, Barrackpore

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
82.	National Webinar on "Abiotic Stress in Agriculture: Geospatial Characterization and management Options"	27 August 2020	Dibakar Bhakta	Online ICAR-National Institute of Abiotic Stress Management, Baramati,
83.	Meeting with Dr Anil Rai, ADG, ICT on under the chairmanship of Hon'ble DG and presence of all DDGs for finalizing the network program on precision agriculture	7 September 2020	B. K. Das	Online
84.	Meeting with the SMD officials under the Chairmanship of Hon. DDG (Fy. Sc.)	8 September 2020	B. K. Das	Online
85.	Global webinar on "Certification And Technology" arranged by INFOFISH	9 September 2020	B. K. Das	Online
86.	Sub-committee Meeting on Data of river Yamuna and Drain	9 September 2020	B. K. Das	Online
87.	Webinar on Understanding and Managing Small Scale Fisheries	9-10 September 2020	B. K. Das, Preetha Panikkar, M. Feroz Khan, M. Karthikeyan, Ajoy Saha, V. L. Ramya, Jesna P. K., Sibina Mol S., D.N. Jha, Absar Alam, Jeetendra Kumar, V.R. Thakur, Monika Gupta, B. K. Bhattacharjya, S. Yengkokpam, D. Debnath, Pronob Das, S. C. S. Das , A.K. Yadav,S. Borah, N. Sharma, N.S. Singh, S.P. Kamble, W. Anand Meetei, P. Maurye, Dhrubajyoti Sarkar, Kavita Kumari, P. K. Parida, Tanushree Bera, M. Shaya Devi, Santhana Kumar V., Hassan MA, Manna SK, Raju Baitha, Gunjan Karnataka, Swain HS,T. Tayung, Meena DK, Srikanta Samanta, Sanjoy K. Das, Ranjan K Manna, Dibakar Bhakta, Lohith Kumar, Aparna Roy, Ganesh Chandra, Arun Pandit	Online ICAR-CIFRI, Barrackpore

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
88.	Interaction meeting with the Agency for the Review and the SMD for Third Party Evaluation of DARE/ICAR plan schemes	11 September 2020	B. K. Das	Online
89.	Virtual workshop on IPRs in Agricultural Research & Education in India	12-28 September 2020	Ganesh Chandra	Online
90.	National Workshop on "Fish Health and Disease Management in Tropics"	14 September 2020	B. K. Das	Online College of Fishery Science Nanaji Deshmukh Veterinary Science University Adhartal, Jabalpur (M.P.)
91.	Virtual meeting with GIZ officials for Pong fisheries assessment	15 September 2020	B. K. Das	Online
92.	4th NMCG-WII project monitoring committee meeting for NMCG-WII sponsored project " Planning and management for Aquatic species conservation and maintenance of Ecosystem services in the Ganga river basin for a clean Ganga"	15 September 2020	B. K. Das	Online
93.	Interaction meeting with all the Deans of Fisheries College of the Country with DoF and SMD under the Chairmanship of the Secretary DoF	16 September 2020	B. K. Das	Online
94.	National Webinar on Climate-Smart Integrated Farming System	18 September 2020	V.R. Thakur	Online ICAR-NIASM, Baramati, Pune
95.	One Day International Webinar on "Science and Technology for Sustainable Development"	19 September 2020	B. K. Das	Online Indian Science Congress Association, Kanpur Chapter
96.	One Day Webinar on "Pradhan Mantri Matsya Sampada Yojana"	19 September 2020	B. K. Das, Ganesh Chandra, Suman Kumari	Online Regional Outreach Bureau, PIB, Patna
97.	International Webinar on Perspective on Fish taxonomy	20 September 2020	Kavita Kumari	Bajkul Milani Mahavidyalaya, Bajkul, West Bengal
98.	4th Meeting of Central Standing Committee in PMMSY	24 September 2020	B. K. Das	Online

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
99.	33rd Foundation Day	24 September 2020	S. Dam Roy	Online ICAR-Directorate of Cold Water Research (online)
100.	International Webinar on Advances in Aquaculture Nutrition – 2020	24 September 2020	Pronob Das	Online Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Tamilnadu
101.	Meeting with Social Science Team of World Fish, Penug	25 September 2020	Aparna Roy	Online MS Team
102.	Webinar on empowering youth through inland fisheries management	29 September 2020	D.N. Jha, Absar Alam, Jeetendra Kumar, V.R. Thakur, Monika Gupta, Ganesh Chandra, A.K. Das	Online ICAR-CIFRI, Barrackpore
103.	National webinar on 'Advances in fish vaccines and prophylactics'	30 September 2020	Pronob Das	Online Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Tamilnadu
104.	International Webinar on "Soil Spectroscopy: An Emerging Technique for Rapid Soil Health Assessment"	1 October 2020	Sanjoy K. Das	Online ICRAF, New Delhi and ICAR-IISS, Bhopal.
105.	Webinar on " Women Empowerment: an overview in the light of Gandhian philosophy"	1 October 2020	Tanushree Bera, Aparna Roy, Ganesh Chandra	Online ICAR - CIFRI
106.	Inaugural programme of VAIBHAV summit inaugurated by Honourable Prime Minister	2October 2020	B. K. Das, Ganesh Chandra	Online
107.	Horizontal session on "Precision Agriculture" in the Vaibhav Summit 2020	5 October 2020	B. K. Das	Online
108.	Biodiversity Genomics Conf erence 2020	5-9 October 2020	Kavita Kumari	Online Wellcome Sanger Institute, London
109.	XXV meeting of the ICAR Regional Committee II	8 October 2020	B. K. Das	Online
110.	Meeting with British High Commission on "Seed Funding and Research Linkage" under the chairmanship of DDG (FS) Dr. J. K. Jena	9 October 2020	B. K. Das	Online
111.	Agricultural Production and Entrepreneurship Development in Andaman Islands in COVID Scenario through Technological Intervention	12-15 October 2020	S. Dam Roy	Online ICAR-Central Island Agricultural research institute, Port Blair and NABARD

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
112.	Stakeholder meeting for discussion with World Bank Preparation Mission for Fisheries Sector Covid 19 Recovery Project-New Value Chains and Diversification (Ornamental Fisheries, Cold Water Fisheries, Seaweed Mariculture)	15 October 2020	B. K. Das	Online
113.	National webinar on "Advanced Strategies for the Management of Coastal Agriculture"	15 October 2020	B. K. Das, Sanjoy K. Das	Online The Neotia University, West Bengal and ICAR-CSSRI, Karnal, Haryana
114.	International webinar on "Sustainable ornamental fisheries: Way forward"	15-17 October 2020	Pronob Das	Online Cochin University of Science and Technology (CUSAT), Kochi, Kerala
115.	Vaibhav Summit 2020 horizontal session "Modern Fisheries, Aquaculture and Seed Production"	16 October 2020	B. K. Das, Ganesh Chandra, S. K. Sahu	Online
116.	Virtual webinar on the occasion of 75th foundation day of FAO as World food day	16 October 2020	B. K. Das, Ganesh Chandra	Online
117.	Virtual workshop on Atmanirbhar Krishi se Aatmanirbhar Bharat with focus on Agriculture reforms and value chain development	17 October 2020	Ganesh Chandra	Online PHD Chamber of Commerce
118.	Statutory e- meeting of the Executive Committee of Indian Science Congress Association	19 October 2020	B. K. Das	Online ISCA
119.	Review Meeting of Foreign Aided International Collaborative Research Projects with ICAR institutes under FSD	19October 2020	B. K. Das	Online
120.	Virtual conference on "Sustainable, Technology led and responsible development of Fisheries Sector The Next Level of Growth	19 October 2020	Ganesh Chandra	Online Confederation of Indian Industries
121.	Webinar "Impact of Minimum Ecological Flows in downstream of reservoirs on riparian ecosystem (aquatic life) along River Ganga"	21 October 2020	B. K. Das	Online Organized by the Central Pollution Control Board, Noida

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
122.	Stakeholder Consultation for Strategic Environmental, Economic and Social Assessment (SEESA) Project	21 October 2020	B. K. Das	Online ARKITECHNO along with NMCG
123.	EndNote Training & Certificate Program 2020	26 & 28 October 2020	Dibakar Bhakta	Online Clarivate Web of Science, USA
124.	Meeting of the Expert Group reconstituted to review and finalized the draft Bill on the Fisheries and Aquaculture Council of India in the same line of Veterinary Council of India	28 October 2020	B. K. Das	Online
125.	Meeting with SMD under the chairmanship of DDG (Fy. Sc), ICAR	29 October 2020	B. K. Das	Online
126.	Induction of Gender Concepts in Inland Fisheries and Aquaculture Sectors	31 October to 6 November 2020	Aparna Roy	Online College of Fisheries, Tripura
127.	Workshop on Introduction of new J-Gate @CeRA Consortia Database	2 November 2020	Ajoy Saha, V. L. Ramya, Sibina Mol S., Tanushree Bera, U. K. Sarkar, Ganesh Chandra	Online
128.	Virtual meeting on development of global project for Sustainable Fisheries and Aquaculture, One-World No Hunger	3 November 2020	B. K. Das, U. K. Sarkar	Online GIZ
129.	Technical Monitoring Committee (TMC) Meeting to validate the data prepared for the release of the Handbook on Fisheries Statistics: 2020 under the Chairmanship of Director, IASRI	4 November 2020	B. K. Das	Online
130.	FICCI Webinar on 'Post Covid19:The Future and Dynamics of Agrochemical Industry'	5 November 2020	S. K. Nag	Online FICCI
131.	"Review Meeting of Ongoing Projects funded by NFDB and implemented by ICAR institutes under Fisheries Science Division"	10 November 2020	B. K. Das, Ganesh Chandra, Suman Kumari, M. A. Hassan, P. Mishal, R. Baitha	Online Fisheries Science Division, ICAR

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
132.	Senior Officers Meeting of Fisheries SMD	17 November 2020	B. K. Das	Online Organized under the chairmanship of DDG (Fy. Sc), ICAR
133.	Virtual meeting on "Connectivity of Sundarban mangroves and coastal waters based on the life stages of selected fish species using Otoliths" with the Scientists of Glassgow University, U.K	18 November 2020	B. K. Das, U. K. Sarkar	Online ICAR-CIFRI, Barrackpore
134.	International webinar on 'Opportunities and Challenges for Vulnerability and Viability in SSF and Fisheries Value Chains'	19 November 2020	B. K. Das	Online Organized by V2V
135.	National Webinar on "Sustainable Management of Aquatic Resources for Fish Production and Conservation in commemoration of World Fisheries Day 2020"	21 November 2020	Dibakar Bhakta	Online Fisheries College and Research Institute (Tamil Nadu J. Jayalalithaa Fisheries University) through online mode
136.	International Webinar during the observance of International Freshwater Dolphin Day 2020	24 November 2020	B. K. Das, Srikanta Samanta, Sanjoy K. Das, Ranjan K Manna, Dibakar Bhakta, Roshith, C.M., Aparna Roy, Ganesh Chandra	Online ICAR-CIFRI, Barrackpore
137.	Meeting of the Joint Committee constituted by Hon. NGT to discuss on assessment of environmental damage in monetary terms for River Yamuna-Delhi stretch	26 November 2020	B. K. Das	Online
138.	All Country Coordinator's Meeting with V2V Global Partners	27 November 2020	B. K. Das	Online
139.	Meeting on Network Program on Precision Agriculture	28 November 2020	B. K. Das	Online
140.	Meeting of the Expert Group reconstituted to review and finalized the draft Bill on the Fisheries and Aquaculture Council of India in the same line of Veterinary Council of India	28 November 2020	B. K. Das	Online

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
141.	All country Coordinator's Meeting with V2V Global Partners	29 November 2020	B. K. Das	Online
142.	Inaugural meeting of the V2V I-ADApT Working Group	30 November 2020	B. K. Das	Online
143.	Fish Mart-Virtual Exposition, B2B, Masterclass and Conference	30 November 2020	B. K. Das	Online Confederation of India Industry
144.	Special workshop for governments and policy makers on "Transdisciplinarity for small-scale fisheries governance"	30 November, 2 & 4 December 2020	T. N. Chanu, S. K. Koushlesh, Aparna Roy	Online Too Big to Ignore (TBTI) – Global Partnership for Small-Scale Fisheries Research
145.	9th Agrochemical Conference 2020 on 'Role of agrochemicals in achieving vision of $ 5 trillion economy by 2025'	1 December 2020	S. K. Nag	Online FICCI
146.	3rd Expert Group Meeting on Fishery Interventions	2 December 2020	B. K. Das	Online Organized by NMCG
147.	Discussions on Online Training Programmes of ICAR-DoF Convergence	2 December 2020	B. K. Das	Online Organized under the chairmanship of DDG (Fy. Sc.)
148.	Annual conference of Vice Chancellors of Agricultural Universities and Directors of ICAR Institutes	5 December 2020	B. K. Das	Online
149.	Meeting and signing of MoU with Central Sericultural Research and Training Institute (CSRTI), Mysuru	8 December 2020	B. K. Das	Central Sericultural Research and Training Institute (CSRTI), Mysuru
150.	Management Development Programme on Leadership Development (a Pre-RMP Programme)	8-19 December 2020	S.K. Nag	Online ICAR-NAARM
151.	FAO project meeting on preparation of a status paper on Inland Fisheries of India	9 December 2020	U. K. Sarkar	Online ICAR-CIFRI, Barrackpore
152.	Situational analysis webinar	10 December 2020	B. K. Das	Online Organized by V2V
153.	Big Data Analytics in Agriculture	10-11 December 2020	S. K. Sahu	Online ICAR-NAARM
154.	National webinar on "Introduction to GC MS"	12 December 2020	Sanjoy K. Das	Online Chromatographic Society of India

SL. No.	Name of the Programme	Date	Name of the Official(s)	Organizer and Venue
155.	Tilapia steering cum monitoring committee virtual meeting	14 December 2020	Preetha Panikkar	Online Directorate of fisheries, Govt of Karnataka
156.	DTU-sponsored one week international e-workshop on Bioinformatics	14-18 December 2020	Kavita Kumari	E-WORKSHOP by Department of Biotechnology Delhi Technological University, Delhi
157.	Session on River Conservation Synchronised Inland-water Navigation and Flood Management" in the 5th India Water Impact Summit	15 December 2020	B. K. Das	Online National Mission for Clean Ganga, Ministry of Jal Shakti, Govt. of India and the Centre for Ganga River Basin Management and Studies (cGanga) led by the Indian Institute of Technology Kanpur
158.	Monthly Meeting of Direct ors & Fisheries SMD	15 December 2020	B. K. Das	Online
159.	Workshop on Gender Sensitization by ICAR	15 December 2020	V. L. Ramya, Sibina Mol S., Deepa Sudheesan, T. T. Paul, Vandana .G	Online ICAR, New Delhi
160.	NITI Aayog meeting	16 December 2020	B. K. Das	Online
161.	International Webinar "Mahseer (*Tor* spp.) of the World: status and conservation challenges"	16 December 2020	Monika Gupta	Online ICAR-DCFR, Bhimtal
162.	Meeting reg e-flow under Chairmanship of DG, NMCG	23 December 2020	B. K. Das	Online NMCG, New Delhi
163.	General Body of the Academy (NASI)	29 December 2020	B. K. Das	Online
164.	TN-IAM PROJECT Fourth steering committee meeting	29 December 2020	M. Feroz Khan	Online TN Fisheries Department

Distinguished Visitors

Prof. P. Biswas, VC, WBUAFS (2nd from left); Dr. G. H. Pailan,I/C CIFE, Kolkata centre (3rd from left)

The whole world had faced an unprecedented lockdown due to COVID-19 pandemic in the year 2020. India was no exception. The global pandemic and restrictions on transport systems had put a brake on movement of personnel. As such, very limited number of distinguished persons and dignitaries in the field of fisheries and allied domains had visited the Institute in 2020, as given below:

- Dr. J. K. Jena, DDG (Fy. Sc.) ICAR, New Delhi; Dr. Bindu R. Pillai, Actg. Director, ICAR-CIFA, Bhubaneswar; Dr. P.C. Das, Principal Scientist, ICAR-CIFA; Dr. Suseela Mathew and Dr. A. K. Mohanty, Heads of Divisions, ICAR-CIFT, Kochi visited ICAR-CIFRI, Barrackpore, on 4 January 2020.

- Dr. Selvarajan Ramaswamy, Principal Scientist, Plant Pathology, NRC for Banana, Tiruchirapalli, Tamil Nadu, visited the Institute on 4 February, 2020.

- Prof. Rita Bahuguna Joshi, Convener of Hindi Rajbhasa Committee; Other members of the Committee, viz., Sh. Pradip Tamta, Sh. Sushil Kumar Gupta, Smt. Ranjanben Dhanjay Bhatt; Sh. B. L. Meena, Secretary of the Committee Secretariat; Sh. Kamal Swarup, Research Officer; and Sh. Kiran Pal, Senior Hindi Translator Representative of ICAR, New Delhi; Dr. Praveen Putra, ADG (M. Fy.); Smt. Seema Chopra, Director (Rajbhasha), New Delhi, visited the ICAR-CIFRI, Vadodara Centre during 25-28 February 2020.

- Dr. B. P. Mohanty, ADG (I. Fy.), ICAR, New Delhi visited ICAR-CIFRI, Barrackpore on 8 March 2020, and 14 September 2020.

Dr. (Smt.) Vijayalakshmi Saxena, General President of ISCA, Dr. Ashok Kr. Saxena, Former President, ISCA & Dr. Jivan Mitra,HoD, ICAR-CRIJAF at 74th Foundation Day of ICAR-CIFRI

Prof. Rita Bahuguna Joshi, Convener of Hindi Rajbhasa Committee (2nd form Left)

Shri Deepankar Bhattacharya, IPS and DIG of Vivekananda State Police Academy (2nd from right)

Dr. Salvarajan Ramaswamy, PS, NRC for Banana (Left) & Dr. B. P. Mohanty, ADG(I.Fy.), ICAR (Right)

Shri Pratap Chandra Sarangi, Minister of State Fisheries, AHD & MSME
at ICAR-CIFRI Pen demonstration site, Rishia Reservoir, Balasore, Odisha

Shri Amarendra Kumar Singh, Chief Engineer, Central Water Commission (CWC), New Delhi (middle)

Hon'ble Shri Gajendra Singh Shekhawat, Union Minister of Jal Shakti

- Dr. (Smt.) Vijayalakshmi Saxena, General President, ISCA; Dr. Ashok Kumar Saxena, Former President, ISCA; Dr. Jivan Mitra, HOD, ICAR-CRIJAF visited ICAR-CIFRI, Barrackpore on 17 March 2020.

- Sh. Rakesh Kr. Saini, Chief Technical Officer (IT), Division of Computer Applications, ICAR-IASRI was at ICAR-CIFRI, Barrackpore during 11-12 February 2020.

- Shri Pratap Chandra Sarangi, Minister of State for Fisheries, AH D & MSME visited CIFRI Pen demonstration site at Rishia reservoir, Balasore, Odisha on 30 September 2020.

- Sh. Dhrubajyoti De, IPS, Joint Commissioner of Police, Barrackpore Police Commissionerate graced an occasion at ICAR-CIFRI, Barrackpore on 2 November 2020.

- Hon'ble Sh. Gajendra Singh Shekhawat, Union Minister of Jal Shakti; Sh. U. P. Singh, IAS, Secretary, Department of Water Resources, River Development and Ganga rejuvenation, Ministry of Jal Shakti; Sh. A. K. Jain, Commissioner, Flood Control Management, Ministry of Jal Shakti; and Sh. Saibal Ghosh, General Manager, Farakka Barrage Authority (FBA) and staffs of FBA, Inland Waterways Authority (IWAI), Central Water Commission (CWC) visited the CIFRI Hilsa Ranching Station at Farakka on 18 December 2020.

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