Annual Report | वार्षिक प्रतिवेदन

2022

भाकृअनुप – केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान
बैरकपुर, कोलकाता- 700 120, पश्चिम बंगाल
ICAR- Central Inland Fisheries Research Institute
Barrackpore, Kolkata-700120, West Bengal

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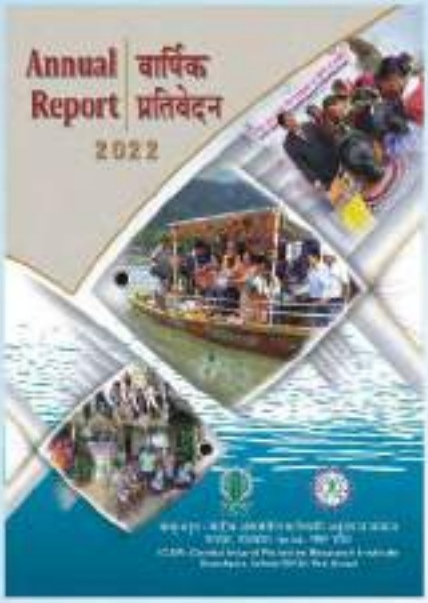

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PREFACE

Millions of rural poor people depend on inland open-water fisheries for their lives and livelihoods. It offers income and employment opportunities as well as prospects for food and nutritional security. Inland open waters are one of the most significant fisheries resources in the nation as they have a high potential for production enhancement and are the sources of native fish germplasm. India has witnessed remarkable growth in fish production in the last couple of years and has set a target of 220 lakh tons of production in the post-COVID era. Our country is blessed with a huge array of inland open water resources 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 highland lakes. These resources are the lifelines of the country's vast population and provide water, fish for food and nutrition, transport, and livelihood besides other innumerable economic, social, and ecological services.

Over the years, the institute has generated a vast knowledge base through interdisciplinary research for ensuring sustainability in the inland fisheries sector. The inland aquatic ecosystems comprising a diversity of ephemeral, seasonal and persistent types of lentic and lotic habitats maintained by hydrologic variability have a strong evolutionary backdrop to provide support to fish species diversity and fisheries. The dynamically varying physical habitat features, regulated by the magnitude and rate of change of hydrologic conditions play the most crucial role in biological productivity, biodiversity and production sustainability. Climatic variability and responses of stock levels to fishing efforts include among the identified areas of research in ICAR-CIFRI. The significant harm to ecosystem functions and alterations to trophic relationships arising from the rampant destruction of unintended and non-targeted species are a major concern, as they diminish sustainable yields in multispecies open-water fisheries to a large extent. The trophic relationships, as the determinants of harvest levels in openwaters have attracted attention for detailed study. In concert with the contemporary necessity, ICAR-CIFRI is poised to R&D trajectory of Natural Resource Management to set the research perspectives and priority in inland open water fisheries. It recognizes the deeper connection between environment and production and therefore, the imperatives of ecosystem-based sustainable fisheries.

During the year, the institute has conducted research on Ganga, Yamuna, Mahanadi, Krishna, Barak, and Kosi rivers; Hooghly-Matlah, Rushikulya, Mandovi-Zuari, Netravathi-Gurupurand Vembanad estuarine systems with different objectives. The impact of damming in River Rangit in Sikkim was studied. Explorations of fish diversity in eight protected areas of four states were carried out. Hirakud, Panam, Idukki, Kodar, Poondi, Serlui-B, Beko, Patloi, Loharsol, Muruguma, Futiyari, Sunei, Kalo, Gayatri, Karapuzha, Mettur and Manchanbele reservoirs were studied for ecology and fisheries. A new circular pen of 0.3 ha area has been designed and put to test in deep waters of Maithon reservoir for grow-out culture of fish in reservoirs. Carbon sequestration studies were carried out in 12 wetlands of Assam and West Bengal. Climate Resilient culture based fisheries was implemented by introducing *Systomus sarana*, *Mystus gulio*, *Labeo bata*, in 3 wetlands of West Bengal, *Etroplus suratensis* and *Liza* sp. in Vembanad Lake. Spatio-temporal asynchronous data of 2667 locations and 14 years have been programmatically retrieved from the CPCB website, standardized, synchronized and transferred to cloud storage. An exhaustive list of 1428 endemic inland fish species and 227 exotic fish species of India has been prepared and saved to the same cloud storage after validation.

The institute bred and ranched around 24.45 lakh Indian major carp seeds for ecosystem restoration and fisheries conservation in the river Ganga. Anti-microbial resistance campaigns were carried out at different locations in India and more than 10,000 public/farmers and students were sensitized. Induced breeding of *Danio dangila* and larval rearing *Macrognathus aral*, has also been achieved under captivity.

Through research, training, extension, HRD and other development activities the institute has been attempting to mitigate the challenges and to enhance the fish production. The Institute took the 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 1322 fishers, officials, and students through offline and online modes. Under STC programme the Institute has taken up several initiatives including imparting scientific knowledge, distributing fisheries inputs, conducting demonstrations benefitting 1067 fishers and fish farmers. Institute technologies /products /publications showcased in 11 exhibitions in different parts of the country. The institute also organized the first Indian Fisheries Outlook 2022 and also observed/celebrated several symposiums, workshops, and events during the period. In addition to the regular meetings and events, the Institute organized an interactive meeting with the fishery officials of Meghalaya, an interface meeting with farmers- planners and researchers of West Bengal, national campaigns on diversification in aquaculture, a satellite symposium on "Hilsa Dialogue: A Bay of Bengal (BoB) Perspective", *Garib kalian sammelan*, tribal pride day, etc.

Like in previous years, significant

attention was paid to the northeastern region. Following CIFRI's intervention in 7 *beels* of Assam, there was 31% increase in fish production. Cage culture has been initiated in Doyang reservoir, Nagaland. Cage culture was also demonstrated in Mapithel reservoir, Manipur with the locally preferred common carp (*Cyprinus carpio*). Cage culture of *Osteobrama belangeri* (pengba), *Ctenopharyngodon idella* and *Labeo bata* was demonstrated in Takmu pat, Manipur. Pen culture of *Amblypharyngodon mola* with major carps or alone was initiated in Takmu pat in collaboration with the Department of Fisheries, Govt. of Manipur.

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.

During the year, applications for three patents, two designs, and one trademark have been filed. Technologies, namely, 'CIFRI circular cage', 'FRP coracle with seating arrangement' and 'FRP ornamental tank' have been commercialized, and four more are ready to be commercialized.

I am confident that constant endeavors and persistent efforts of researchers will lead to wider adoption of existing technologies, development of newer technologies, and protocols for sustainable production enhancement and ecosystem health conservation that would push the inland open water fisheries sector to a new height.

I have the privilege of acknowledging the profound support I have received from Dr. Himanshu Pathak, Secretary DARE and DG 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. Subhadeep Ghosh, Dr. Pravin Putra, Assistant Director Generals (Marine Fisheries); as well as to the team of scientists and other members of the CIFRI fraternity for their unstinted support. The guidelines and recommendations given by IRC, learned RAC, IMC, QRT for Institute's development, and streamlining the Institute's research and activities are also humbly acknowledged. The efforts of the Ediorial team in the preparation of this document are commendable.

Dated : 01 January, 2023
Barrackpore

B. K. Das
(Director)

लाखों ग्रामीण और निर्धन मछुआरों का जीवन और आजीविका अन्तर्स्थलीय खुला जल मत्स्य पालन पर निर्भर हैं। यह क्षेत्र उन्हे आय और रोजगार के अवसर के साथ–साथ खाद्य और पोषण सुरक्षा भी प्रदान करता है। अन्तर्स्थलीय खुला जल क्षेत्र देश के सबसे महत्वपूर्ण मत्स्य संसाधनों में से एक माना जाता है क्योंकि ये संसाधन उत्पादन वृद्धि की उच्च क्षमता के साथ स्वदेशी मत्स्य प्रजातियों के जर्मप्लाज्म के स्रोत हैं। भारत में पिछले कुछ वर्षों में मछली उत्पादन में उल्लेखनीय वृद्धि देखी गई है। कोविड महामारी के बाद मछली उत्पादन लक्ष्य 220 लाख टन रखा गया है। हमारे देश में अन्तर्स्थलीय खुला जल संसाधनों का विशाल भंडार है जिसमें नदियाँ (45,000 किमी), ज्वारनदमुख (0.3 मिलियन हेक्टेयर), बैकवाटर और लैगून क्षेत्र (0.19 मिलियन हेक्टेयर), जलाशय (3.524 मिलियन हेक्टेयर), बाढ़कृत मैदानी आर्द्रभूमि (0.354 मिलियन हेक्टेयर) और पर्वतीय झील (0.72 मिलियन हेक्टेयर) आते हैं। ये संसाधन देश की विशाल जनसंख्या के लिए 'जीवन रेखा' के समान हैं जो लोगों को आर्थिक, सामाजिक और पारिस्थितिक सेवाओं के अलावा भोजन और पोषण सुरक्षा के लिए मछली, परिवहन के साधन तथा आजीविका और आय वृद्धि के अवसर प्रदान करते हैं।

संस्थान ने अन्तर्स्थलीय मत्स्य पालन क्षेत्र में स्थिरता सुनिश्चित करने के लिए अंतःविषय अनुसंधान के माध्यम से एक विशाल ज्ञान कोश तैयार किया है जिसमें कई वर्षों के आँकड़े सुरक्षित किए गए हैं। अन्तर्स्थलीय जलीय पारिस्थितिक तंत्र में स्थिर तथा धारा वेग वाली जलीय जीवों की अल्पकालिक, मौसमी और दीर्घकालिक प्रकार की विविधता शामिल है, जो जलीय परिवर्तनशीलता को बनाए रखता है और इससे मछली प्रजातियों की विविधता और मत्स्य पालन को मजबूत आधार मिलता है। गतिशील रूप से बदलती भौतिक आवास, जलीय स्थितियों के परिमाण और परिवर्तन का नियंत्रित जैविक उत्पादकता, जैव विविधता और उत्पादन स्थिरता में सबसे महत्वपूर्ण भूमिका है। भाकृअनुप–सिफरी के शोध प्रयासों के अंतर्गत जलवायु परिवर्तनशीलता और स्टॉक वृद्धि के लिए मछली पकड़ गतिविधियां शामिल हैं। पर अनियंत्रित और गैर–लक्षित प्रजातियों के बड़े पैमाने पर विनाश के कारण पारिस्थितिक तंत्र पर पड़ने वाले हानिकारक प्रभाव तथा ट्राफिक स्थिति एक प्रमुख चिंता का विषय है, क्योंकि इससे खुला जल संसाधनों में बहु–प्रजाति मत्स्य पालन से होने वाली सतत उत्पादन में कमी आती हैं। खुला जल क्षेत्रों में उत्पादन स्तर के निर्धारक के रूप में ट्राफिक स्थति की एक विशेष भूमिका है। यदि वर्तमान शोध पटल को देखा जाए तो सिफरी अन्तर्स्थलीय खुले जल मात्स्यिकी में अनुसंधान दृष्टिकोण और प्राथमिकता निर्धारित करने के लिए प्राकृतिक संसाधन प्रबंधन के अनुसंधान एवं विकास पथ पर अग्रसर है। साथ ही, पारिस्थितिकी तंत्र आधारित सतत और दीर्घकालिक मत्स्य पालन के लिए पर्यावरण और उत्पादन के बीच तारतम्य स्थापित करने के लिए सचेष्ट है ।

रिपोर्ट अवधि के दौरान, संस्थान ने गंगा, यमुना, महानदी, कृष्णा, बराक और कोसी नदियों के साथ–साथ हुगली–मतला, रुशिकुल्या, मंडोवी–जुआरी, नेत्रावती–गुरुपुर और वेम्बनाड ज्वारनादमुखों पर शोध किया है। सिक्किम में रंगित नदी में बाँध बनाने के प्रभाव का अध्ययन तथा चार राज्यों के आठ संरक्षित क्षेत्रों में मत्स्य विविधता पर शोध किया गया। हीराकुड, पानम, इडुक्की, कोडर, पूंडी, सेलुंई–बी, बेको, पटलोई, लोहारसोल, मुरुगुमा, फुतियारी, सुनेई, कालो, गायत्री, कारापुझा, मेट्टूर और मंचनबेले जलाशयों की पारिस्थितिकी और मात्स्यिकी का अध्ययन किया गया। जलाशयों में मछली पालन विकास की दिशा में मैथन जलाशय के गहरे पानी में परीक्षण के लिए 0.3 हेक्टेयर क्षेत्र का एक नया गोलाकार पेन क्षेत्र बनाया गया है। असम और पश्चिम बंगाल की 12 आर्द्रभूमियों में कार्बन पृथक्करण पर अध्ययन किए गए। जलवायु अनुकूल मछली पालन के अंतर्गत पश्चिम बंगाल के 3 आर्द्रभूमि में सिस्टोमस सराना, मिस्टस गुलिओ और लेबीओ बाटा तथा केरल के वेम्बनाड झील में एटरोप्लस सुरेनटेंसिस और लिजा प्रजाति का पालन किया गया। केन्द्रीय प्रदूषण नियंत्रण बोर्ड (CBPC) के वेबसाइट से 2667 स्थानों के गत 14 वर्षों के स्थानिक–अस्थायी अतुल्यकालिक आंकड़ों को पुनर्प्राप्त किया गया है। इसके बाद इन आंकड़ों को मानकीकृत तथा संकलित करके क्लाउड स्टोरेज में स्थानांतरित किया गया है। संस्थान ने देश की 1428 स्थानिक अन्तर्स्थलीय मछली प्रजातियों और 227 विदेशी मछली प्रजातियों की एक विस्तृत सूची तैयार की गई है और सत्यापन के बाद उसी क्लाउड स्टोरेज में सहेजी गई है।

संस्थान ने गंगा नदी में पारिस्थितिकी तंत्र का पुनरुत्थान और मत्स्य संरक्षण के लिए लगभग 24.45 लाख इंडियन मेजर कार्प प्रजातियों के बीजों का प्रजनन और रैंचिंग किया है। भारत में विभिन्न स्थानों पर एंटी–माइक्रोबियल निरोध अभियान चलाए गए और 10,000 से अधिक जनता/किसानों और छात्रों को जागरूक किया गया। घेरे में डेनियो डैंगिला का प्रेरित प्रजनन और मैक्रोग्नाथस अराल का लार्वा पालन किया गया है।

अनुसंधान, प्रशिक्षण, विस्तार, मानव संसाधन विकास और अन्य विकास गतिविधियों के माध्यम से संस्थान मत्स्य पालन क्षेत्र में व्याप्त चुनौतियों को कम करने और मछली उत्पादन वृद्धि हेतु निरंतर प्रयास कर रहा है। संस्थान ने पारिस्थितिक तंत्र आधारित अनुसंधान और सामुदायिक भागीदारी के माध्यम से अन्तर्स्थलीय खुलाजल मात्स्यिकी क्षेत्र में आंकड़ा संचयन के लिए सचेष्ट है। इस वर्ष संस्थान ने ऑफ़लाइन और ऑनलाइन मोड के माध्यम से 1322 से अधिक मछुआरों, अधिकारियों और छात्रों को प्रशिक्षण प्रदान किया है। आदिवासी उपयोजना कार्यक्रम के तहत संस्थान ने वैज्ञानिक सूचनाओं का प्रदान, तकनीकों पर प्रदर्शन और मत्स्य पालन आदानों का वितरण किया है जिससे 1067 मछुआरों और मछली किसान लाभान्वित हुए हैं। संस्थान की प्रौद्योगिकियों/उत्पादों/प्रकाशनों को देश के विभिन्न भागों में 11 प्रदर्शनियों द्वारा प्रदर्शित किया गया। संस्थान ने प्रथम इंडियन फिशरीज आउटलुक (IFO), 2022 संगोष्ठी के साथ कई महत्वपूर्ण संगोष्ठि, कार्यशालाओं और कार्यक्रमों का आजोजन किया तथा प्रतिभागिता की है। नियमित बैठकों और कार्यक्रमों के अलावा, संस्थान ने मेघालय के मत्स्य अधिकारियों के साथ एक संवादात्मक (इंटरैक्टिव) बैठक, पश्चिम बंगाल के किसानों–योजनाकारों और शोधकर्ताओं के साथ एक इंटरफेस बैठक, जलीय कृषि में विविधीकरण पर राष्ट्रीय अभियान, "हिलसा संवाद" पर एक उपग्रह

संगोष्ठी के साथ–साथ बे ऑफ बंगाल (बीओबी) परिपेक्ष्य', गरीब कल्याण सम्मेलन, आदिवासी गौरव दिवस आदि का आयोजन किया।

रिपोर्ट अवधि में पूर्वोत्तर क्षेत्र के विकास पर भी महत्वपूर्ण कार्य किया गया। असम के 7 बीलों में संस्थान के सहयोग से मछली उत्पादन में 31% की वृद्धि हुई। नागालैंड के दोयांग जलाशय में पिंजरा पालन शुरू किया गया है। मणिपुर के मैपिथेल जलाशय में पिंजरा में स्थानीय पसंदीदा कॉमन कार्प प्रजाति, साइप्रिनस कार्पियो के पालन का प्रदर्शन किया गया। मणिपुर के ताकमू पाट में ओस्टियोब्रामा बेलंगेरी (पेंगबा), टेनोफेरीगोडोन आइडेला और लैबियो बाटा का पिंजरे में पालन तकनीक का प्रदर्शन किया गया। इसके साथ मत्स्य पालन विभाग, मणिपुर सरकार के सहयोग से ताकमू पाट के पेनक्षेत्र में एंबलीफेरीगोडोन मोला का एकल पालन तथा इसका मेजर कार्प प्रजातियों के साथ बहु–पालन किया गया।

संस्थान ने मछली उत्पादन बढ़ाने और फील्ड स्तर पर उपलब्ध कराने के लिए कैजग्रो फीड, सिफरी जीआई केज, सिफरी एचडीपीई पेन जैसी व्यावसायिक प्रौद्योगिकियों की पहुंच पर अधिक जोर दिया था। इस वर्ष के दौरान तीन पेटेंट, दो डिजाइन और एक ट्रेडमार्क के लिए आवेदन दाखिल किए गए हैं। 'सिफरी सर्कुलर केज', 'बैठने की व्यवस्था के साथ एफआरपी कोरेकल' और 'एफआरपी सजावटी टैंक' नाम की प्रौद्योगिकियों का व्यवसायीकरण किया गया है, और चार अन्य प्रौद्योगिकियों का व्यवसायीकरण किये जाने की संभावना है।

अतः मुझे विश्वास है कि शोधकर्ताओं के निरंतर प्रयासों से मौजूदा प्रौद्योगिकियों को व्यापक रूप से अपनाने, नई प्रौद्योगिकियों के विकास, सतत उत्पादन वृद्धि और पारिस्थितिक तंत्र स्वास्थ्य संरक्षण के लिए प्रोटोकॉल पर कार्य किया जा रहा है जो अन्तर्स्थलीय खुला जल मात्स्यिकी को एक नई ऊंचाई तक ले जाएगा।

मैं संस्थान की शोध उपलब्धियों के लिए माननीय सचिव, कृषि अनुसंधान एवं शिक्षा तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद, डॉ. हिमांशु पाठक से प्राप्त सहयोग और दिशा–निर्देशों के लिए आभार व्यक्त करता हूँ। मैं डॉ. जे.के. जेना, उप महानिदेशक (मात्स्यिकी विज्ञान); डॉ. बी. पी. मोहंती, सहायक महानिदेशक (अन्तर्स्थलीय मात्स्यिकी); डॉ. सुभदीप घोष (वर्तमान) एवं डॉ. प्रवीण पुत्र (अवकाशप्राप्त), सहायक महानिदेशकगण (समुद्री मात्स्यिकी) के साथ–साथ संस्थान के वैज्ञानिकों और अनुसंधान सहयोगियों के प्रति उनके निरंतर सहयोग के लिए आभारी हूँ। मैं संस्थान के शोध कार्यों में भावी विकास के लिए अनुसंधान सलाहकार समिति (RAC), संस्थान अनुसंधान समिति (IRC), संस्थान प्रबंधन समिति (IMC), पंचवर्षीय समीक्षा दल (QRT) के सुझावों और दिशा–निर्देशों के लिए आभारी हूँ। इस रिपोर्ट के संकलन और इसे तैयार करने में सम्पादन दल के प्रयास सराहनीय हैं।

बी. के. दास
(निदेशक)

दिनांक : 01 जनवरी, 2023
बैरकपुर

Inland open-water fisheries are the life-line of millions of riparian population. These natural resources offer livelihood, income, employment opportunities and nutritional security to the resource poor fishers. The institute continued its unrelenting quest of research and development of these resources in 2022. The institute has commercialized three of its technologies, viz., 'CIFRI circular cage', 'FRP coracle with seating arrangement' and 'FRP ornamental tank', and applications have been filed for three patents, two industrial designs and one trademark. During the period, our scientists were honoured with prestigious awards such as Dr.Hiralal Choudhury Gold Medal, Dr. S. Ayyapan Gold Medal and Prof. A. P. Sharma Gold Medal at the Indian Fisheries Outlook 2022, and other coveted awards at the International Conference on "Responsible Aquaculture and Sustainable Fisheries Interact (RASHI)–2022".

For conservation of native fish stock and to enhance fish production we continued river ranching programmes in which we released 24.45 lakh fingerlings of Indian major carps and Mahseer into the river Ganga. Fish diversity was exploredin eight protected areas of four states. The institute studied Hirakud, Panam, Idukki, Kodar, Poondi, Serlui-B, Beko, Patloi, Loharsol, Muruguma, Futiyari, Sunei, Kalo, Gayatri, Karapuzha, Mettur and Manchanbele reservoirs for ecology and fisheries. A new circular pen has been designed for grow-out culture of fish in reservoirs.Carbon sequestration studies were carried out in the wetlands of Assam and West Bengal. Climate Resilient culture based fisheries was implemented by introducing climate resilient fish species in wetlands of West Bengal and in Vembanad Lake.

Comparative brain transcriptomics analysis on chronic exposure to cypermethrin revealed upregulation of 302 genes and downregulation of 229 genes. Liver transcriptome of tilapia sourced from river Ganga was investigated to identify candidate genes as response mechanisms to pollution. Out of 363 differential expressed genes, 236 genes were found to be upregulated at polluted site and enriched with 20 Gene Ontology.A prototype bio-sensing colorimetric device has been developed for detection of OPs pesticides in openwater resources. The sensor has been deployed in five wetlands of Assam for field validation.

The institute conducted a series of anti microbial resistance campaigns and mass awareness programmes at various locations.A total of 92 Staphylococcus spp., 117 E. coli and 112 Aeromonas spp. were isolated from different fish farms of West Bengal. About 63% of the E. coli isolates harbored TEM-1 & TEM-2 resistance genes, and 41% isolates have Amp C resistant genes. About 17% of Aeromonas isolates were phenotypically resistant to ESBL.

Bioremediation capabilities of a microbial consortium were examined for potential removal of ammonium from contaminated water bodies.Hydrochar based ammonia remediation material was developed which also found to enhance the lipid productivity of microalgae Graesiellaemersonii for biodiesel production.Banana waste-based microalgae biofilm was tested for arsenic remediation and found to convert the metalloid from toxic to non-toxic form. Microalgae biofilm was also found to reduce arsenic accumulation in fish.

The institute undertook several initiatives as part of the SCSP programme, including ornamental fish culture, development of pen culture and other culture-based fisheries in reservoirs and wetlands, the improvement of backyard pond production, and capacity building for more than 5000 fishers and fish farmers from the states of West Bengal, Odisha, Jharkhand, Karnataka, and Tamil Nadu. For the upliftment of SC women, ornamental fish culture clusters were established at West Bengal, Jharkhand and Odisha.

Under the NEH Programme, CIFRI HDPE Pen has been installed in the beels of Assam which significantly increased their fisheries production. Cage culture trials were initiated at Doyang and Mapithel reservoirs OF Nagaland and Manipur respectively. Cage and pen culture technologies were successfully demonstrated at Tamkur pat (Manipur) in collaboration with the Department of Fisheries, Government of Manipur. Successful breeding and larval rearing WERE achieved for two species of indigenous freshwater ornamental fishes, *viz*., Danio dangila (Moustached danio) and Macrognathusaral (Peacock eel). Fishers' Filed School was established at KhalsiBeel in West Bengal based on the principle of Farmers' Field Approach of FAO.

To overcome the inherent data scarcity in potamoplankton assessment in large rivers, a framework has been developed using geostatistical tools which was used to

generate a Plankton Sustainability Map for the entire stretch of River Narmada. The existing Web-GIS portal has been enriched with useful features such as mapping of pollution indicator parameters, hypoxic stress and its trend in Indian rivers, and user-driven search information regarding Indian inland fish species. Under the integrated data discovery system using BigData concept, an exhaustive list of 1428 inland fish species and 227 exotic species of India was prepared and transferred to cloud storage.

The institute organized several capacity building programs in specialized areasfor imparting knowledge and skills to 722 stakeholders.Apart from this, the institute organized seminars, workshops and symposiums such as the interactive meeting with the fishery officials of Meghalaya, workshop on "Inland Fisheries in India and the creation of capacity in the collection and analysis of Inland Fisheries Statistics", webinar on "Impact of anthropogenic interferences in river ecosystem and fisheries", national campaign on "Diversification in aquaculture" and satellite symposium on "Hilsa Dialogue: A Bay of Bengal (BoB) Perspective".

To address the multiple challenges faced by the Indian fisheries sector and for the conservation and sustainable use of fisheries resources, the institute co-organized and hosted the first Indian Fisheries Outlook 2022 titled "Priming Indian Fisheries in Attaining Sustainable Development Goals" during 22-24 March, 2022. More than 500 researchers, academicians, scientists, students, representatives of Industries and 100 farmers participated in this conference.

Our team of scientists, technical officers and research scholars have published 117 research papers having total international Impact Factor of 337. Twenty popular articles and 29 books/book chapters were also published. I appreciate the efforts of all the staff in bringing the Institute to the forefront. I also thank all the Heads of the Divisions and Heads of the Centres and Administration and Finance for their inputs to bring out this document on time.

Dated : 01 January, 2023
Barrackpore

B. K. Das
(Director)

अन्तर्स्थलीय खुला जल मात्स्यिकी तटीय क्षेत्रों में वास करने वाले लाखों लोगों के लिए एक जीवन–रेखा माना जाता है। ये प्राकृतिक संसाधन निर्धन और साधनहीन मछुआरों को आजीविका और आय के अवसर तथा भोजन एवं पोषण सुरक्षा प्रदान करते हैं। संस्थान ने वर्ष 2022 में इन संसाधनों के अनुसंधान और विकास के लिए अथक प्रयास किया है। संस्थान ने अपनी तीन तकनीकों, 'सिफरी सर्कुलर केज', 'बैठने की व्यवस्था के साथ एफआरपी कोरकल' और 'एफआरपी सजावटी टैंक', का व्यावसायीकरण किया है। साथ ही, तीन पेटेंट, दो औद्योगिक डिजाइन और एक ट्रेडमार्क के लिए आवेदन किए गए हैं। इस अवधि के दौरान, संस्थान के वैज्ञानिकों को इंडियन फिशरीज आउटलुक 2022 संगोष्ठी में डॉ. हीरालाल चौधरी गोल्ड मेडल, डॉ. एस. अय्यपन गोल्ड मेडल और प्रो. ए.पी. शर्मा गोल्ड मेडल जैसे प्रतिष्ठित पुरस्कारों और अन्य अंतर्राष्ट्रीय सम्मेलनों जैसे, 'रिस्पॉन्सिबल एक्वाकल्चर एंड सस्टेनेबल फिशरीज इंटरेक्शन (RASHI) – 2022' में कई प्रतिष्ठित पुरस्कारों से सम्मानित किया गया।

देशी मछली के स्टॉक के संरक्षण और मछली उत्पादन को बढ़ाने के लिए संस्थान ने देश के विभिन्न नदीय स्थलों पर रैंचिंग कार्यक्रम आयोजित किया जिसमें इंडियन मेजर कार्प और महासीर प्रजाति के 24.45 लाख अंगुलिकाओं को गंगा नदी में छोड़ा है। चार राज्यों के आठ संरक्षित क्षेत्रों में मत्स्य प्रजाति विविधता का अध्ययन किया गया। संस्थान ने हीराकुड, पानम, इडुक्की, कोडर, पूंडी, सेलुंई–बी, बेको, पटलोई, लोहारसोल, मुरुगुमा, फुटियारी, सुनेई, कालो, गायत्री, कारापुझा, मेट्टूर और मंचनबेले जलाशयों की पारिस्थितिकी और मात्स्यिकी का अध्ययन किया। जलाशयों में मछलियों के पालन के लिए एक नया वृत्ताकार पेन क्षेत्र तैयार किया गया है। असम और पश्चिम बंगाल की आर्द्रभूमि में कार्बन पृथक्करण का अध्ययन किया गया। पश्चिम बंगाल के आर्द्रभूमि और केरल के वेम्बनाड झील में जलवायु अनुकूल मछली प्रजातियों के पालन द्वारा जलवायु अनुकूल पालन आधारित मात्स्यिकी को क्रियान्वित किया गया।

साइपरमेथ्रिन के दीर्घकालिक एक्सपोजर पर तुलनात्मक मस्तिष्क ट्रांसक्रिप्टोमिक्स विश्लेषण में 302 जीन के अपरेगुलेशन और 229 जीनों के डाउनरेगुलेशन को दर्ज किया गया। प्रदूषण के प्रति प्रतिक्रिया तंत्र के अध्ययन और पहचान करने के लिए गंगा नदी की तिलापिया मछलियों के लिवर ट्रांसक्रिप्टोम की जांच की गई। इन 363 डिफरेंशियल एक्सप्रेस्ड जीन में से 236 जीन को प्रदूषित स्थल पर अपरेगुलेट किया गया और 20 जीन ओन्टोलॉजी से समृद्ध पाया गया। खुला जल क्षेत्रों में ओपी कीटनाशकों का पता लगाने के लिए बायो–सेंसिंग कलरिमेट्रिक डिवाइस का एक प्रारूप विकसित किया गया है। फील्ड सत्यापन के लिए सेंसर को असम के पांच आर्द्रभूमि में लगाया गया है।

संस्थान ने विभिन्न स्थानों पर एंटी माइक्रोबियल निरोध अभियान और जन जागरूकता कार्यक्रमों की एक श्रृंखला आयोजित किया। पश्चिम बंगाल के विभिन्न मछली फार्म की मछलियों में से कुल 92 स्टैफिलोकोकस प्रजाति, 117 ई. कोलाई और 112 एरोमोनस प्रजाति को अलग किया गया। लगभग 63% ई. कोलाई आइसोलेट्स में TEM–1 और TEM–2 प्रतिरोध जीन होते है, और 41% आइसोलेट्स में AMPC प्रतिरोधी जीन होते हैं। लगभग 17% एरोमोनास आइसोलेट्स फेनोटाइपिक रूप से ईएससीसल निरोधी पाए गए।

दूषित जल निकायों से अमोनिया को हटाने के लिए एक माइक्रोबियल कंसोर्टियम की बायोरेमेडिएशन क्षमताओं की जांच की गई थी। हाइड्रोचर आधारित अमोनिया उपचारात्मक सामग्री विकसित की गई थी, जो बायोडीजल उत्पादन के लिए *माइक्रोएल्गा ग्रेसीलाएमर्सनई* की लिपिड उत्पादकता को बढ़ाने के लिए भी पाई गई थी। आर्सेनिक के लिए केले के पौधों के अपशिष्ट आधारित माइक्रोएल्गी बायोफिल्म का परीक्षण किया गया था। उपचारात्मक और उपधातु को विषाक्त से गैर–विषैले रूप में परिवर्तित करने के लिए पाया गया। माइक्रोएल्गी बायोफिल्म में मछली में आर्सेनिक संचय को कम करने की क्षमता पाई गई।

संस्थान ने अनुसूचित जाति उप–योजना कार्यक्रम के अंतर्गत सजावटी मछली पालन, पेन में मछली पालन का विकास और जलाशयों और आर्द्रभूमि में पालन आधारित मात्स्यिकी, घर के पिछवाड़े के तालाब में मछली उत्पादन में सुधार और पश्चिम बंगाल, ओडिशा, झारखंड, कर्नाटक और तमिलनाडु राज्यों के 5000 से अधिक मछुआरों और मछली किसानों के लिए क्षमता निर्माण शामिल है। अनुसूचित जाति की महिलाओं के आर्थिक सशक्तिकरण के लिए, पश्चिम बंगाल, झारखंड और ओडिशा में सजावटी मछली पालन इकाई स्थापित किए गए हैं।

पूर्वोत्तर राज्यों के विकास कार्यक्रम के तहत, असम के बील में सिफरी एचडीपीई पेन स्थापित किया गया है, जिससे उनके मत्स्य उत्पादन में काफी वृद्धि हुई है। नागालैंड और मणिपुर के क्रमशः दोयांग और मापीथेल जलाशयों में पिंजरा पालन परीक्षण शुरू किया गया है। मणिपुर सरकार के मात्स्यिकी विभाग के सहयोग से तामकुर पाट (मणिपुर) में पिंजरा और पेन पालन प्रौद्योगिकियों का सफलतापूर्वक प्रदर्शन किया गया।

मीठे पानी की सजावटी मछलियों की दो स्वदेशी प्रजातियों, अर्थात् डैनियो डांगिला (मूंछ वाले डैनियो) और मैक्रोनेथस अराल (पीकॉक ईल) के लिए सफल प्रजनन और लार्वा पालन किया गया। एफएओ के किसानों के फील्ड दृष्टिकोण के आधार पर पश्चिम बंगाल में खोलसे बील में फिशर्स फील्ड स्कूल की स्थापना की गई थी।

बड़ी नदियों में पोटामोप्लांकटन मूल्यांकन में निहित डेटा की कमी को दूर करने के लिए, भू–सांख्यिकीय उपकरणों का उपयोग करके एक ढांचा विकसित किया गया है, जिसका उपयोग नर्मदा नदी के पूरे खंड के लिए प्लवक स्थिरता मानचित्र तैयार किया गया था। वर्तमान वेब–जीआईएस पोर्टल को उपयोगी विशेषताओं जैसे प्रदूषण संकेतक मापदंडों की मैपिंग, हाइपोक्सिक तनाव और भारतीय नदियों में इसकी प्रवृत्ति, और भारतीय अन्तर्स्थलीय मछली प्रजातियों के बारे में उपयोगकर्ता द्वारा संचालित खोज से समृद्ध

किया गया है। बिगडेटा का उपयोग करते हुए एकीकृत डेटा खोज प्रणाली के तहत, भारत की 1428 अन्तर्स्थलीय मछली प्रजातियों और 227 विदेशी प्रजातियों की एक विस्तृत सूची तैयार की गई और क्लाउड स्टोरेज में स्थानांतरित की गई।

संस्थान ने 722 हितधारकों को ज्ञान और कौशल प्रदान करने के लिए विशेष क्षेत्रों में कई क्षमता निर्माण कार्यक्रम आयोजित किए। इसके अलावा, संस्थान ने मेघालय के मत्स्य अधिकारियों के साथ इंटरैक्टिव बैठक, 'भारत में अन्तर्स्थलीय मत्स्य पालन' पर कार्यशाला जैसे सेमिनार, कार्यशालाएं और संगोष्ठी आयोजित की। अन्तर्स्थलीय मत्स्य सांख्यिकी के संग्रह और विश्लेषण में क्षमता का निर्माण, "नदी पारिस्थितिकी तंत्र और मत्स्य पालन में मानवजनित हस्तक्षेप के प्रभाव" पर वेबिनार, "जलीय कृषि में विविधीकरण" पर राष्ट्रीय अभियान और "हिलसा संवाद: बे ऑफ बंगाल" पर उपग्रह संगोष्ठी (बीओबी) परिप्रेक्ष्य" आयोजित किए गए।

देश के मात्स्यिकी क्षेत्र की कई चुनौतियों का समाधान करने के लिए और मत्स्य संसाधनों के संरक्षण और सतत उपयोग के लिए, संस्थान ने 22–24 के दौरान "सतत विकास लक्ष्यों को प्राप्त करने में भारतीय मत्स्य पालन को प्राथमिकता" विषय पर प्रथम इंडियन फिशरीज आउटलुक 2022 का सह–संगठन और आयोजन किया। मार्च, 2022 में आयोजित इस सम्मेलन में 500 से अधिक शोधार्थियों, शिक्षाविदों, वैज्ञानिकों, छात्रों, उद्योगों के प्रतिनिधियों और 100 किसानों ने भाग लिया।

वैज्ञानिकों, तकनीकी अधिकारियों और अनुसंधान विद्वानों की हमारी टीम ने 337 के कुल अंतर्राष्ट्रीय प्रभाव कारक वाले 117 शोध पत्रों का प्रकाशन किया हैं। साथ ही, 20 लोकप्रिय लेख और 29 पुस्तकें/पुस्तक अध्याय भी प्रकाशित किए गए हैं। मैं संस्थान को सबसे आगे लाने के लिए सभी कर्मचारियों के प्रयासों की सराहना करता हूं। मैं इस दस्तावेज़ को समय पर लाने के लिए सभी प्रभागों के प्रमुखों और केंद्रों और प्रशासन और वित्त के प्रमुखों को उनके इनपुट के लिए धन्यवाद देता हूं।

बी. के. दास
(निदेशक)

दिनांक : 01 जनवरी, 2023
बैरकपुर

During the period under report, the Institute executed 18 Institute funded and Network projects, 16 externally funded research projects and 4 consultancy projects. In addition, the NEH, SCSP, STC programmes were executed in several parts of the country for livelihood improvement of the downtrodden fishers through technology dissemination, input distribution, knowledge and skill upgradation, etc. Salient achievements of the Institute in the year 2022 are summarized below:

Awards

- The Institute bagged 2nd prize in the exhibition *Sundarban Krishti Mela O Loko Sanskriti Utsab*. Five scientists were awarded with prestigious Dr. S. Ayyapan Gold Medal, Prof. A.P. Sharma Gold medal, Dr. Hiralal Choudhury Gold Medal and Best Presentation Award in the Indian Fisheries Outlook 2022. Two scientists got fellowships of professional societies.
- The Institute scientists also received coveted awards in the International Conference on 'Responsible Aquaculture and Sustainable Fisheries Interact (RASHI) - 2022 held at College of Fisheries, Tripura. In addition, the staff members also bagged the Best Presentation Award in 2nd International Conference on River Corridor Research and Management; International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research" and National Conference on "Sustainable Aquaculture for *Atmanirbhar Bharat*" held at different places of our country. Four scientists also got Vigyan Sera Pratibha Award, Best Young Scientists award, best Ph.D. Thesis award in different forum.

Technology Management

- During the year under report, applications of three patents, two designs and one trademark have been filed. Technologies, namely, 'CIFRI circular cage', 'FRP coracle with seating arrangement' and 'FRP ornamental tank' have been commercialized, and four more are ready to be commercialized.

Riverine and Estuarine Fisheries

- During 2022, research was conducted on Ganga, Yamuna, Mahanadi, Krishna, Barak and Kosi rivers; Hooghly-Matlah, Rushikulya, Mandovi-Zuari, Netravathi-Gurupur and Vembanad estuarine systems and some of the protected habitats with different objectives.
- A total of 122 finfish species were recorded in pre-monsoon and 136 in monsoon seasons in the Hooghly estuary. Six species viz., *Ariomma indica, Nemipterus randalli, Priacanthus prolixus, Aluterus monoceros, Seriolina nigrofasciata* and *Lobotes surinamensis* were recorded for the first time from Hooghly-Matlah estuary. Biological studies found positive allometric growth *of Polynemus paradiseus* with relative fecundity of 365±46 eggs per g body weight in the estuary.
- In Rushikulya Estuary, a total of 75 fish species were recorded with dominance of Carangidae and Leiognathidae. The shell fish catch was dominated by *Fenneropenaeus indicus* and *F. merguiensis*. Gastropoda accounts for 57-90% to the total benthic assemblages in terms of biomass. The estuary has no significant metal contamination.
- In Mandovi and Zuari estuaries, a total of 114 fish species were recorded. Marine stragglers (mainly, mackerels, sardines and shads) formed the major fishery in the lower estuarine zone of Mandovi and Zuari. Shell fishes, contributed by *Penaeus monodon, Metapenaeus dobsonii, Fenneropenaeus indicus* and *Parapeneopsis* spp. form a lucrative fishery.
- Water quality index (WQI) of Natravathi-Gurupur estuary for post-monsoon, pre-monsoon and monsoon seasons were 66, 64 and 42 respectively indicative of fair to marginal quality in post and pre-monsoon and poor quality in monsoon months. Fish landings of 31.2 tonnes, 14.5 tonnes, and 47.85 tonnes were recorded in pre-monsoon, monsoon, and post-monsoon season with corresponding CPUE of 3.8 kg, 2.2 kg and 5.9 kg. Fish catch was dominated by *Sillago sihama* and *Rastrelliger kanagurta*.
- Trophic study indicated eutrophic state of Vembanad lake with average productivity of 141.9 $mgC/m^3/h$. In pre-monsoon, shrimps (dominated by *Metapenaeus dobsoni*) and in monsoon and post-monsoon seasons finfishes (dominated by *Etroplussuratensis*) contributed maximum to the catch. Pollution and habitat degradation are major concerns for sustainable fishery of the lake.
- Three hydropower projects situated in 70 km long stretch of River Rangit in Sikkim were surveyed. Impact of damming was evidenced by disturbed ecology just below the dam site. Upstream water was hypoxic due to stratification in dams, and the impact extended to two downstream stations next to the dam site.
- Total fish catch from rivers Mahanadi, Tapti, Krishna and Barak were estimated to be15tonnes,134.43 tonnes, 6,946 tonnes, 18,902 tonnes, and 1,593 tonnes, respectively.
- In river Krishna innovative-fishing crafts made of thermocol were used in Maharashtra while coracles were common in Belgaum stretch of Karnataka.
- Destructive fishing using dynamite, poisoning water bodies

and electricity were witnessed in river Mahanadi and Barak.

- Explorations of fish diversity in eight protected areas in four states were carried out. Kusheshwar Asthan Bird sanctuary in Bihar was identified as the most diverse fisheries resource with 72 fish species, 2 prawn species and 2 crab species.
- The Parvati and Arga Bird Sanctuary recorded 51 fish species of which 5 are Threatened, 1 Endangered (*Clarias magur*), 3 Near Threatened (*Ompok bimaculatus, Hypophthalmichthys molitrix, Parambassis lala*) and 1 Vulnerable (*Wallago attu*).
- *Craspedacusta sowerbii*, a freshwater jelly fish, was reported from the water body of Arga-Parvati bird sanctuary with population density of 350-380 individuals/m^3 in the upper 0.5 m water.
- At Panna National Park, impact of diamond mining was evident with low DO, high BOD and conductance in Hinota dam. In Jaldapara National Park impact of dolomite mining was vivid in Holong River with high turbidity, conductivity, alkalinity and total hardness and severely low Ca-Mg ratio.
- In the river Yamuna, total nitrogen, BOD, bicarbonates, specific conductivity and dissolved organic matter values were highest at Mathura. The gross primary productivity was higher in middle stretch, while net primary productivity was higher at Pachnada.
- Fish diversity study in the river Yamuna recorded 111 fish species, including 8 exotics, belonging to 13 orders, 32 families and 76 genera. Fish landing from Allahabad stretch of the river Ganga was estimated to be 105.155 tonnes during 2022 with 17.41 % share of exotic fishes.
- Leaf litter decomposition contributes significantly to internal recycling of nutrients in Indian Sundarbans, however, decomposition rate of leaf litters differed for different mangrove species. 35 juvenile fish species belonging to 22 families were recorded from the mixed mangrove stands.

Reservoir and Wetland Fisheries

- Hirakud, Panam, Idukki, Kodar, Poondi, Serlui-B, Beko, Patloi, Loharsol, Muruguma, Futiyari, Sunei, Kalo, Gayatri, Karapuzha, Mettur and Manchanbele reservoirs were studied for ecology and fisheries.
- In Hirakud reservoir a total of 68 fish species under 17 families were recorded from the commercial catch. Carps and catfishes contributed maximum to the catch. Catch per unit effort (CPUE) for gill nets and drag nets ranged from 1.5-19.4 kg/day /fisher and 100-150 kg/day, respectively.
- About 25 fish species were documented from Panam reservoir with dominance of *Sperata seenghala, Cirrhinus mrigala, Labeo rohita, Systomus sarana* and *Cirrhinus reba* in the catch.
- Morpho-edaphic index in Idukki reservoir ranged from 0.256 (pre-monsoon) to 0.54 (monsoon) indicating allochthonous inputs during monsoon season thus enhancing its productivity. Volume development index ranged from 0.96 (pre-monsoon) to 1.93 (post-monsoon) in Idukki reservoir indicating availability of deep zones for fishery enhancement schemes.
- Three medium reservoirs viz., Kodar of Chhattisgarh, Poondi of Tamil Nadu and Serlui-B of Mizoram fall under oligotrophic category with inadequate stocking. Strengthening of CBF management with proper stocking of IMC fingerlings as per the carrying capacity and macrophyte management in reservoirs were suggested.
- The ecology conditions of 8 small reservoirs, (Beko, Patloi, Loharsol, Muruguma, Futiyari in West Bengal, Sunei, Kalo in Odisha and Gayatri in Karnataka) are found to be congenial to support good fisheries.
- The time dynamic simulation in Karapuzha reservoir, Kerala showed that increasing the fishing effort by 50% will lead to a drastic decline of *Clarias gariepinus* population which may ultimately disappear from the reservoir by 2040. Major carps were found to be overexploited in this reservoir and regular stocking is required to revive the fishery.
- The simulation modeling in Manchanbele reservoir, Karnataka showed that the murrel stocks are likely to be fully exploited by 2036 unless fishing effort is reduced by 40%. Major carps are under-exploited and the system has low degree of maturity in the Mettur reservoir of Tamil Nadu.
- Fisheries ecology, macrophytes, primary productivity, fish production potential, major issues, management guidelines and fishers' socio-economics of Dandua, Lakhanabandha, 46-Morakolong and Rupahibeels of Assam were documented.
- Ecology and fisheries of Rampara, Chara, Bellon, Daserchara and Magradahabeelsfrom Murshidabad, West Bengal were assessed. Fish yield potential ranged from 1335 to 2174 kg/ha/yr indicating a good scope for enhancement of fish production in the wetlands.

- The ecology of Manika, Simra and Bhusra *mauns* in Muzaffarpur district of Bihar were studied which suggested Simra and Manika *mauns* are favorable for culture-based fisheries.
- Studies recorded a total of 57 fish species from four wetlands of Uttar Pradesh, while only 33 species were documented from the four wetlands of Madhya Pradesh.

Fisheries Enhancement and Management

- A new circular pen of 0.3 ha area has been designed and put to test in deep waters of Maithon reservoir for grow out culture of fish in reservoirs.
- For grow out cage culture a stocking density of 10 no./m^3 gave best growth performances of Amur carp.
- An experiment has been initiated to optimize stocking density of Indian major carps in composite culture in pens in a wetland.
- Three different feeds have been formulated incorporating plant (soybean), insect (silkworms), and purified protein (casein).
- Lab based studied estimated that during culture of *Pangasianodon hypophthalmus* and *Oreochromis niloticus* use of plant-based feed cause higher phosphorus loading in the environment as compared to animal and purified protein source-based diet. The two species showed differential nutrient retention pattern from feeds.

Fishery Resource Assessment and Informatics

- The contamination of water and sediments with pesticide residues was detected at a very low level in River Cauvery. Residues of TCS and TCC have been detected in 14% of the fish samples. However, levels of Pb and Cd exceeded the USEPA prescribed limits for aquatic community. In sediments, Cr level indicated moderate to heavy pollution. Toxic metals like Cr, Cd and Pb were also detected, albeit in low concentrations, in fish tissue.
- Arsenic accumulation has been detected in high levels in Media beel, West Bengal. Banana waste-based microalgae biofilm was tested for arsenic remediation and found to convert the metalloid from toxic to non-toxic form. Microalgae biofilm was also found to reduce arsenic accumulation in fish.
- Spatio-temporal asynchronous data of 2667 locations and of 14 years have been programmatically retrieved from the CPCB website, standardized, synchronized and transferred to cloud storage. An exhaustive list of 1428 endemic inland fish species and 227 exotic fish species of India has been prepared and saved to the same cloud storage after validation.
- The existing Web-GIS portal has been enriched with two useful features, viz., (a) basic exploratory analysis like mapping of pollution indicator parameters, hypoxic stress and the trend in hypoxic stress in Indian rivers, and (b) user-driven search and summarized information of Indian fish species.
- Potamoplankton assessment is often plagued by data deficiency in a large river, especially in remote areas where sampling is difficult. A framework has been developed using geostatistical tools to overcome data deficiency, generating a plankton sustainability map for entire stretch of river Narmada using data collected at 28 locations. The framework also unravels a food-induced zoo-phytoplankton nonlinear relationship which has rarely been studied in a large river.

Aquatic Environmental Biotechnology and Nanotechnology

- Bioremediation capabilities of a microbial consortium was examined for potential removal of ammonium from contaminated water bodies.
- Hydrochar based ammonia remediation material was developed which also found to enhance the lipid productivity of microalgae *Graesiella emersonii* for biodiesel production.
- Metagenomic profile of East Kolkata wetland found that sewage site has the highest concentration of microorganisms including virus and bacteria. The wetland microbiome has 50% of their genes involved in metabolism, 20% genes in cellular processes & signalling and 18% of the genes in information storage & processing.
- Stock characterization of two small indigenous catfish species of the bagridae family, *Mystus gulio* and *Mystus cavasius* from freshwater and estuarine resources have been done.

Fisheries Socioeconomics

- A study found that 15 different small indigenous fishes form a crucial part of daily diet of fisher families of Duma wetland, West Bengal.
- Three types of marketing channels have been observed to be practiced by the fishers of Duma wetland.
- Knowledge on CBF was imparted and inputs were given to the local PFCS of Kalo reservoir of Odisha. Fish production has increased from 25 tonnes in 2018-19 to 50 tonnes in 2020-21 in the reservoir.
- A food web model of Beledanga wetland was developed and benthos and zooplanktons were found to be the most utilized

groups with the higher ecotropic efficiencies.

- To address SDGs, ornamental fish culture was introduced in Jharkhand for women empowerment through distribution of kits, exposure visits, hands-on training and demonstration. The livelihood improvement program was done through distribution of pen culture units, fish seeds, fish feed, FRP boats.
- Pen culture was demonstrated in Duma wetland of West Bengal for augmenting fish production and popularizing climate resilient fish species. 'Grass carp model' has also been adopted in this wetland.
- By employing the Data Envelopment Analysis (DEA) technique overall technical efficiency was estimated as 22.2 % for crop farmers, 44.3 % for vegetable farmers and 63% for fish farmers in South Dinajpur district of West Bengal. All the fish farmers have efficiency score above 0.60 and thus are more efficient in all the three measures of technical efficiencies.

Network Projects

- A total of 92 *Staphylococcus spp.*, 117 *E.coli* and 112 *Aeromonas sp.* were isolated from different fish farms of West Bengal. About 63% of the *E. coli* isolates harboured TEM-1 & TEM-2 resistance genes, and 41% isolates have Amp C resistant genes. About 17% of *Aeromonas* isolates were phenotypically resistant to ESBL.
- A series of AMR campaigns and mass awareness programmes were carried out at different locations of India with participation of more than 10,000 public/farmers and students.
- Induced breeding of *Danio dangila* has been achieved in captivity. Larval rearing of this ornamental species has been achieved with 40% survival of hatchlings.
- Successful larval rearing of another ornamental species, *Macrognathus aral*, has also been achieved under captivity.

Externally Funded Projects

- Comparative brain transcriptomics analysis on chronic exposure to cypermethrin revealed upregulation of 302 genes and downregulation of 229 genes. Similarly, liver transcriptome analysis revealed 1242 DEGs with 323 up-regulated and 374 down-regulated genes.
- Chronic exposure to bisphenol A and diethyl phthalate to *Labeo catla* showed a significant up-regulation in the expression of *Kiss 1*, *Vtg*, *FSH* and *LH* genes.
- Liver transcriptome of tilapia sourced from river Ganga was investigated to identify candidate genes as response mechanisms to pollution. Out of 363 differential expressed genes, 236 genes were found to be upregulated at polluted site and enriched with 20 Gene Ontology.
- A prototype bio-sensing colorimetric device has been developed for detection of OPs pesticides in openwater resources. The sensor has been deployed in five wetlands of Assam for field validation.
- A prototype device based on colorimetric sensor has been developed for detection of Cr (VI) in water with a linearity range 100 ppb to 1 ppm.
- Fin fish samples have been screened and found negative for KHV, SVCV, EUS, TiLV pathogens. Shrimp samples tested were also found negative for WSSV, EHP, YHV and AHPND.
- Study showed rapid absorption of antibiotic florfenicol from gut of Pangasius with nearly 22% bioavailability after in-feed administration which is satisfactory for field use. Pharmacokinetic parameters of the drug have been determined in Pangasius.
- Study showed that the antibiotic enrofloxacin, widely used in aquaculture sector of Asia and some other countries, has a very long persistence time of over 6 weeks in Pangasius flesh and thus, considering consumer safety, it is not recommended for use in this catfish.
- Study estimated need for release of 53.1 cumec water during lean season, 162.9 cumec water during pre-monsoon and 407.8 cumec water during monsoon from Garudeswar weir towards conservation of the Mahseer in downstream of the weir.
- To conserve native fish stock as well as for enhancing fish production, 18 river ranching pragrammes were performed releasing 24.45 lakh fingerlings of Indian major carps and Mahseer in river Ganga in Uttrakhand, Uttar Pradesh, Jharkhand and West Bengal. A total of 15,055 hilsa brood fish were also ranched in upstream of the Farakka barrage in West Bengal and 1921 samples were recovered/caught by fishers from several locations of West Bengal (above Farakka), Jharkhand and Bihar.
- A total of 178 fish species (169 native and 9 exotics) belonging to 121 genera, 56 families, and 20 orders were recorded from the Ganga River. Distribution of *Megarasbora elanga, Danio rerio, Nemacheilus corica, Salmo trutta fario, Schizothorax progastus, Clarias magur* were recorded in the river for the first time.
- Fishers' Field School was established at Khalsi Beel, West Bengal based on the principle of Farmers' Field School Approach of FAO.

- Rearing of Hilsa brood stock in ponds resulted in 277.4±18.9 g body weight gain in 20 months indicating culture potential of the high value species. Gonadal maturity of the brood fishes was assessed by ultrasonography.
- Hirakud reservoir was assessed to be medium productive in nature. A total of 68 fish species under 25 families have been recorded in the reservoir. Fish catch is majorly contributed by carps and catfishes. CPUE varied from kg/day/fisher during pre-monsoon. The dragnet operations in the reservoir has a high CPUE of 100-150 kg/day/net.
- Climate Resilient Pen Systems was demonstrated in 5 wetlands using climate smart species like *Systomus sarana* and *Labeo bata* along with IMCs. Similarly, Climate Resilient Cage Systems (CRCS) was demonstrated in Media beel using resilient species.
- Climate Resilient CBF was implemented by introducing *S. sarana*, *Mystus gulio*, *L. bata*, in 3 wetlands of West Bengal, *Etroplus suratensis*and *Liza* sp. in Vembanad Lake.
- Stakeholder driven vulnerability assessment study was carried out in wetlands of Assam, Odisha, West Bengal and Kerala. Estimation of vulnerability index of inland fishery of Vembanad lake was done for the first time.
- Carbon sequestration studies were carried out in 12 wetlands of Assam and West Bengal. Green-house gas emission studies were conducted in 3 wetlands of West Bengal.
- *Cyprinus carpio* was recorded for first time in the Bichom reservoir, Arunachal Pradesh. The species has well established showing well developed gonad and successful breeding.
- Four fish feeds of different pellet sizes and nutrient composition have been formulated using silkworm (*Antheraea mylitta)* pupae meal for various life stages of fishes.

NEH Programme

- Fish stock enhancement in 7 beels of Assam led to 31% increase in fish production in the beels following CIFRI's intervention.
- CIFRI HDPE Pen have been installed in 6 beels of Assam for raising stocking materials of IMCs and *Labeo bata*.
- Cage culture has been initiated in Doyang reservoir, Nagaland. Cage culture was also demonstrated in Mapithel reservoir, Manipur with the locally preferred fish Common carp (*Cyprinus carpio*).
- Cage culture of *Osteobrama belangeri* (pengba), *Ctenopharyngodon idella* and *Labeo bata* was demonstrated in Takmu pat, Manipur. Pen culture of *Amblypharyngodon mola* with major carps or alone was initiated in Takmu pat in collaboration with the Department of Fisheries, Govt. of Manipur.
- Ecology and fisheries of Dumbur reservoir located around Gomti and Dhalai districts of Tripura were studied with record of 55 finfish species. Cage culture was demonstrated in this reservoir using *Cyprinus carpio* with production of 10.7 - 11.90 kg fish/m^3.
- Ecology and fisheries of Umiam reservoir, Meghalaya was studied. A total of 38 fish species, including five varieties/strain of *Cyprinus carpio*, have been documented.
- Cage culture trial was carried out in the reservoir. After six months of rearing (rohu, common carp and silver barb), an average fish production of 500 kg/cage was achieved.

SCSP and STC Programmes

- The SCSP programme was carried out in the form of demonstration of pen culture and culture-based fisheries in wetlands and reservoirs, ornamental fish culture, production enhancement from backyard ponds, capacity building and mass awareness creation benefitting more than 5000 fishers and fish farmers in West Bengal, Odisha, Jharkhand, Karnataka and Tamil Nadu.
- Culture based fisheries along with in-situ seed raising in pens were carried out in a participatory mode by involving the local SC fishers in 11 wetlands of West Bengal.
- The Institute is working on fisheries enhancement in 10 reservoirs of Jharkhand, Odisha, Karnataka and Tamil Nadu.
- Ornamental fish culture clusters involving the SC women of West Bengal, Jharkhand and Odisha were established. Awareness and hands-on training were given to the beneficiaries before initiating the ornamental fish culture unit.
- Under STC programme the Institute has taken up several initiatives including imparting scientific knowledge, distributing fisheries inputs, conducting demonstrations benefitting 1067 fishers and fish farmers in five states.

HRD and Other Activities

- The Institute organized 24 trainings imparting knowledge and skills to 722 stakeholders. Five training cum awareness programmes were organized covering more than 600 participants. Institute technologies/ products/ publication were showcased in 11 exhibitions in different parts of the country.

- The Institute co-organized and hosted the first Indian Fisheries Outlook 2022 titled "Priming Indian Fisheries in Attaining Sustainable Development Goals" during 22-24 March 2022. More than 500 researchers, academician, scientists, students, representatives of industries and 100 farmers of West Bengal participated.
- The institute also organized/ observed/ celebrated several seminars, symposiums, workshops, events during the period. In addition to the regular meetings and events the Institute organized interactive meeting with the fishery officials of Meghalaya, workshop on "Inland Fisheries in India and the creation of capacity in the collection and analysis of Inland Fisheries Statistics", webinar on "Impact of anthropogenic interferences in river ecosystem and fisheries", interface meeting with farmers-planners and researchers of West Bengal, platinum jubilee lecture series #4, national campaign on diversification in aquaculture, satellite symposium on "Hilsa Dialogue: A Bay of Bengal (BoB) Perspective", webinar on natural fish farming, *Garib kalyan sammelan*, solidarity programme at old age homes, fit India freedom run 3.0, tribal pride day, etc.
- The Institute scientists, technical officers, research scholars have published 117 research papers having total international IF of 337, twenty popular articles, twenty ninebooks/ book chapters, etc.

रिपोर्ट अवधि के दौरान, संस्थान ने 18 वित्तपोषित और नेटवर्क परियोजनाओं, 16 बाह्य वित्तपोषित अनुसंधान परियोजनाओं और 4 परामर्शी परियोजनाओं को निष्पादन किया है। इसके अलावा, पूर्वोत्तर क्षेत्र (एनईएच), अनुसूचित जाति उप–योजना (एससीएसपी), आदिवासी उप–योजना (एसटीसी) कार्यक्रमों के माध्यम से देश के अलग–अलग भागों में प्रौद्योगिकी प्रसार, आदान वितरण, सूचनाओं के सम्प्रेषण तथा प्रशिक्षण द्वारा मछुआरों का कौशल विकास किया है जिससे साधनहीन मछुआरों की आजीविका में बहुत सुधार देखने को मिल रहा है। वर्ष 2022 में संस्थान की प्रमुख उपलब्धियों का सारांश नीचे दिया गया है।

पुरस्कार

- संस्थान ने सुंदरवन कृषि–मेला–ओ–लोको संस्कृति उत्सव में प्रदर्शनी के लिए दूसरा पुरस्कार जीता। मार्च 2022 में संस्थान में आयोजित प्रथम इंडियन फिशरीज आउटलूक सम्मेलन में संस्थान के पांच वैज्ञानिकों को प्रतिष्ठित डॉ. एस. अय्यप्पन स्वर्ण पदक, प्रो. ए. पी. शर्मा स्वर्ण पदक, डॉ. हीरालाल चौधरी स्वर्ण पदक और सर्वश्रेष्ठ प्रस्तुति पुरस्कारों से सम्मानित किया गया। इस अवसर पर दो वैज्ञानिकों को प्रोफेशनल सोसायटी की फैलोशिप भी प्रदान किया गया।

- मात्स्यिकी महाविद्यालय, त्रिपुरा में आयोजित अंतर्राष्ट्रीय सम्मेलन, 'रिस्पॉन्सिबल एक्वाकल्चर एंड सस्टेनेबल फिशरीज इंटरेक्शन (RASHI)–2022' में संस्थान के वैज्ञानिकों ने प्रतिष्ठित पुरस्कार प्राप्त किया। इसके अलावा, अन्य पुरस्कारों में "रिवर कॉरिडोर अनुसंधान और प्रबंधन" पर दूसरे अंतर्राष्ट्रीय सम्मेलन में सर्वश्रेष्ठ प्रस्तुति पुरस्कार; अंतर्राष्ट्रीय सम्मेलन, "रिसेंट एडवानसेंज इन एग्रीकल्चर, बायोलॉजीकल एंड एप्लाइड साइन्सेज रिसर्च"; राष्ट्रीय सम्मेलन, "आत्मनिर्भर भारत के लिए सतत जलकृषि" (Sustainable Aquaculture for Atmanirbhar Bharat) तथा देश के विभिन्न भागों में आयोजित कार्यक्रमों में संस्थान के वैज्ञानिकों ने विज्ञान सेरा प्रतिभा पुरस्कार, सर्वश्रेष्ठ युवा वैज्ञानिक पुरस्कार, सर्वश्रेष्ठ पीएच.डी. थीसिस पुरस्कार आदि शामिल हैं।

प्रौद्योगिकी प्रबंधन

वर्ष 2022 में संस्थान ने तीन पेटेंट, दो डिजाइन और एक ट्रेडमार्क के लिए आवेदन दिया है। इस अवधि में 'सिफरी सर्कुलर केज', 'एफआरपी कोराकल (बैठने की व्यवस्था के साथ) और 'एफआरपी ओरनामेन्टल (सजावटी मछली पालन) टैंक' नाम की प्रौद्योगिकियों का व्यवसायीकरण किया गया है तथा अन्य चार प्रौद्योगिकियों का व्यवसायीकरण की प्रक्रिया चल रही है।

नदीय एवं ज्वारनदमुख मात्स्यिकी

वर्ष 2022 के दौरान गंगा, यमुना, महानदी, कृष्णा, बराक और कोसी नदियों के साथ साथ हुगली–मतलाह, रुशिकुल्या, मंडोवी–जुआरी, नेत्रावती–गुरुपुर और वेम्बनाड मुहाना क्षेत्र और कुछ संरक्षित मात्स्यिकी आवास का सर्वेक्षण किया गया।

- हुगली नदी मुहाना क्षेत्र में मानसून पूर्व अवधि में कुल 122 तथा मानसून काल में 136 फिनफिश प्रजातियां दर्ज की गई। हुगली–मतलाह नदीय मुहाने से पहली बार छह प्रजातियों जैसे *एरिओमा इंडिका, नेमिटेरस रैंडली, प्रिकैंथस प्रोलिक्सक्स, एलयुटेरस मानोसेरास, सेरियोलिनानिग्रो फासिआटा और लोबोटेस यूरिनमैंसिस* को रिकॉर्ड किया गया। इनके जैविक अध्ययनों में मुहाना में मछली के वजन के प्रति ग्राम 365±46 अंडे की सापेक्ष उर्वरता के साथ पोलिनेमस पैराडाइजस एलोमेट्रिक के स्तर में वृद्धि पाई गई।

- रुशिकुल्या मुहाना क्षेत्र में कुल 75 मत्स्य प्रजातियों को दर्ज किया गया जिनमें कैरांगिडे और लिओग्नाथिडे की बहुलता देखी गई। जैवभार की दृष्टि से कुल बेंथिक जमाव का 57–90% भाग कवच मछली का था जिसमें *फेनेरोपेनियस इंडिकस* और *एफ. मेर्गुइएन्सिस* का प्रभुत्व देखा गया। पर मुहाना क्षेत्र में कोई धातु संदूषण नहीं पाया गया।

- मंडोवी और जुआरी मुहाना क्षेत्रों में कुल 114 मछली प्रजातियां दर्ज की गईं। इन मुहाना क्षेत्रों के निचले भाग में समुद्री स्ट्रैगलर्स (मुख्य रूप से मैकेरल, सार्डिन और शेड्स) पाए गए। इन भागों में कवच मछली में *पीनियस मोनोडॉन, मेटापेनियस डॉब्सोनी, फेनेरोपेनियस इंडिकस* और *पैरापेनोप्सिस* प्रजातियों का प्रभुत्व देखा गया।

- नेत्रावती–गुरुपुर मुहाने की जल गुणवत्ता सूचकांक (Water quality index) मानसून पश्चात, मानसून पूर्व और मानसून में क्रमशः 66, 64 और 42 पाया गया जो मानसून पश्चात और मानसून पूर्व महीनों में उपयुक्त से कम गुणवत्ता वाला तथा और मानसून के महीनों में खराब गुणवत्ता का संकेत देता है। मानसून पूर्व, मानसून के दौरान और मानसून पश्चात महीनों में मछली की लैंडिंग क्रमशः 31.2 टन, 14.5 टन और 47.85 टन तथा सीपीयूई क्रमशः 3.8 किग्रा, 2.2 किग्रा और 5.9 किग्रा दर्ज की गई। मत्स्य पकड़ में *सिलागो सिहामा* और *रैस्ट्रेलिगर कानागुर्ता* का प्रभुत्व देखा गया।

- अध्ययन में वेम्बनाड झील के ट्रॉफिक अध्ययन में इस झील की औसत उत्पादकता 141.9 mgC/m3/h देखा गया जो इसके यूट्रोफिक स्थिति का संकेत देता है। मानसून पूर्व महीनों में झींगा मछली (*मेटापेनियस डोब्सोनी* की बहुलता) तथा मानसून और मानसून पश्चात महीनों में फिनफिश (*एट्रोप्लस सुरटेन्सिस* की बहुलता)

का अधिकतम प्रतिशत दर्ज की गई। इस झील के सतत मत्स्य पालन में प्रदूषण और मत्स्य आवास में ह्रास प्रमुख समस्याएँ देखी गई हैं।

- सिक्किम में रंगित नदी के 70 किमी विस्तार क्षेत्र में स्थित तीन जलविद्युत परियोजनाओं का सर्वेक्षण किया गया। इसमें यह देखा गया कि बांध स्थल के निचले भाग की पारिस्थितिकी पर प्रतिकूल प्रभाव पड़ा है। बांधों में स्तरीकरण के कारण ऊपरी क्षेत्र का जल हाइपोक्सिक (जल में पर्याप्त ऑक्सीजन में कमी) देखा गया। ऐसी स्थिति का प्रभाव बांध स्थल के आसपास के दो निचले स्टेशनों तक पाया गया।

- महानदी, ताप्ती, कृष्णा और बराक नदियों से कुल अनुमानित मछली पकड़ क्रमशः 15 टन, 134.43 टन, 6,946 टन, 18,902 टन और 1,593 टन था।

- महाराष्ट्र में कृष्णा नदी में थर्मोकोल से बने मछली पकड़ने के क्राफ्ट (नौका) का उपयोग किया जाता था, जबकि कर्नाटक के बेलगाम में कोरकल का अधिक प्रचलन देखा गया।

- महानदी और बराक नदी में मछली पकड़ने में विनाशकारी पद्धति जैसे डायनामाइट और बिजली का प्रयोग देखा गया जिससे जल निकायों का जल जहरीला हो जाता है।

- चार राज्यों के आठ संरक्षित क्षेत्रों में मत्स्य विविधता का अन्वेषण किया गया। इन सबमें बिहार का कुशेश्वर अस्थान पक्षी अभयारण्य सबसे विविध मत्स्य संसाधन के रूप में पाया गया। यहाँ 72 मछली प्रजातियों, 2 झींगा प्रजातियों और 2 केकड़े की प्रजातियां दर्ज की गईं।

- पार्वती और अरगा पक्षी अभयारण्य में मछलियों की 51 प्रजातियां दर्ज की गई हैं, जिनमें से 5 प्रजातियों का अस्तित्व खतरे में, 1 लुप्तप्राय (*क्लारियस मागुर*), 3 निकट संकटग्रस्त (*ओम्पोक बिमाकुलैटस, हाइपोथालमिथिस मोलिट्रिक्स, परम्बसिस लालो*) और 1 संकटग्रस्त (*बालगो एट्टू*) के रूप में दर्ज किया गया।

- मीठाजल जेली फिश, *क्रैस्पेडाकुस्टा सोवरबी* को अरगा–पार्वती पक्षी अभयारण्य के जल निकाय से दर्ज किया गया था। इसकी उपलब्धता 0. 5 मीटर जल के ऊपर 350–380 जेली फिश प्रति घन मीटर पाया गया।

- पन्ना राष्ट्रीय उद्यान क्षेत्र के अंतर्गत हिनोटा बांध में हीरा खनन का प्रभाव देखा गया जिसमें कम घुलित ऑक्सीजन, उच्च बीओडी और चालकता प्रमुख था। जलदापारा राष्ट्रीय उद्यान में डोलोमाइट खनन के कारण होलोंग नदी में गंदलापन, चालकता, क्षारीयता, और कुल कठोरता उच्च स्तर तथा कैल्सियम–मैगनिसियम कम पाए गए।

- मथुरा में यमुना नदी में कुल नाइट्रोजन, बीओडी, बाइकार्बोनेट, विशिष्ट चालकता और घुलित कार्बनिक पदार्थ का मान उच्चतम पाया गया। मध्य खंड में सकल प्राथमिक उत्पादकता अधिक थी, जबकि पचनदा में शुद्ध प्राथमिक उत्पादकता अधिक दर्ज की गई।

- यमुना नदी में मछली विविधता अध्ययन में 111 मछली प्रजातियां दर्ज की गईं, जिनमें 8 विदेशी प्रजातियां (13 आर्डर, 32 परिवारों और 76 जेनेरा) शामिल है। गंगा नदी के इलाहाबाद खंड से 2022 के दौरान 105.155 टन मछली लैंडिंग का अनुमान है जिसमें 17.41 प्रतिशत विदेशी प्रजातियाँ थीं।

- भारतीय सुंदरवन में पत्तियों के कूड़े के अपघटन का पोषक तत्वों के आंतरिक पुनर्चक्रण में महत्वपूर्ण भूमिका है, हालांकि, अलग–अलग मैंग्रोव प्रजातियों के लिए पत्तियों के कूड़े का अपघटन दर अलग–अलग होता है। मिश्रित मैंग्रोव क्षेत्रों से 22 परिवारों की 35 किशोर मछलियों को दर्ज किया गया।

जलाशय एवं आर्द्रक्षेत्र मात्स्यिकी

- पारिस्थितिकी और मात्स्यिकी के लिए हीराकुड, पानम, इडुक्की, कोडर, पूंडी, सेलुई–बी, बेको, पटलोई, लोहारसोल, मुरुगुमा, फुटियारी, सुनई, कालो, गायत्री, कारापुझा, मेट्टूर और मंचनबेले जलाशयों का अध्ययन किया गया।

- हीराकुड जलाशय में व्यावसायिक तौर पर महत्वपूर्ण कुल 68 मछली प्रजातियों को दर्ज किया गया जिनमें कार्प और कैटफिश का अधिकतम प्रतिशत था। गिल जाल और ड्रैग जाल से पकड़ प्रति यूनिट प्रयास (सीपीयूई) 1.5–19.4 किग्रा प्रति दिन प्रति मछुआरा और 100–150 किग्रा प्रति दिन प्रति मछुआरा दर्ज किया गया।

- पानम जलाशय से मछली की लगभग 25 प्रजाति संबंधी सूचनाओ का संकलन किया गया, जिनमें *स्पेराटा सींघाला, सिरिहिनस मृगाला, लेबियो रोहिता, सिस्टोमस सराना* और *सिरिहिनस रेबा* प्रमुख हैं।

- इडुक्की जलाशय में मॉर्फो–एडैफिक इंडेक्स 0.256 (मानसून पूर्व) से 0.54 (मानसून) तक पाया गया, जो मानसून के मौसम के दौरान बाहरी इनपुट का संकेत देता है और इससे इसकी उत्पादकता में वृद्धि होती है। मात्रा विकास सूचकांक 0.96 (मानसून पूर्व) से 1.93 तक (मानसून पश्चात) तक पाया गया। यह इडुक्की जलाशय में मत्स्य वृद्धि योजनाओं के लिए गहरे जलक्षेत्रों की उपलब्धता का संकेत देता है।

- तीन मध्यम जलाशय जैसे छत्तीसगढ़ का कोडर, तमिलनाडु का पूंडी और मिजोरम का सेरलुई–बी अपर्याप्त भंडारण के कारण ओलिगोट्रोफिक श्रेणी के अंतर्गत आते हैं। जलाशयों की वहन क्षमता और मैक्रोफाइट प्रबंधन के आधार पर इंडियन मेजर कार्प की अंगुलिकाओं के उचित भंडारण के साथ पालन आधारित मात्स्यिकी प्रबंधन को मजबूत करने का सुझाव दिया गया।

- पश्चिम बंगाल के 8 छोटे जलाशयों (बेको, पटलोई, लोहारसोल, मुरुगुमा, फुतियारी) ओडिशा में सुनेई तथा कालो और कर्नाटक में गायत्री जलाशयों की पारिस्थितिकी उत्तम मत्स्य पालन के अनुकूल पाई गई है।

- केरल के कारापुझा जलाशय में समय गतिकी सिमुलेशन से पता चला है कि मछली पकड़ प्रयास में 50% की वृद्धि से *क्लेरियस गारीपिनस* की संख्या में भारी गिरावट आएगी जिससे अंततः यह प्रजाति वर्ष 2040 तक इस जलाशय से विलुप्त हो सकती है। इस जलाशय में मेजर कार्प प्रजातियों का अत्यधिक दोहन किया गया है। अतः इसके पुनर्स्थापन के लिए नियमित स्टॉकिंग की आवश्यकता है।

- कर्नाटक के मंचनबेले जलाशय में सिमुलेशन मॉडलिंग यह बताता है कि यदि मरेल मछली के मत्स्ययन प्रयास को 40% तक कम नहीं किया जाता है तो वर्ष 2036 तक इस मछली के स्टॉक का पूरी तरह से दोहन होने की संभावना है। दूसरी ओर तमिलनाडु के मेट्टूर जलाशय में प्रमुख कार्प मछलियों की परिपक्वता कम होने के कारण इसका दोहन कम किया जाता है।

- असम के ददुआ, लखनबंधा, 46–मोराकोलोंग और रुपाही बीलों की मत्स्य पारिस्थितिकी, मैक्रोफाइट्स, प्राथमिक उत्पादकता, मछली उत्पादन क्षमता, प्रमुख मुद्दे, प्रबंधन दिशानिर्देश और मछुआरों के सामाजिक–अर्थशास्त्र संबंधित सूचनाओं को प्रलेखित किया गया।

- मुर्शिदाबाद, पश्चिम बंगाल के रामपारा, चारा, बेलोन, दसेरचरा और मगरदाह बीलों की पारिस्थितिकी और मात्स्यिकी का आकलन किया गया। इसमें यह देखा गया कि मत्स्य उपज क्षमता 1335 से 2174 किग्रा प्रति हेक्टेयर प्रति वर्ष के बीच है जो आर्द्रभूमि में मछली उत्पादन में वृद्धि की संभावना का संकेत देते है।

- बिहार के मुजफ्फरपुर जिले में मनिका, सिमरा और भूसरा मनों की पारिस्थितिकी का अध्ययन किया गया, जिससे पता चला कि सिमरा और मनिका मौन पालन आधारित मात्स्यिकी के लिए अनुकूल हैं।

- उत्तर प्रदेश की चार आर्द्रभूमि से कुल 57 मत्स्य प्रजातियाँ दर्ज की गईं, जबकि मध्य प्रदेश की चार आर्द्रभूमि से केवल 33 प्रजातियों का दस्तावेजीकरण किया गया।

मत्स्य संवर्धन और प्रबंधन

- जलाशयों में मछली पालन के लिए मैथन जलाशय के गहरे पानी में परीक्षण के लिए 0.3 हेक्टेयर क्षेत्र का एक नया सर्कुलर पेन डिजाइन किया गया है।

- आर्द्रभूमि में मिश्रित पालन हेतु पेन क्षेत्र में भारतीय प्रमुख कार्प के स्टॉकिंग घनत्व को अनुकूलित करने के लिए एक परीक्षण शुरू किया गया है।

- पौधे (सोयाबीन), कीट (रेशम के कीड़े), और शुद्ध प्रोटीन (केसीन) को मिलाकर तीन अलग–अलग फीड तैयार किए गए हैं।

- लैब आधारित अध्ययन में यह देखा गया है कि *पंगासियेनोडोन हाइपोथाल्मस* और *ओरियोक्रोमिस नाइलोटिकस* के पालन में जन्तु और शुद्ध प्रोटीन स्रोत–आधारित आहार की तुलना में पौधे–आधारित फीड के उपयोग से पर्यावरण में फास्फोरस का स्तर बढ़ जाता है। इसके लिए दो प्रजातियों के फीड अध्ययन से अंतर पोषक तत्व का प्रतिधारण अलग–अलग देखा गया।

मत्स्य संसाधन आंकलन और सूचना विज्ञान

- कावेरी नदी में पानी और तलछट के संदूषण में कीटनाशक अवशेषों का स्तर बहुत कम पाया गया। मछली के नमूनों में TCS और TCC के अवशेष 14% पाए गए हैं। हालाँकि, लेड और कैडमियम का स्तर जलीय समुदाय के लिए USEPA द्वारा निर्धारित सीमा से अधिक था। तलछट में, क्रोमियम का स्तर मध्यम से उच्च प्रदूषण का संकेत देते हैं। मछली के ऊतकों में क्रोमियम (Cr), कैडमियम (Cd) और लेड (Pb) जैसी जहरीली धातु कम सांद्रता में पाए गए।

- पश्चिम बंगाल के मेदिया बील में उच्च स्तर में आर्सेनिक जमाव का पता चला है। इसके लिए केले के पौधे का अपशिष्ट–आधारित माइक्रोएलगी बायोफिल्म का आर्सेनिक उपचार के लिए परीक्षण किया गया था और यह पाया गया कि यह मेटलॉइड को विषाक्त से गैर–विषैले रूप में परिवर्तित कर सकता है। माइक्रोएलगी बायोफिल्म मछलियों में आर्सेनिक जमाव को कम कर सकता है।

- केन्द्रीय प्रदूषण नियंत्रण बोर्ड के वेबसाइट से गत 14 वर्षों का 2667 स्थलों से प्राप्त आंकड़ों को मानकीकृत और सिंक्रोनाइज़ करके क्लाउड स्टोरेज में संग्रहीत किया गया है। इसी क्रम में भारत की 1428 स्थानिक अन्तर्स्थलीय मछली प्रजातियों और 227 विदेशी मछली प्रजातियों की एक विस्तृत सूची तैयार की गई है और सत्यापन के बाद इन्हे

भी क्लाउड स्टोरेज में संचय किया गया है।

- वर्तमान वेब–जीआईएस पोर्टल को दो विशेषताओं से समृद्ध किया गया है, (1) बुनियादी खोजपूर्ण विश्लेषण जैसे प्रदूषण संकेतक मापदंडों की मैपिंग, हाइपोक्सिक तनाव और भारतीय नदियों में हाइपोक्सिक तनाव की प्रवृत्ति, और (2) उपयोगकर्ता – संचालित सर्वेक्षण और भारतीय मत्स्य प्रजातियों की संक्षिप्त जानकारी।

- एक बड़ी नदी में जन्तुप्लवक बहुतायता के पूर्वानुमान हेतु एक भू–सांख्यिकीय फ्रेमवर्क : पोटामो प्लांकटन मूल्यांकन में नदीय आंकड़ों की कमी एक बड़ी समस्या है जिसके कारण विशेषकर सुदूर क्षेत्रों में सैंपलिंग में बहुत कठिनाइयों का सामना करना पडता है। अतः आंकड़ों की कमी संबंधी समस्या को दूर करने के लिए एक भू–सांख्यिकीय उपकरणों के प्रयोग से एक फ्रेमवर्क विकसित किया गया है जिससे नर्मदा नदी के पूरे खंड के 28 स्थलों से आंकड़ों को एकत्र करके एक प्लवक संबधित मानचित्र प्राप्त किया जा सकता है। यह फ्रेमवर्क बड़ी नदियों में खाद्य–प्रेरित जन्तु प्लवकों के गैर–रैखिक संबंध को दिखाता है जो इस दिशा में एक प्रथम पहल कहा जा सकता है।

जलीय पर्यावरण जैव प्रौद्योगिकी और नैनो प्रौद्योगिकी

- दूषित जल निकायों से अमोनिया की संभावित स्तर को काम करने में माइक्रोबियल कंसोर्टियम की बायोरेमेडिएशन क्षमताओं की जांच की गई।

- हाइड्रोकार्बन आधारित अमोनिया उपचारात्मक सामग्री विकसित की गई जो बायोडीजल उत्पादन के लिए माइक्रोएल्गी ग्रेसीएला इमरसोनी की लिपिड उत्पादकता को बढ़ाती है।

- ईस्ट कोलकाता वेटलैंड के मेटागेनोमिक प्रोफाइल में अवशिष्ट क्षेत्र में वायरस और बैक्टीरिया सहित सूक्ष्मजीवों की उच्चतम सांद्रता पायी गई। वेटलैंड माइक्रोबायोम में उनके 50% जीन चयापचय प्रक्रिया, 20% जीन सेलुलर प्रक्रिया और 18% जीन सिग्नलिंग, सूचना भंडारण और प्रसंस्करण प्रक्रिया में शामिल होते हैं।

- मीठाजल और ज्वारनदमुख संसाधनों से बैग्रिडे परिवार की दो छोटी स्वदेशी कैटफिश प्रजातियों, *मिस्टस गुलियो* और *मिस्टस केवसियस* का स्टॉक लक्षण वर्णन किया गया है।

मात्स्यिकी का सामाजिक, आर्थिक पहलू

- एक अध्ययन में यह पाया गया कि पश्चिम बंगाल के डूमा आर्द्र झील क्षेत्र में 15 अलग–अलग छोटी देशी मछलियां मछुआरा परिवारों के दैनिक आहार का एक महत्वपूर्ण हिस्सा हैं।

- डूमा आर्द्र झील क्षेत्र के मछुआरें तीन प्रकार के विपणन चैनल प्रयोग करते हैं ।

- ओडिशा के कालो जलाशय के स्थानीय मछुआरा सहकारी समिति को पालन आधारित मात्स्यिकी पर प्रशिक्षण तथा आदान वितरित किए गए। इससे जलाशय में मछली उत्पादन में 25 टन (2018–19) से बढ़कर 50 टन (2020–21) हो गया है।

- बेलेडंगा आर्द्रभूमि का एक खाद्य वेब मॉडल विकसित किया गया। इसमें यह देखा गया कि बेंथोस और जन्तु प्लवक का उपयोग सबसे अधिक (उच्च इकोट्रोपिक मान) पाया गया।

- एसडीजी मुद्दों को संबोधित करने तथा झारखंड में महिला सशक्तिकरण के लिए किट वितरण, एक्सपोजर विजिट, प्रशिक्षण और प्रदर्शन के माध्यम से सजावटी मछली पालन की शुरुआत की गई। पेन पालन इकाई, मछली बीज, मछली चारा, एफआरपी नावों के वितरण के माध्यम से आजीविका सुधार कार्यक्रम चलाया गया।

- पश्चिम बंगाल के डूमा आर्द्रभूमि में मछली उत्पादन बढ़ाने और जलवायु अनुकूल मछली प्रजातियों को लोकप्रिय बनाने के लिए पेन पालन का प्रदर्शन किया गया। इस आर्द्रभूमि में 'ग्रास कार्प मॉडल' को अपनाया गया है।

- पश्चिम बंगाल के दक्षिण दिनाजपुर जिले में डेटा एनवेलपमेंट एनालिसिस (डीईए) तकनीक द्वारा समग्र तकनीकी दक्षता का अनुमान फसल किसानों के लिए 22.2%, सब्जी किसानों के लिए 44.3% और मछली किसानों के लिए 63% लगाया गया। सभी मछली किसानों का दक्षता स्कोर 0.60 से ऊपर पाया गया । अतः यह कहा जा सकता है कि वे तकनीकी तौर पर अधिक कुशल हैं।

नेटवर्क परियोजना

- पश्चिम बंगाल के विभिन्न मछली फार्मों में कुल 92 *स्टैफिलोकोकस* एसपीपी, 117 *ई. कोलाई* और 112 *एरोमोनस* एसपी. का पृथककरण किया गया था। *ई. कोलाई* लगभग 63% हार्बरेडटेम–1 और टीईएम–2 प्रतिरोध जीन को अलग करता है और 41% आइसोलेट्स में। उच्च प्रतिरोधी जीन होते हैं। लगभग 17% *एरोमोनास* आइसोलेट्स फेनोटाइपिक रूप से ESBL के प्रतिरोधी पाए गए।

- इस वर्ष देश के विभिन्न स्थानों पर 10,000 से अधिक जनता/किसानों और छात्रों की भागीदारी के साथ एएमआर अभियान और जन जागरूकता कार्यक्रमों आयोजित किए गए।

- घेरे में *डैनियो डांगिला* का उत्प्रेरित

प्रजनन किया गया। इस सजावटी मछली प्रजाति के रियरिंग में हैचलिंग की लगभग 40% उत्तरजीविता देखी गई।

- घेरे में सजावटी मत्स्य प्रजाति, *मैक्रोगनेथस अराल* का लार्वा पालन सफल रहा है।

बाह्य संगठनों द्वारा वित्तपोषित परियोजनाएं

- साइपरमेथ्रिन के क्रोनिक एक्सपोजर पर तुलनात्मक मस्तिष्क ट्रांसक्रिप्टोमिक्स विश्लेषण से 302 जीन के अपरेगुलेशन और 229 जीन के डाउनरेगुलेशन का पता चला। इसी तरह, लीवर ट्रांस्क्रिप्टोम विश्लेषण में 323 अप–रेगुलेटेड और 374 डाउन–रेगुलेटेड जीन के साथ 1242 डीईजी का संकेत मिलता है।

- *लैबियो कतला* के बिस्फेनॉल ए और डायथाइल थैलेट का क्रोनिक एक्सपोजर किस 1, वीटीजी, एफएसएच, एलएचजीन के एक्स्प्रेसन में एक महत्वपूर्ण अप–रेगुलेशन दिखाता है।

- गंगा नदी से प्राप्त तिलापिया के लिवर ट्रांस्क्रिप्टोम की जांच की गई ताकि प्रदूषण के प्रति प्रतिक्रिया तंत्र के रूप में कारक (कैंडिडेट) जीन की पहचान की जा सके। कुल 363 डिफरेंशियल अभिव्यक्त जीन में से 236 जीनों को प्रदूषित स्थल पर अपग्रेड किया गया और 20 जीन ओन्टोलॉजी से समृद्ध पाया गया।

- खुलाजल संसाधनों में ओपी कीटनाशकों का पता लगाने के लिए एक प्रोटोटाइप जैव–संवेदन वर्णमिति (Bio & Sensing Colorimetric) उपकरण विकसित किया गया है। फील्ड सत्यापन के लिए सेंसर को असम के पांच आर्द्रभूमि में लगाया गया है।

- 100 पीपीबी से 1 पीपीएम की लीनियरिटी रेंज के साथ जल में क्रोमियम (VI) का पता लगाने के लिए वर्णमिति सेंसर वर्णमिति (Colorimetric Sensor) पर आधारित एक प्रोटोटाइप उपकरण विकसित किया गया है।

- फिन मछली के नमूनों की जांच की गई और केएचवी (KHV), एसवीसीवी (SVCV), ईयूएस (EUS), टीआईएलवी (TiLV) रोगजनकों के लिए नकारात्मक परिणाम पाया गया। परीक्षण किए गए झींगा के नमूने भी डब्लूएसएसवी (WSSV), ईएचपी (EHP), वाइएचवी (YHV) और एएचपीएनडी (AHPND) के लिए नकारात्मक परिणाम पाए गए।

- अध्ययन से पता चलता है कि पेंगासियस मछली को फीड देने के बाद लगभग इसकी आंत में एंटीबायोटिक फ्लोर्फेनीकॉल का तेजी से अवशोषण होता है। इसकी जैव उपलब्धता 22% आँकी गई है जो फील्ड में उपयोग के लिए उपयुक्त माना गया है। पेंगासियस में दवा के फार्माकोकाइनेटिक पैरामीटर निर्धारित किए गए हैं।

- अध्ययन में यह देखा गया है कि एशिया और कुछ अन्य देशों के जलीय कृषि में एंटीबायोटिक एनरोफ्लोक्सासिन का व्यापक तौर उपयोग किया जाता है जिससे इसका प्रभाव पंगेसियस मछली में लगभग 6 सप्ताह तक रहता है। अतः उपभोक्ता सुरक्षा को देखते हुए, इस कैटफिश को मानव उपभोग के लिए वर्जित किया गया है।

- महासीर मछली के संरक्षण की दिशा में गरुड़ेश्वर बांध से वर्ष रहित काल में 53.1 क्यूमेक्स जल, मानसून पूर्व में 162.9 क्यूमेक्स जल और मॉनसून के दौरान 407.8 क्यूमेक जल छोड़ने की अनुमानित आवश्यकता का अध्ययन किया गया।

- देशी मछली स्टॉक संरक्षण के साथ मछली उत्पादन बढ़ाने के लिए, उत्तराखंड, उत्तर प्रदेश, झारखंड और पश्चिम बंगाल में गंगा नदी में भारतीय प्रमुख कार्प और महासीर की 18 नदी रैनचिंग कार्यक्रम आयोजित किए गए जिसमें 24.45 लाख अंगुलिकाओं को नदी में छोड़ा गया। पश्चिम बंगाल में फरक्का बैराज के अपस्ट्रीम में कुल 15,055 हिल्सा की ब्रूड मछलियों का रैनचिंग किया गया। इन छोड़ी गई मछलियों के 1921 नमूनों को पश्चिम बंगाल (फरक्का के ऊपर), झारखंड और बिहार के कई स्थानों से मछुआरों द्वारा पकड़ा गया।

- गंगा नदी से 121 जेनेरा, 56 फैमिली और 20 ऑर्डर से संबंधित कुल 178 मछली प्रजातियाँ (169 देशी और 9 विदेशी) को दर्ज किया गया। इस नदी में प्रथम बार *मेगरसबोस एलांगा, डैनियो रेरियो, नेमाचेइलस कोरिका सल्मो ट्रुटा फारियो, साई जोथोरैक्स प्रोगैस्टस, क्लारियस मागुर* को दर्ज किया गया।

- पश्चिम बंगाल के खोलसे बील में एफएओ (Food and Agriculture Organization) के फार्मर्स फील्ड स्कूल के सिद्धांत पर फिशर्स फील्ड स्कूल की स्थापना की गई है।

- तालाबों में हिल्सा ब्रूड स्टॉक के पालन के परिणामस्वरूप 20 महीनों में उनके शारीरिक वजन में 277.4±18.9 ग्राम की वृद्धि हुई जो उच्च मूल्य प्रजातियों की पालन क्षमता को दर्शाता है। अल्ट्रासोनोग्राफी द्वारा ब्रूड मछलियों की गोनाडल परिपक्वता का आकलन किया गया।

- हीराकुद जलाशय का मूल्यांकन में मध्यम उत्पादक के तौर पर किया जाता है। जलाशय में 25 परिवारों के तहत कुल 68 मछली प्रजातियों को दर्ज किया गया है। मछली पकड़ने में मुख्य रूप से कार्प और कैटफिश का योगदान है। मानसून पूर्व का सीपीयूई 2.5 से 5.2 किग्रा/दिन/मछुआरा के बीच होता है। जलाशय में ड्रगनेट

संचालन में 100–150 किग्रा प्रति दिन प्रति नेट का CPUE होता है।

- इंडियन मेजर कार्प के साथ *सिस्टोमस सराना* और *लेबीओ बाटा* जैसी जलवायु स्मार्ट प्रजातियों का उपयोग करके 5 आर्द्रभूमि में जलवायु लचीला पेन पालन प्रणाली का प्रदर्शन किया गया। इसी तरह जलवायु अनुकुली प्रजातियों के पालन के साथ मेदिया बील में क्लाइमेट रेजिलिएंट केज सिस्टम्स (CRCS) का प्रदर्शन किया गया।

- वेम्बनाड झील में *एस. सराना, मिस्टस गुलियो, एल. बाटा,* पश्चिम बंगाल के 3 आर्द्रक्षेत्र में *एट्रोप्लस सुराटेंसिस* और *लिजा* एसपी के पालन के साथ जलवायु अनुकूल पालन शुरू किया गया।

- असम, ओडिशा, पश्चिम बंगाल और केरल की आर्द्रभूमि में हितधारक संचालित भेद्यता मूल्यांकन अध्ययन किया गया। वेम्बनाड झील के अंतर्देशीय मात्स्यिकी के भेद्यता सूचकांक का अनुमान पहली बार किया गया था।

- असम और पश्चिम बंगाल की 12 आर्द्रभूमि में कार्बन उत्सर्जन का अध्ययन किया गया। पश्चिम बंगाल की 3 आर्द्रभूमि में ग्रीन–हाउस गैस उत्सर्जन का अध्ययन किया गया।

- मछलियों के विभिन्न जीवन चरण के लिए रेशमकीट (*एंथेरिया माइलिट्टा*) प्यूपा मील द्वारा विभिन्न आकार के पैलेट और पोषक तत्वों की संरचना के आधार पर चार प्रकार के मछली आहार तैयार किए गए हैं।

- अरुणाचल प्रदेश के बिचोम जलाशय में पहली बार *साइप्रिनस कार्पियो* की उपलब्धता दर्ज की गई। इस प्रजाति के विकसित गोनाड और सफल प्रजनन को देखते हुए यह कहा जा सकता है कि बिचोम जलाशय की पारिस्थितिकी इस प्रजाति के उचित विकास के लिए उपयुक्त है।

- रेशमकीट (*एन्थेरिया माइलिट्टा*) प्यूपा मील का उपयोग करके मछलियों के विभिन्न जीवन चरण के लिए विभिन्न आकार और पोषक तत्वों को सम्मिलित कर चार प्रकार के मछली आहार तैयार किए गए हैं।

पूर्वोत्तर क्षेत्रों के लिए कार्यक्रम

- संस्थान के हस्तक्षेप के बाद असम के 7 बीलों में मछली के स्टॉक में वृद्धि करके मछली उत्पादन में 31% की वृद्धि दर्ज की गई।

- असम के 6 बीलों में इंडियन मेजर कार्प और *लेबियो बाटा* की स्टॉकिंग को बढ़ाने के लिए सिफरी एचडीपीई पेन स्थापित किया गया है।

- दोयांग जलाशय, नागालैंड में पिंजरा पालन शुरू किया गया है। मणिपुर के मैपिथेल जलाशय में स्थानीय रूप से पसंद की जाने वाली कॉमन कार्प मछली (*साइप्रिनस कार्पियो*) के साथ पिंजरा पालन का भी प्रदर्शन किया गया।

- *ओस्टियोब्रामा बेलंगेरी* (पेंगबा), *टेनोफेरींगोडोन आइडेला* और *लेबियो बाटा* का पिंजरे में पालन तकनीक का प्रदर्शन ताक्मू पाट, मणिपुर में किया गया। मछली पालन विभाग, मणिपुर सरकार के सहयोग से ताक्मू पट में प्रमुख कार्प या एकल प्रजाति, *एंबलीफेरिंगोडोन मोला* का पेन पालन शुरू किया गया।

- त्रिपुरा के गोमती और धलाई जिलों के आसपास स्थित डंबुर जलाशय की पारिस्थितिकी और मत्स्य पालन का 55 फिनफिश प्रजातियों का अध्ययन किया गया। इसके अंतर्गत इस जलाशय में *साइप्रिनस कार्पियो* (उत्पादन 10.7–11.90 किग्रा मछली प्रति घन मी) का पिंजरे में पालन का प्रदर्शन किया गया।

- मेघालय की उमियाम जलाशय की पारिस्थितिकी और मत्स्य पालन का अध्ययन किया गया। *साइप्रिनस कार्पियो* की पांच प्रकार/स्ट्रेन सहित कुल 38 मछली प्रजातियों का दस्तावेजीकरण किया गया है।

- जलाशय में पिंजरे में मछली पालन का परीक्षण किया गया। छह महीने के पालन (रोहू, कॉमन कार्प और सिल्वर बार्ब) के बाद औसतन 500 किग्रा प्रति पिंजरे से मछली उत्पादन प्राप्त किया गया।

अनुसूचित जाति उप–योजना (एससीएसपी) और आदिवासी उप–योजना (एसटीसी)

- अनुसूचित जाति उप–योजना (एससीएसपी) कार्यक्रम के अंतर्गत आर्द्रभूमि और जलाशयों में पालन आधारित मत्स्य पालन, सजावटी मछली पालन, घर के पिछवाड़े में स्थित तालाबों से उत्पादन वृद्धि, क्षमता निर्माण और जन जागरूकता के माध्यम से कार्यक्रम आयोजित किया गया, जिससे पश्चिम बंगाल, ओडिशा, झारखंड, कर्नाटक और तमिलनाडु में 5000 से अधिक मछुआरे और मछली पालक लाभान्वित हुए।

- पश्चिम बंगाल की 11 आर्द्रभूमि में स्थानीय अनुसूचित जाति के मछुआरों की सहभागिता से पालन आधारित मात्स्यिकी के साथ–साथ पेन क्षेत्रों में इन–सीटू बीज पालन किया गया।

- संस्थान झारखंड, ओडिशा, कर्नाटक और तमिलनाडु के 10 जलाशयों में मत्स्य उत्पादन वृद्धि पर काम किया जा रहा है।

- पश्चिम बंगाल, झारखंड और ओडिशा की अनुसूचित जाति की महिलाओं को प्रशिक्षण देकर सजावटी मछली पालन समूहों की स्थापना की गई। सजावटी मछली पालन इकाई शुरू करने से पहले लाभार्थियों को

जागरूकता और व्यावहारिक प्रशिक्षण दिया गया।

- आदिवासी उप–योजना (एसटीसी) कार्यक्रम के तहत संस्थान ने पांच राज्यों में 1067 मछुआरों और मछली किसानों को लाभान्वित करने के लिए वैज्ञानिक ज्ञान प्रदान करने, मत्स्य आदानों का वितरण, प्रदर्शन आयोजित करने सहित कई पहल किया है।

मानव संसाधन विकास एवं अन्य गतिविधियां

- संस्थान ने 722 हितधारकों को ज्ञान और कौशल प्रदान करने के लिए 24 प्रशिक्षण आयोजित किया। इसके अंतर्गत 600 से अधिक प्रतिभागियों के साथ पांच प्रशिक्षण सह जागरूकता कार्यक्रम आयोजित किए गए। संस्थान द्वारा विकसित प्रौद्योगिकियों / उत्पादों / प्रकाशनों को देश के विभिन्न भागों में 11 प्रदर्शनियों में प्रदर्शित किया गया।
- संस्थान ने अपने मुख्यालय, बैरकपुर में 22–24 मार्च 2022 के दौरान "प्राइमिंग इंडियन फिशरीज इन अटेनिंग सस्टेनेबल डेवलपमेंट गोल्स" से प्रथम इंडियन फिशरीज आउटलुक 2022 का आयोजन किया। इस अवसर पर 500 से अधिक शोधकर्ता, शिक्षाविदों, वैज्ञानिक, छात्र, उद्योगों के प्रतिनिधि और पश्चिम बंगाल के 100 किसान उपस्थित हुए।
- संस्थान ने रिपोर्ट अवधि के दौरान कई, संगोष्ठी, कार्यशाला, कार्यक्रमों का आयोजन किया – अन्तर्स्थलीय मत्स्य आंकड़ों का संग्रह और विश्लेषण में क्षमता निर्माण", "नदी पारिस्थितिकी तंत्र और मत्स्य पालन में मानवजनित हस्तक्षेपों का प्रभाव" पर वेबिनार, पश्चिम बंगाल के किसानों–योजनाकारों और शोधकर्ताओं के साथ इंटरफेस बैठक, प्लेटिनम जयंती व्याख्यान श्रृंखला, राष्ट्रीय अभियान जलीय कृषि में विविधीकरण, "हिलसा संवाद: बे ऑफ बंगाल (BoB) परिपेक्ष्य" पर उपग्रह संगोष्ठी, प्राकृतिक मछली पालन पर वेबिनार, गरीब कल्याण सम्मेलन, वृद्धाश्रमों में कार्यक्रम, फिट इंडिया फ्रीडम रन 3.0, आदिवासी गौरव दिवस, आदि।
- संस्थान के वैज्ञानिकों, तकनीकी अधिकारियों, शोधार्थियों के 125 शोध पत्र, 17 लोकप्रिय लेख, 29 पुस्तकें / पुस्तक अध्याय आदि प्रकाशित हुए हैं। इनमें से 13 शोध पत्र 5 से अधिक इम्पैक्ट फैक्टर वाली पत्रिकाओं में प्रकाशित हुए हैं।

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

Since inception in 1947, the passage of 75 years has been extraordinary. The blue revolution in the country has been possible largely due to ICAR-CIFRI's contribution. The founders of this great institution had a vision of service to the mankind through quality research for food and nutritional security. Subsequently many stalwarts led this institute and with the help of quality staff, this institute becomes a doyen in the field of fisheries in the world. This institution not only did world class research but also produces highly competent and qualified scientists.

Following the recommendation of the sub-committee of Central Government on Agriculture, Forestry and Fisheries, the Central Inland Fisheries Research Station was born in Calcutta under the Ministry of Food and Agriculture, Government of India on 17 March 1947. The Station was promoted to Central Inland Fisheries Research Institute in 1959 shifting its location to Barrackpore, West Bengal. The Institute was brought 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 research institute in the field of inland fisheries research in India and abroad. The major responsibilities of the Institute were to assess inland fishery resources and to develop strategies to optimize fish production in sustainable manner.

The Government of India put much emphasis on aquaculture research and development in the late sixties and seventies. 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 and for the fulfillment of these objectives the institute has prioritized adaptation of the latest available technologies and also introduction of new ones.

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 Prayagraj, 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. The Regional Research Centers at Prayagraj, Guwahati and Bengaluru are administered by Heads of Regional Centers appointed by ICAR, other research 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 programme, TSP programme, SCSP programme, ICAR Regional Committee meetings, and HRD executing different functions of the Institute.

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

Prayagraj RRC

Bengaluru RRC

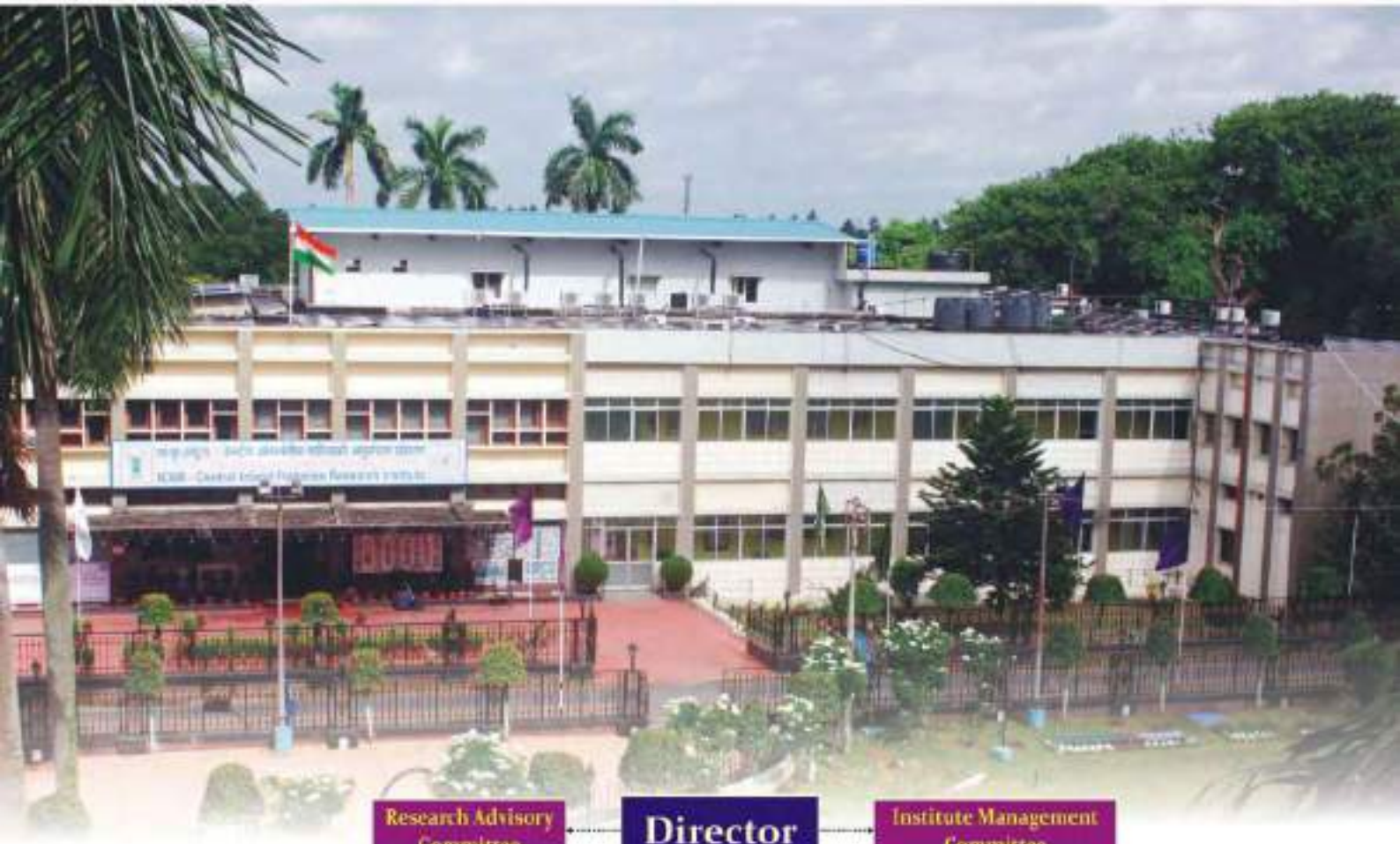
Guwahati RRC

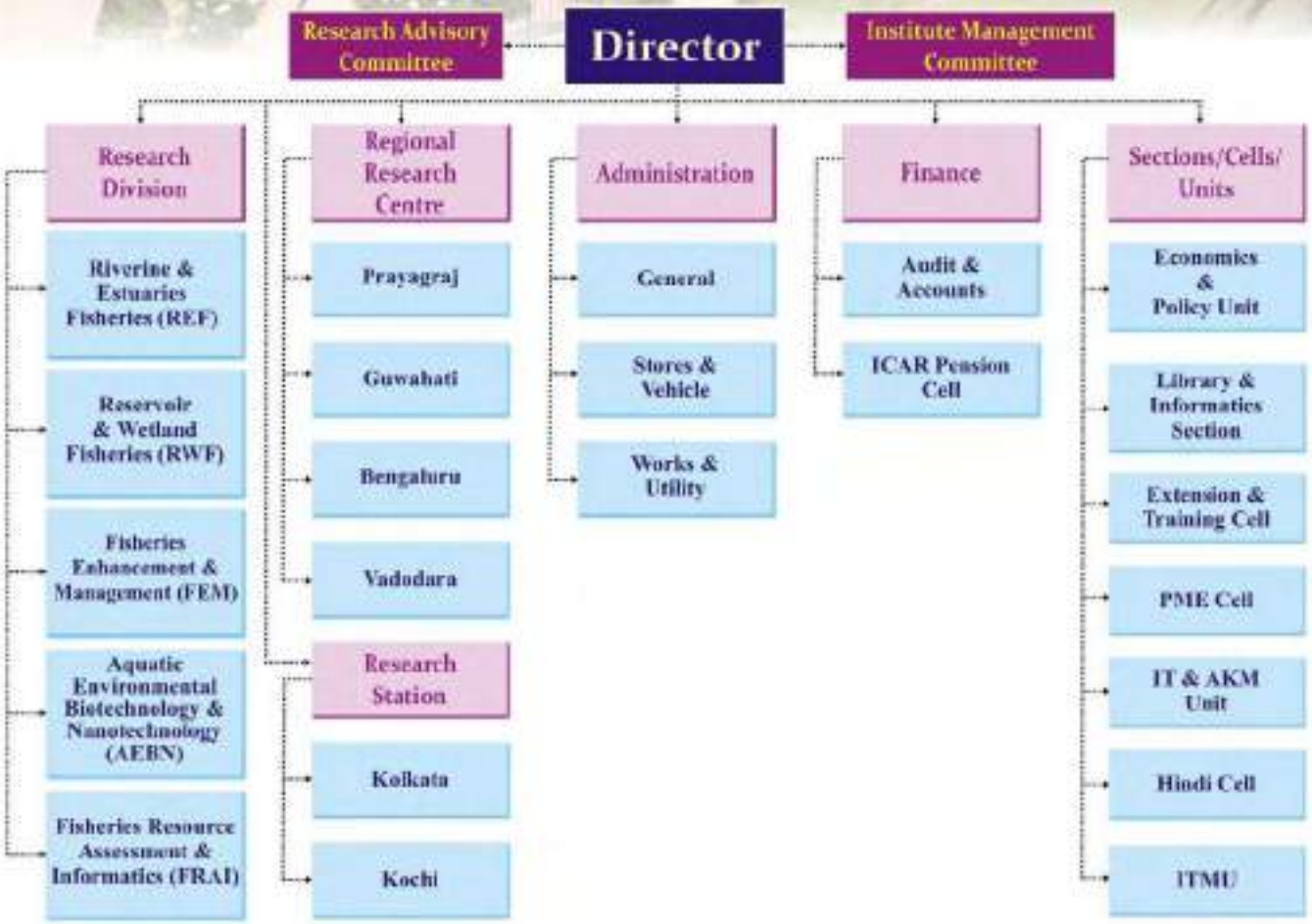
Barrackpore HQ

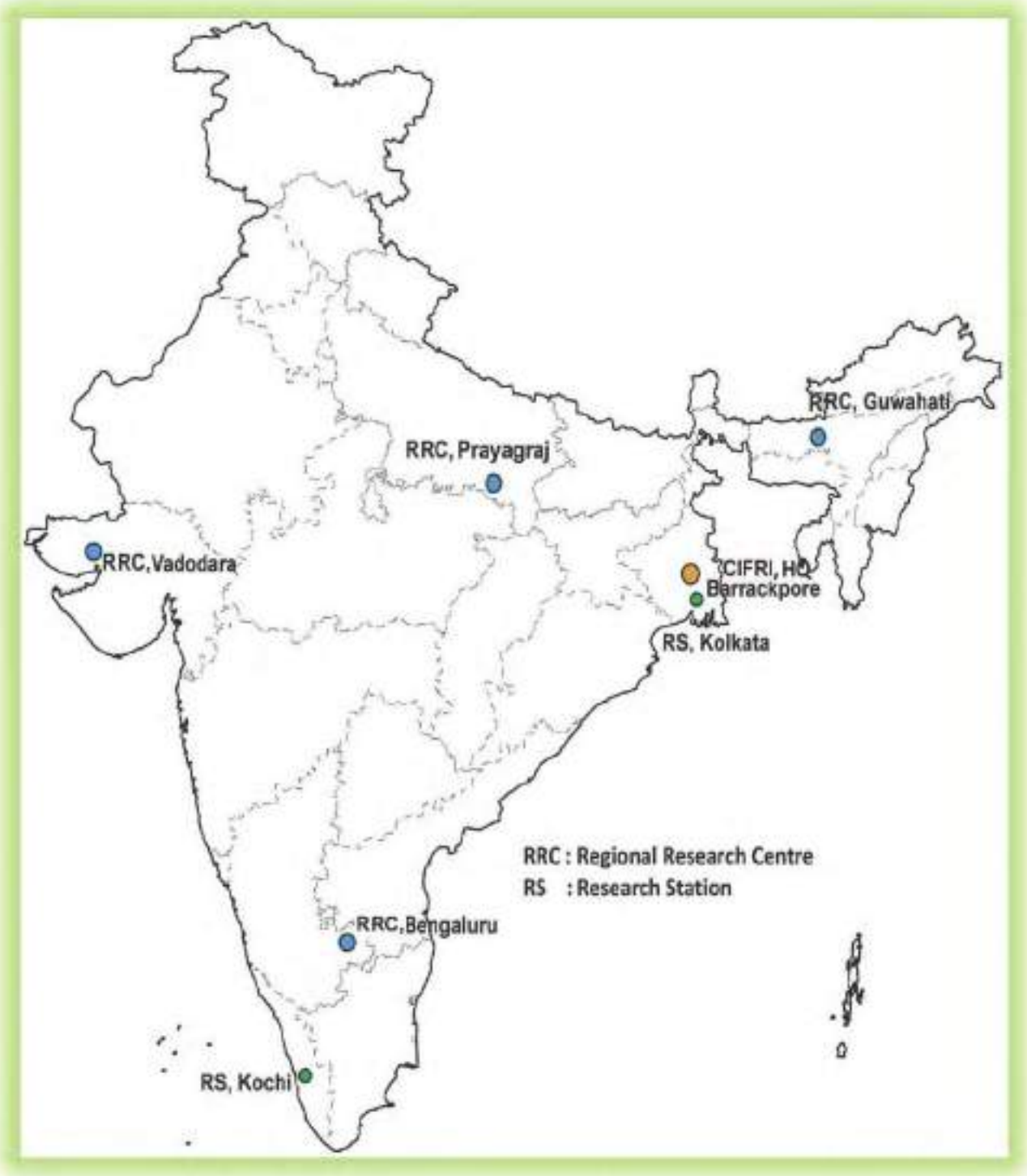
Vadodara RRC

Kochi RS

Kolkata RS




Research Advisory Committee
Director
Institute Management Committee
Research Division
Riverine & Estuaries Fisheries (REF)
Reservoir & Wetland Fisheries (RWF)
Fisheries Enhancement & Management (FEM)
Aquatic Environmental Biotechnology & Nanotechnology (AEBN)
Fisheries Resource Assessment & Informatics (FRAI)
Regional Research Centre
Prayagraj
Guwahati
Bengaluru
Vadodara
Research Station
Kolkata
Kochi
Administration
General
Stores & Vehicle
Works & Utility
Finance
Audit & Accounts
ICAR Pension Cell
Sections/Cells/ Units
Economics & Policy Unit
Library & Informatics Section
Extension & Training Cell
PME Cell
IT & AKM Unit
Hindi Cell
ITMU


RRC, Guwahati
RRC, Prayagraj
RRC,Vadodara
CIFRI, HQ Barrackpore
RS, Kolkata
RRC : Regional Research Centre
RS : Research Station
RRC,Bengaluru
RS, Kochi

Budget of the Institute for the year 2022-23 (up to 31.12.2022) (₹ in lakh)

Head of Accounts	Budget (BE)	Expenditure
Pay and Allowance including Pension	12110.00	9777.99
TA	50.00	44.21
Other charge including Equipment, Library, IT and HRD	1094.45	811.68
Works	41.55	41.55
Grand Total	**13296.00**	**10675.43**

The Budget & Expenditure under Institute for the financial year 2022-23 (up to 31.12.2022) (₹ in lakh)

Budget Head	Budget	Expenditure
Revenue		
Estt. Charges	3260.00	2592.77
OTA	0.00	0.00
TA	50.00	44.21
Other charges	609.00	442.44
Office Building	12.00	4.66
Residential Building	1.00	0.42
Minor Works	3.00	2.47
Misc. Expenses including HRD	25.00	8.81
TSP General	59.00	58.53
NEH General	53.00	50.82
Capital		
Equipment	80.80	57.74
Information Technology	20.00	11.36
Library Books	5.00	0.73
Vessels / Vehicles	9.65	0.71
Furniture & Fixture	13.00	6.09
Works	41.55	41.55
Minor Works	0.00	0.00
TSP Capital	34.00	33.31
NEH Capital	30.00	26.34
SCSP Capital	50.00	17.98
SCSP General	90.00	88.95
Total	**4446.00**	**3489.89**
Pension	8850.00	7185.21
Grand Total	**13296.00**	**10675.10**
Loans & Advances	**101.50**	**66.82**

Other Projects 2022-23 (up to 31.12.2022) (₹ in lakh)

Budget Head	Receipts including opening balance	Expenditure	Refund
NICRA	38.33	30.30	0.00
CABIN	15.00	7.85	0.00
NASF	39.91	32.94	0.00
ITMU	7.50	6.16	0.00
Fish Health	11.25	6.76	0.00
Deposit Schemes (Externally funded)	134.25	199.04	3.09

Revenue Receipts 2022-23 (up to 31.12.2022) (₹ in lakh)

Head	ICAR	Institute
Income from Sales / Services	19.54	
Fee / Subscription	0.00	
Income from Royalty, Publication etc.	0.86	
Other income	12.77	50.98
STD Interest	0.00	
Sale of Assets	0.00	
Recoveries on Loans and Advances	18.75	
CPWD / Grants Refund	3.29	
Total	55.21	50.98

Institute Funded Research Projects

Sl. No.	Project Code & Title	P.I.
1	REF/20-23/11: Temporal assessment of estuarine fisheries resources for sustainable management (Hooghly – Matla, Rushikulya, Mandovi – Zuari, Netravathi – Gurupur and Vembanad lake)	S. Samanta
2	REF/20-23/12: Assessment of ecological impacts of dams and barrages in selected rivers with special references to fisheries	A. K. Sahoo
3	REF/20-23/13: Estimation of fish landings and catch structure in the Rivers Mahanadi, Krishna, Barak, Tapti and Kosi	B. K. Das
4	REF/20-23/14: Exploration and assessment of fisheries in protected inland water bodies	R. K. Manna
5	REF/20-23/15: Eco-variability and impact study of River Yamuna on River Ganga with special emphasis on fisheries	D. N. Jha
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	B. K. Das
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	U. K. Sarkar/ A. K. Das
8	RWF/20-23/11: Eco-orientation approach for fisheries enhancement of floodplain wetlands in diverse eco-regions of India	A. K. Das
9	RWF/21-24/12: Sustainable production enhancement and livelihood improvement through technological intervention (pen culture) in selected reservoirs and wetlands of India	M. A. Hassan
10	FREM/20-23/16: Ecosystem health risks and food safety assessment in relation to chemical contaminants in inland aquatic environment	S. K. Nag
11	FREM/20-23/17: Evaluation and management of environmental health through omics technologies	B. K. Behera/ Vikash Kumar
12	FREM/20-23/18: Fisheries resource assessment and predictions in inland open-water under AI and Big Data platform	M. Naskar
13	FREM/21-24/19: Development of ammonium and phosphate remediation techniques using nanostructured materials for refurbishment of polluted wetlands	D. J. Sarkar
14	FSE/20-23/04: Sustainable inland fisheries development pathways to ensure Sustainable Development Goals	B. K. Das
15	NEH/20-23/03: Refinement of management strategies for openwater fisheries of Northeastern Region through location and ecosystem-based approaches	B. K. Bhattacharjya
16	Network Project: Antimicrobial resistance (AMR) in fisheries and aquaculture	A. K. Sahoo
17	Network Project: Breeding of indigenous fish species of ornamental value from West Bengal and Assam	U. K. Sarkar/ Suman Kumari

Externally funded research projects

Sl. No.	Project Title	Funded by
1	Fish stock enhancement including Hilsa and livelihood improvement to sustainable fisheries and conservation in river Ganga under Namami Gange Programme	NMCG
2	Impact of climate change in inland fisheries and development of adaptation strategic Research component of National Innovation in Climate resilient Agriculture	NICRA
3	National surveillance programme for aquatic animal diseases	NFDB-NSPAAD
4	Microbiome meta transcriptomics assessment of Indian river basins for ecosystem health monitoring	ICAR-IASRI
5	All India Network Project on Fish Health	ICAR-CIBA
6	Development of Biosensor for detection of fish pathogenic bacteria and hazardous metalloids in selected waterbodies	ICAR-NASF
7	Capture Breeding of Hilsa, *Tenualosa ilisha*	ICAR-NASF
8	Environmental and aquaculture animal health monitoring in Hirakund Reservoir under cage culture programme	Directorate of Fisheries, Govt. of Odisha
9	Collaborative research project with WorldFish Centre under Window-3 Program	ICAR-WorldFish
10	Assessment of endocrine disruption in fish production	DBT
11	Empowering women of wetland dependent fisher flock community of lower Gangetic plain through cost effective technologies	DBT
12	Utilization and diversification of silkworm pupae products for human & animal consumption and composting	Central Silk Board
13	Mean: Measuring EDCs and aquatic diagnostics through biosensor networks with special reference to NE India	Ministry of Electronics and Information Technology, Govt. of India.
14	A review of the inland fisheries of India and the creation of capacity in the collection and analysis of inland fisheries statistics	FAO
15	Investigation on fisheries and ecological status threats and remedial measures for enhancement of fish production in Govind Sagar reservoir	Govt. of Himachal Pradesh
16	Addressing Skill Gap in the FPO Ecosystem in Eastern and North Eastern parts of India	Indian Council of Social Science Research (ICSSR)

Consultancy projects

Sl. No.	Project Title	Funded by
1.	Environmental flows for river ecology with focus on downstream fisheries of Sardar Sarovar Dam (SSD), in Naramada river	SSNL
2.	Planning and design of fish hatchery at Bichom dam site along with studies on reproductive biology on Snow Trout *Schizothorax richardssonii* for conservation and ratification propagation in River Bichom, Arunachal Pradesh	North Eastern Electric Power Corporation Ltd. Shillong (NEEPCO)
3.	"Imparting state of art knowledge on fish breeding to the local fishermen for livelihood improvement and enhancing the native fish population through ranching programme in river Ganga"	NTPC
4.	Study on "Impact of water intake due to Gadarwara STPP on ecology of Narmada river"	NTPC

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

Project Code: REF /20-23/11

Duration: April 2020 - March 2024

Principal Investigator: S. Samanta

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

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

Sub-project 3: Temporal assessment of the Mandovi-Zuari estuarine fishery resources for sustainable Management

Sub-project 4: Temporal assessment of Netravathi-Gurupur estuarine fishery resources for sustainable management

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

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

Scientific Personnel: D. Bhakta (Sub-project Leader), R. K. Manna, Sangeetha M. Nair, Arun Pandit (w.e.f. 01.04.22) and C. Jana (w.e.f. 01.04.22)

New records from Hooghly-Matlah estuarine systems

During 2022, recorded 6 new entries in the fish diversity from Hooghly-Matlah estuarine system viz., Indian driftfish *Ariomma indica* (Day, 1871); Randall's threadfin bream *Nemipterus randalli* Russell, 1986; Elongate bulleye, *Priacanthus prolixus* Starnes, 1988; Unicorn leatherjacket filefish *Aluterus monoceros* (Linnaeus, 1758); blackbanded trevally *Seriolina nigrofasciata* (Ruppell, 1829), and tripletail *Lobotes surinamensis* (Bloch, 1790). *Lobotes surinamensis* was recorded from the gill net catch at the Jharkhali fishing area, rest of those species were from the bag net catches from Bakkhali.

Fish and fisheries

A total of 122 fish species during pre-monsoon and 136 fish species during monsoon were recorded. From the Hooghly estuary, maximum species diversity was recorded from the Kuntighat station with 51 species during pre-monsoon and 44 species during monsoon due to operation of wide varieties in fishing gears. In the Matlah estuary, maximum species diversity was recorded at Pathar Pratima with 42 finfish species during monsoon, and the lowest of 15 species from Sandeshkhali during pre-monsoon season.

Stock estimation

Two species such as *Polynemus paradiseus*, and *Setipiana phasa* were taken into consideration for the stock assessment study. For *Polynemus paradiseus*, length-frequency data of 195 samples were taken with the size ranging from 84-231 mm in length, and 2.00-65.79 g in weight. The exponent value 'b' was observed at 3.201 with a correlation of determination (R^2) as 0.94 showing a positive allometric growth pattern for the species. For *Setipinna phasa*, length-frequency data were collected for 145 samples with the size ranging from 61-185 mm in length, and 0.80-26.50 g in weight,

Ariomma indica

Nemipterus randalli

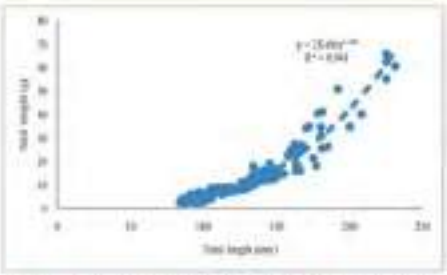
Aluterus monoceros

Priacanthus prolixus

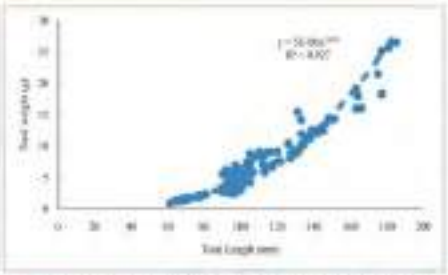
Lobotes surinamensis

Seriolina nigrofasciata

New records from Hooghly-Matlah estuarine system during 2022



Length-weight relationship of *P. paradiseus* from Hooghly-Matlah estuary



Length-weight relationship of *S. phasa* from Hooghly-Matlah estuary

respectively. The exponent value 'b' was observed at 2.991 with a correlation of determination (R^2) as 0.94 showing an isometric growth pattern for the species.

Reproductive biology

For assessing the reproductive biology, a total of 13 matured *Polynemus paradiseus*, with sizes range 158-192 mm, and 22.70-50.80 g were taken into consideration with the gonad weight range 3.20-8.60 g (4.88±1.36). The absolute fecundity ranged 8155 to 16770 eggs (11308±2590) and relative fecundity ranged 294 to 462 eggs per g body weight (365±46).

Juvenile fishery

During pre-monsoon, juveniles of *Gudusia chapra* were found abundant at Nabadwip, *Sperata aor* and *Setipinna phasa* at Kuntighat, and *P. paradiseus* along with *O. pama* at Birlapur stretches. Among the juvenile fishery during monsoon (June-September) juveniles of *Gudusia chapra, Sperata aor* and *Heteropneustes fossilis* were found abundant at Nabadwip and *Labeo bata, Eleotris fusca, Setipinna phasa* at Kuntighat and *Setipinna phasa* along with *T. ilisha* at Birlapur stretches. Juveniles of *Tenualosa ilisha, Ilisha megaloptera, Sperata aor, Mystus gulio*, etc. were found dominant in the Roychak site; *Terapon jarbua, Escualosa thoracata, Chrysochir aureas*, etc. at Kakdwip sites; and *Harpadon nehereus, Ilisha megaloptera*, etc. at Bakkhali sites, under Hooghly estuary. From the Matlah estuary during monsoon, juveniles of *Harpadon nehereus, Coilia ramcarati, Ilisha megaloptera, Scatophagus argus*, etc. were found to be the most dominant species.

Juveniles of double spotted queenfish, *Scomberoides lysan* reported from all four fishing sites in Matlah estuary (Sandeshkhali to Pathar Pratima), during the post-monsoon season (October) indicating its breeding season and probable breeding ground. A good number of *Pisodon ophisboro, Muraenesox bagio*, and *Himantura marginata* juveniles were also recorded from all the stations. Record of juvenile mangrove horseshoe crab *Carcinoscorpius rotundicauda* from the Pakhiralaya/Gosaba indicating its suitable breeding grounds.

Physico-chemical analysis

Water and sediment samples were collected from 10 sampling stations viz., Nabadwip, Kuntighat, Birlapur, Roychak, Kakdwip and Bakkhali (Hooghly estuary) and Sandeshkhali, Gosaba, Jharkhali and Pathar Pratima (Matlah estuary) covering freshwater, intermediate, and saline zone for study of ecology and fisheries in Hooghly-Matlah estuary.

Turbidity

Water was highly turbid during monsoon due to surface run-off especially in upper Hooghly estuary. Highest turbidity (755±165 NTU) recorded at Nabadwip during monsoon sampling. In Matlah estuary, turbidity was quite low during post-monsoon months indicating lack of riverine discharge. The lowest turbidity (8.7±1.1 NTU) was recorded at Jharkhali during post-monsoon.

Water pH

Water pH was alkaline in entire Hooghly-Matlah estuary. Upper Hooghly estuary (Nabadwip and Kuntighat) exhibited higher pH (8.5) during post-monsoon whereas middle and lower Matlah estuary (Gosaba, Jharkhali and Pathar Pratima) exhibited higher pH during monsoon. The relatively lower pH was recorded at Birlapur in Hooghly estuary and Sandeshkhali in Matlah estuary during pre-monsoon, a possible impact of Kolkata city sewage loading.

Dissolved oxygen

Dissolved oxygen was > 5 mg/l in both Hooghly and Matlah estuary. Significantly higher DO was recorded during post-monsoon month especially in Hooghly estuary when water became more transparent

Juveniles of *Eleotris fusca* at Kuntighat

Juveniles of *Tenualosa ilisha* at Birlapur

Juveniles of *Chrysochir aurea* at Kakdwip

Juveniles of *Silloginopsis panijus* at Bakkhali

Distribution of juvenile fishery in different stretches of Hooghly-Matlah estuary system

to facilitate higher planktonic photosynthesis. The lowest dissolved oxygen (5.1±0.3 mg/l) was recorded at Sandeshkhali during monsoon indicating impact of anthropogenic loading at the upstream from Kolkata city sewage effluent discharge.

Salinity regime

Hooghly estuary exhibited near freshwater stretch in upper and middle estuary with the highest value of 0.94±0.13 ppt at Roychak during pre-monsoon. In Matlah estuary higher salinity recorded throughout the year with the lowest value of 1.85±0.05 ppt during post-monsoon at Sandeshkhali.

Biochemical oxygen demand (BOD)

Biochemical oxygen demand was low except slightly higher values in Birlapur (1.4±0.8 mg/l) and Sandeshkhali (2.3±0.7 mg/l) during post-monsoon due to impact of loading of Kolkata city sewages.

Soil parameters

Among soil parameters, soil pH was alkaline in all the sites with higher values during post-monsoon months; highest soil pH (8.94±0.04) was recorded at Nabadwip during monsoon and the lowest (7.08±0.21) at Pathar Pratima during pre-monsoon. Soil organic carbon was higher in Birlapur in Hooghly estuary and Sandeshkhali in Matlah estuary due to impact of Kolkata city sewage discharge.

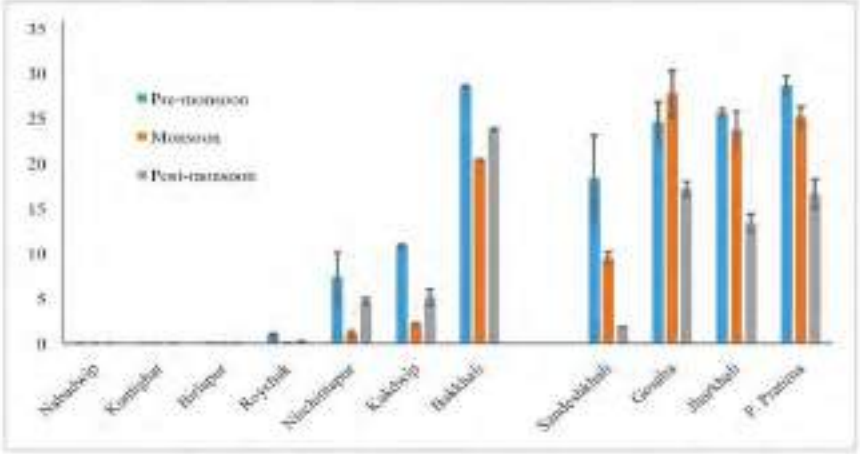
Plankton and periphyton assemblage

Phytoplankton communities recorded under 75 genera, with the clear dominance of Bacillariophyceae (40 species) followed by Chlorophyceae (20 species), Desmidophyceae (4 species), Dinophyceae (3 species) and Euglenophyceae (2 species). Freshwater stretch was abundant with the members of Chlorophyceae, and estuarine stretch was with the members of Bacillariophyceae. Dinophycean members were only restricted to high saline stretches. *Aulacosiera* spp. was the dominant genera under Bacillariophyceae whereas *Scenedesmus* spp. was the dominant one under Chlorophyceae. The highest abundance was recorded in monsoon (2.21×10^4 nos per litre) followed by post-monsoon (1.46×10^4 nos per litre) and pre-monsoon (1.15×10^4 nos per litre). The occurrence of blue-green algae was found higher during monsoon (1.54×10^3 nos per litre) whereas the green algae were recorded higher during pre-monsoon (3.41×10^3 nos per litre). The diatoms were abundant and recorded maximum during monsoon (1.43×10^4 nos per litre).

Periphyton population comprised five groups; Bacillariophyceae, Cyanophyceae, Chlorophyceae, Rhodophyceae and Protozoa with the dominance of Bacillariophyceae which contributes 72% of total periphytic community. The pre-monsoon survey recorded the highest density of periphyton at Jharkhali (1132 no/cm^2) and the lowest at Roychak (180 no/cm^2). The density of periphyton was recorded higher at Kakdwip (2649 no/cm^2) and lower in Birlapur (459 no/cm^2) during monsoon.

Benthos diversity

A total of 15 species of macrobenthic fauna belonging to eight families comprising gastropods (13 species, 14 families) and bivalves (2 species, 1 family) were recorded during pre-monsoon and monsoon season of 2022. The bivalve species recorded are *Meretrix casta* and *Dosinia* sp. The remarkable observation is abundance of *Tarebia granifera* and *Tarebialineata* from Kuntighat. The other major gastropods are *Neritabalteata, Filupaludina bengalensis, Thiarascabra, Cerithidea obtusa*. The macrobenthic fauna was found maximum from freshwater zone at Kuntighat.



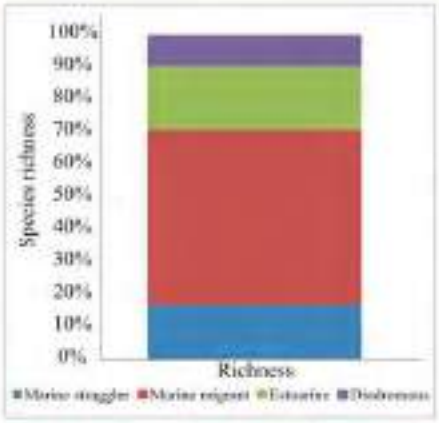
Salinity distribution in Hooghly-Matlah estuary

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

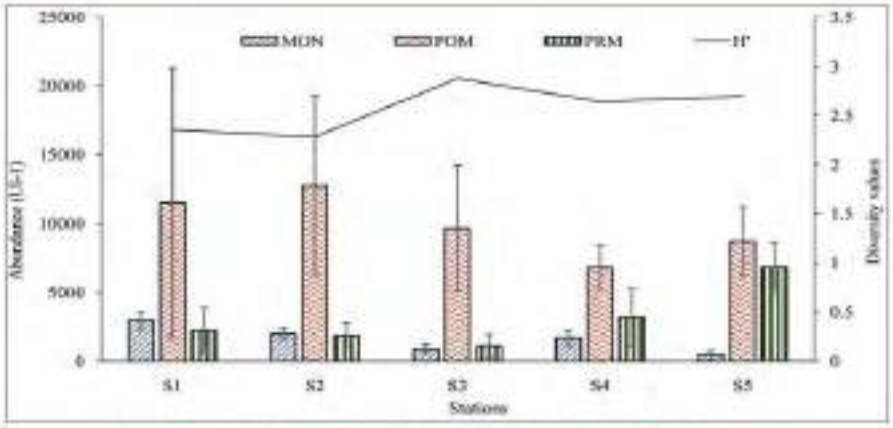
Scientific Personnel: S. K. Das (Sub-project Leader), Roshith C. M.(Study leave 07.04.22-09.11.22), L. Kumar (upto 08.12.22), P. Gogoi (w.e.f. 01.04.22), C. Jana (w.e.f. 01.04.22)

Fish and shellfish diversity of Rushikulya Estuary

In total, 75 fish species belonging to 35 families were recorded. In terms of species richness, Carangidae and Leiognathidae dominated (8 species each), followed by Engraulidae and Clupeidae (5 species each). Marine



Fish Trophic guild of Rushikulya estuary



Abundance and diversity of phytoplankton in Rushikulya estuary

stragglers (MS) namely, *Pennahaia anea, Nibea maculata, Siganus javas, Platycephalus indicus, Chaetodon decussatus, Strophiodon sathete* accounted 12% of the total ecological fish guild composition, indicating the prevalence of high salinity during most part of the year in the estuary. Freshwater shark *Wallago attu* recorded in significant numbers in the upper estuary during the late-monsoon period (November). The shellfish catch mainly dominated by *Fenneropenaeus indicus* (Indian white prawn) and *F. merguiensis* (Banana prawn). Four species of crabs recorded with dominance of *Scylla* sp. (mud crab) and *Portunus sanguinolentus*. Mugilidae, Carangidae, Ariidae, Leognathidae and Clupeidae were the major contributors to the total observed fish biomass in the estuary. *Mugil cephalus, Planiliza subviridis, Chelon parsia, Planiliza tade, Caranx ignobilis, C. papuensis, C. hippos, Rhabdosargus sarba, Arius arius, Lutjanus johnii, Deveximentum insidiator, Gerres* spp. contributed significantly to the overall fish assemblages. The majority of fish species are of least concern (LC). Based on the estuarine use functional groups, marine migrants (MM) were the dominant group. The relative contribution of marine migrants accounted for at most 54% of the total estuarine use functional groups

Plankton assemblages

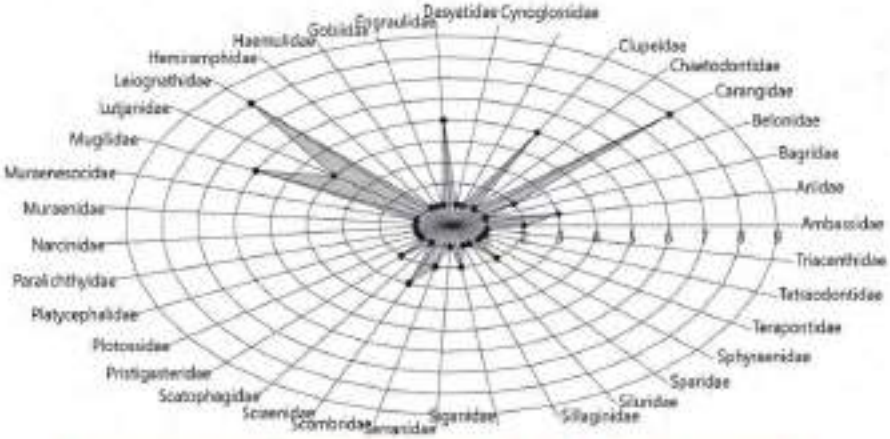
Out of 63 species of phytoplankton recorded under 48 genera from Rushikulya estuary, chain forming centric diatom *Chaetoceros* contributed 28% followed by dinoflagellate *Peridinium* (10%). Mediophyceae alone contributed 30% of the assemblage primarily dominated by *Chateoceros lorenzianus* and *C. decipens*. Phytoplankton abundance was maximum during post-monsoon (9,878±2081 u/l) and lowest in monsoon season (1,889±866 u/l). Contributions of holoplankters and meroplankters were between 28-82% and 25-62%, respectively in total zooplankton population. Richness (*d'*) and Shannon diversity (*H'*) were more than 2.20, which indicated moderate phytoplankton diversity. The *H'* of zooplankton resulted in similar values during monsoon and post-monsoon (1.69 and 1.68, respectively), implying comparatively low zooplankton diversity in the sampling sites.

Bloom of filamentous algae in the Rushikulya estuary

The filamentous algae formed algal bloom in the Rushikulya estuary and created clogging in fishing nets during operation. It persisted during January to March with peak in February. Multiple *Spirogyra* sp. were present with remarkable dominance of *Spirogyra varians* (Hassall) Kützing 1849; *S. varians* was recorded up to 4.0‰ salinity regime.

Macro-benthic assemblage

Four functional groups of benthos were recorded comprising 21 taxa. Gastropoda accounts for 57% - 90% to the total benthic assemblages in terms of biomass followed by Bivalves. The abundance of macrobenthos ranged from 295 to 684 ind./m^2 with the maximum during



Species richness under different fish families and fish guild composition in Rushikulya estuary

Clogging in fishing nets by filamentous algae

Spirogyra variani, major component of algal bloom

Clithonoua laniensis

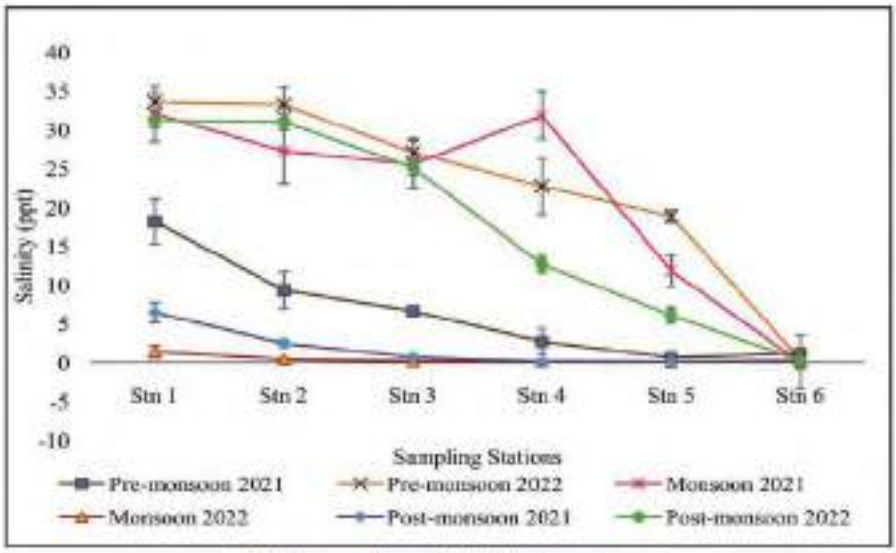
Pirenella cingulate

Prionospio oligobranchia (Gills)

post-monsoon season. *Pirenella cingulate* and *Clithonoua laniensis* were the major contributors to the total Gastropod population. The bivalves were mainly dominated by *Meretrix meretrix* in the estuary. The sediment properties sand, silt, and clay (%) were positively associated with the benthic functional groups.

Water Quality Analysis

Rushikulya water quality parameters varied seasonally and some properties like salinity was very much dependent on quantity and timing of rainfall in the catchment area. Salinity changes in the years 2021 and 2022 were quite different due to the rainfall pattern; in 2021, monsoon rain was delayed and a good shower was received in winter. So, salinity in monsoon was much higher than the post-monsoon season contrary to the common concept. Nitrate content was 0.01-0.02 mg/l across the seasons. Phosphate contents varied widely ranged from 0.01-0.03 mg/l in various seasons, but in post-monsoon 2022, an increase in phosphate content upto 0.2 mg/l was observed in estuarine part. No significant metal contamination was observed.



Salinity gradient in Rushikulya estuary

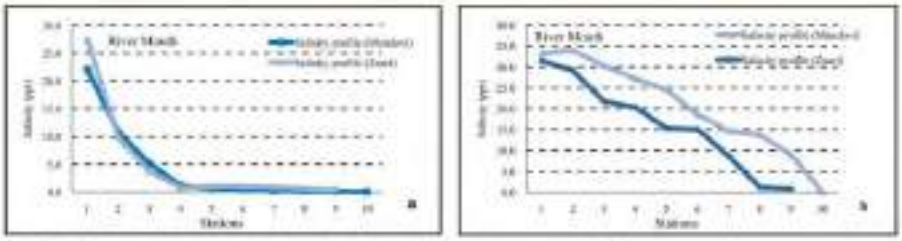
Sub-project 3:

Temporal assessment of the Mandovi-Zuari estuarine fishery resources for sustainable management

Scientific Personnel: S. P. Kamble (Sub-Project Leader), L. Kumar (01.04.22 to 08.12.22), W. A. Meetei (upto 31.03.22) and Vaisakh G.

Fish assemblage

Fish fauna collected from Mandovi-Zuari estuarine system represented by 114 fish species belonging to 25 families. The Marine juvenile migrants (MM) formed the major component in the ecological guild followed by Marine stragglers (MS) irrespective of the season and the spatial gradient and the higher percentage of marine migrant juveniles clearly indicated the nursery role of this estuary. The estuarine resident species yielded from the estuary during the study (ES) were very less (8 species). The gobies formed a major group in the ES guild (5 species). The lesser abundance of the estuarine species (ES) compared to the marine species indicates that a few fish species are adapted to the fluctuating tropical estuarine conditions as reported in many previous studies. The fluctuating salinity in Mandovi-Zuari



Salinity profile of Mandovi and Zuari estuarine stretch from mouth to upstream in the order of 1 to 10: (a) monsoon season; (b) pre-monsoon season

estuarine system during monsoon and dry seasons is evident from the salinity profile study. The higher species diversity evident in the Mandovi estuary might be owing to the high saline conditions in the dry seasons. The feeding guild assemblage was dominated by CR (Carnivore) and OV (Omnivore), with a relatively low assemblage of herbivores and planktivores. The dominance of CR may be due to the lucrative abundance of the young of several taxa as observed in the estuarine systems, which serve as food for predatory or Carnivores fish.

Fishery

Fisheries in the Mandovi estuary and that of Zuari estuary are almost similar, with the comparatively higher composition of marine migrants and estuarine species in the Mandovi estuary. The major fish groups that contributed to the fishery in the Mandovi-Zuari estuarine systems were Sardines- 3 species (14%), Shads- 3 species (12%), Croakers- 8 species (10%), Anchovies- 4 species (10%), Silver bellies- 5 species (10%), Pearl spots (7%), Catfishes- 4 species (7%), Carangids (5%), Mullets- 4 species (5%), Ribbon fishes- 2 species (4%) and Gobies- 5 species (4%). The major single species fishery observed in the estuarine system was that of *Rastrelliger kanagurta, Sardinella longiceps, Sillago sihama* and *Arius arius*. The catch of *Sillago sihama* was found to be highly seasonal with a high spatial difference also, it increases in the upper estuary (oligohaline and mesohaline) during the monsoon season while in other seasons the catch was mainly concentrated in the lower estuary (polyhaline zone). The marine stragglers (mainly mackerels, sardines and shads) formed the major fishery in the lower estuarine zone of Mandovi and Zuari irrespective of the season.

Shellfishes also formed a lucrative fishery in the estuarine system of which the major species that form the shrimp fishery includes *Penaeus monodon, Metapenaeus dobsonii, Fenneropenaeus indicus* and *Parapeneopsis* spp. The crab fishery in the estuary was mainly contributed by *Portunus pelagicus, P. sanguinolentus, Charybdis feriata, C. cruciata, Scylla serrata* and *S. tranquibarica*. The fishery of edible oyster *Ostrea* sp. (CPUE- 5 Kg/boat) was also observed in the lower estuary during the pre-monsoon season.

Isopod parasite (Family: Bopyridae) infection of *Macrobrachium scabriculum*

Isopod parasite (family: Bopyridae) infected *Macrobrachium scabriculum* with a length range of 25-60 mm were collected from the tidal freshwater zone of the river near Ganjem village, Goa (salinity: 0.33-0.45 ppt). *M. scabriculum* is a commercially important freshwater palaemonid prawn commonly observed in the riverine systems of India. The Bopyrid isopods are reported to infect the zoeal and post-larval stages of the prawn and impair the reproduction and normal growth of the organism. The parasite was found attached to the gill chamber of the infected specimens, while visible lesions were absent in the gills.

Habitat characteristics

A wide seasonal variation in the salinity of the Mandovi-Zuari estuarine system was observed. Though a fall in salinity of both estuaries (Mandovi and Zuari) was observed during Monsoon, delimitation of the boundaries of oligohaline, mesohaline and polyhaline zones was quite possible. Euhaline water was observed in the

Fish caught at Panjim (Mandovi river)

stations near the mouth of both estuaries during the dry seasons (pre-monsoon) as portrayed in the salinity profile.

A similar trend was also observed in other salinity related parameters such as total dissolved solids, specific conductivity and total hardness. Water transparency was high (>80 cm) at all stations except for Banastarim station (79.7 cm) on Cumburjua canal during Post Monsoon. Major nutrients, viz. nitrate and inorganic phosphate found higher during monsoon both estuaries which were attributed to agriculture runoff. A similar trend was also observed in sediment nutrients such as available phosphorus and available nitrogen in both the estuaries.

Sub-project 4:
Temporal assessment of Netravathi-Gurupur estuarine fisheries resources for sustainable management

Scientific Personnel: M. Feroz Khan (Sub-Project Leader), Sibina Mol, A Saha (upto 31.03.22) and S. Sahoo

Water quality

Post-monsoon, pre-monsoon and monsoon sampling were conducted in Netravathi-Gurupur Estuary in nine sampling stations. Water pH varied from 7.09 to 7.92. The Gurupur stretch had slightly lower pH than the bar mouth and Netravathi stretch during post monsoon and monsoon season. In pre-monsoon, the Gurupur stretch had slightly higher pH than the Netravathi stretch. This may be associated with the pH of sewage discharge in Gurupur stretch.

Dissolved oxygen (DO) levels were lower in all three seasons in Gurupur than the Netravathi stretch due to higher anthropogenic stress in the former. In post and pre-monsoon, DO values for Gurupur stretch were <5 mg/l. DO values followed a vertically decreasing trend toward the bottom.

In post-monsoon and pre-monsoon, salinity levels were higher throughout the estuary due to sea water intrusion, whereas, in monsoon the salinity level was very less (lowest was 0 ppt in station VI) for all the stations caused by terrestrial freshwater runoff. Salinity followed an increasing trend toward the bottom in both post- and pre-monsoon seasons.

Nitrate levels in surface water ranged between 0.02-0.05 mg/l, 0.02-0.04 mg/land 0.03-0.1 mg/l during post-monsoon, pre-monsoon and monsoon seasons respectively. Levels of total phosphate varied between 0.18-0.37 mg/l, 0.01-0.13 mg/l and 0.08-0.61 mg/l during post-monsoon, pre-monsoon and monsoon seasons respectively. Higher phosphate and nitrate values during monsoon may be attributed to heavy rainfall, land runoff and weathering of rocks liberating soluble alkali metal phosphates. Lower values of nutrients during other seasons may be due to the utilization of these nutrients by the phytoplankton. Silicate concentration ranged between 3.19-13.00 mg/l with higher values during monsoon due to heavy influx of freshwater carrying silicate and also from bottom sediments exchanging with overlying water due to the turbulence. Low values during post monsoon suggest that silicate is actively removed from the water column by the aquatic community. Spatial variation maps have been prepared using spatial interpolation (Krigging) technique in Arc-GIS platform for water quality parameters.

Water quality index

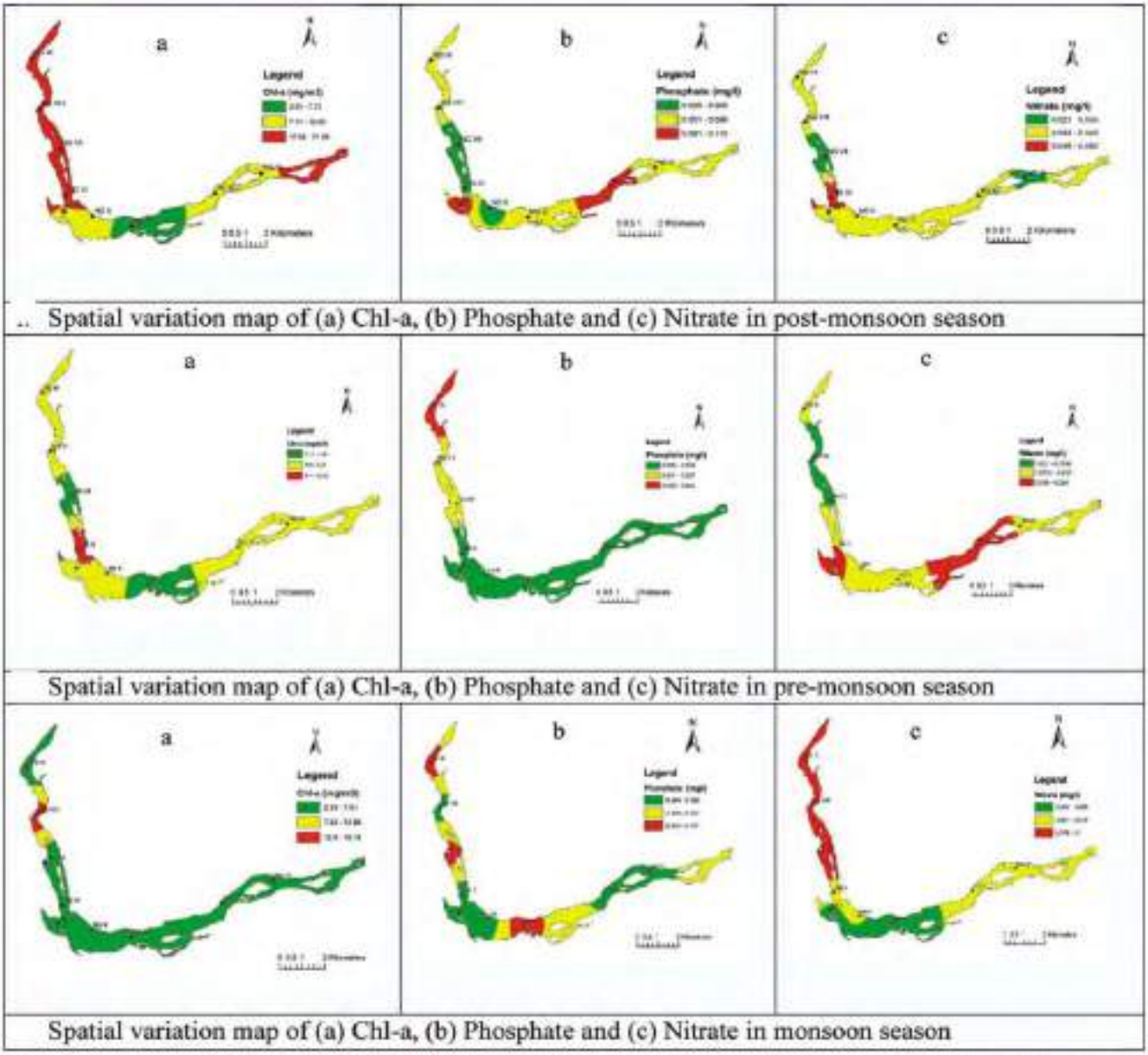
Water quality index (WQI) of Netravathi-Gurupur estuary for brackish water fisheries has been calculated with the guideline values of the Canadian Council for Ministers of the Environment (CCME) water quality index calculator, and the permissible limits were replaced with an ideal range of water quality parameters for brackish water fisheries. WQI for the post-monsoon, pre-monsoon and monsoon were calculated to be 66, 64 and 42 respectively. According to the CCME guidelines Netravathi-Gurupur estuary falls under fair to marginal quality in post and pre-monsoon and poor quality in monsoon for brackish water fisheries. Poor water quality during monsoon was mostly due to very low salinity which is unsuitable for osmoregulation of brackish water fishes and also due to higher turbidity. WQI was also calculated for the individual stations. It was observed that WQI decreased towards the upstream of the estuary. All the stations were of marginal quality except station VI which fell under poor category. This indicates that Nethravathi-Gurupur estuary water quality is frequently impaired, and the conditions are often deviated from desirable levels. The marginal and poor water quality of the sampling stations was due to lower salinity levels and high turbidity in monsoon and higher total hardness in post and pre monsoon which were undesirable for brackish water fisheries.

Fishery

During pre-monsoon, an estimated 31.2 tonnes of fish were landed at various landing centres in Nethravathi-Gurupur estuary with a CPUE of 3.8 kg. The landings declined to 14.5 tonnes with a CPUE of only 2.2 kg during monsoon

Table : WQI for different sampling stations of Netravathi-Gurupur estuary

Stations	WQI	Category
NG I	55.4	Marginal
NG II	53.9	Marginal
NG III	52.4	Marginal
NG IV	54.5	Marginal
NG V	47.7	Marginal
NG VI	44.6	Poor
NG VII	58.9	Marginal
NG VIII	54.6	Marginal
NG IX	52.5	Marginal



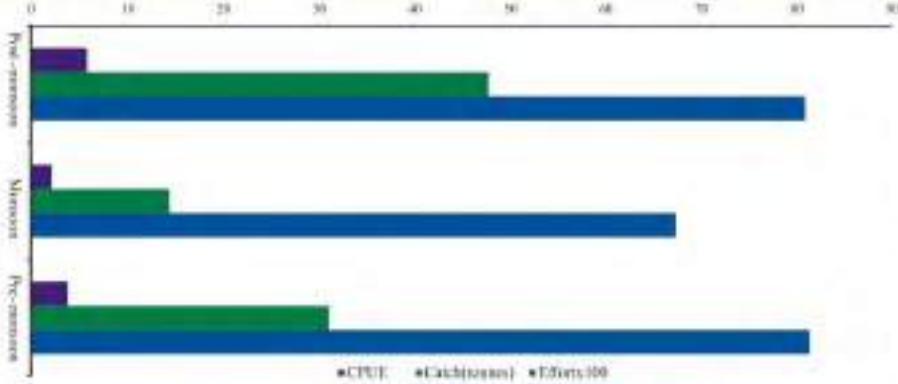
Spatial variation map of Chlorophyll-a (Chl-a), Phosphate and nitrate in water of Netravthi-Gurupur estuary in three different seasons

whereas in post-monsoon, there was an increase of both landings and CPUE to the tune of 47.85 tonnes and 5.9 kg respectively.

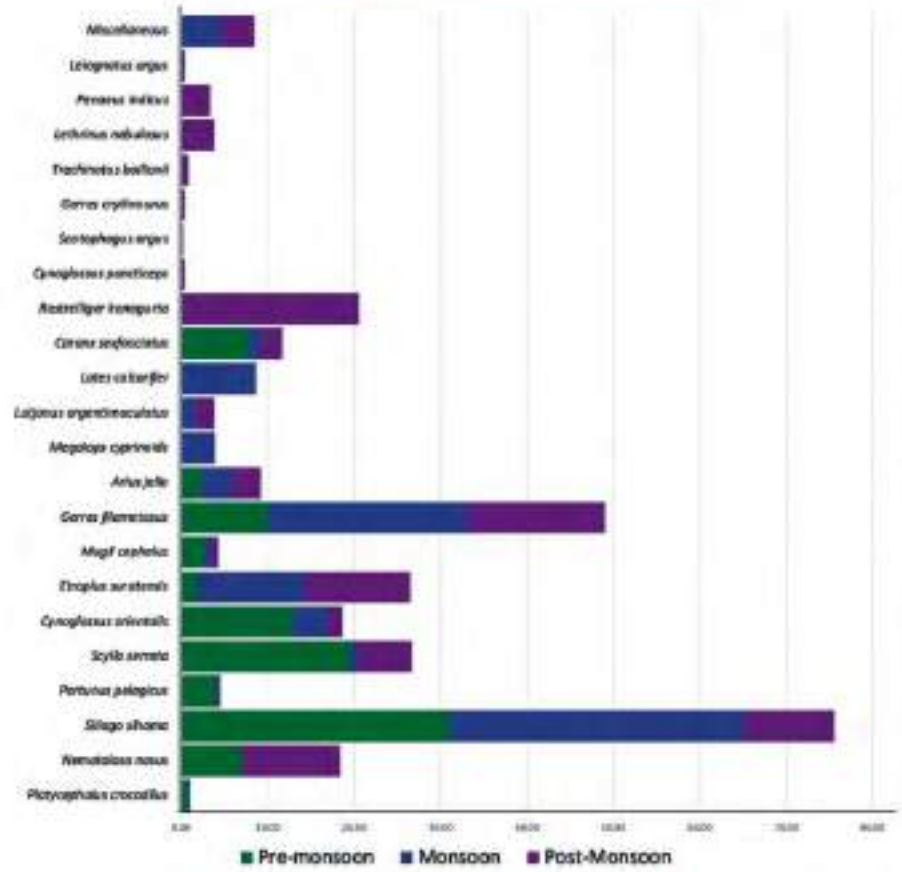
Fish catch was dominated by *Sillago sihama* (31.07 %) followed by *Scylla serrata* (19.47%) *Cynoglossus orientalis* (12.98%) *Gerres filamentosus* (9.99%), *Caranxsex fasciatus* (7.71%), *Nematalosa nasus* (7.08%), *Portunus pelagicus* (3.93%), *Mugil cephalus* (2.75%) *Arius jello* (2.36%), *Etroplus suratensis* (1.97%) and Miscellaneous (0.69%) during the pre-monsoon whereas in monsoon also *Sillago sihama* dominated the estuarine fishery forming 34.15% followed by *Gerres filamentosus* (23.14%), *Etroplus suratensis* (12.4%), *Lates calcarifer* (8.67%), *Cynoglossus puncticeps* (3.97%), *Megalops cyprinoides* (3.89%), *Arius jello* (3.47%), *Caranxsex fasciatus* (1.46%) and Miscellaneous group (8.85%). During the post-monsoon season *Rastrelliger kanagurta* dominated the landings forming 20.5% followed by *Gerres filamentosus* (15.9%), *Etroplus suratensis* (12.1%), *Nematalosa nasus* (11.3%), *Sillago sihama* (10.4%), *Scylla serrata* (6.3%), *Lethrinus nebulosa* (3.8%), *Arius jello* (3.3%), *Penaeus indicus* (3.3%), *Caranxsex fasciatus* (2.5%), *Lutjanus argentimaculatus* (2.1%) and Miscellaneous (8.5%).

The sizes of *R. kanagurta* ranged from 17.5 to 21.5 cm with mode at 19.0 cm whereas the sizes of *N. nasus* ranged from 17.0 to 20.0 cm with mode at 19.0 cm. The sizes of *Sillago sihama* ranged from 15.0 to 23.0 cm with modes at 19.0 & 20.0 cm.

Fishing effort and catch in the gill nets was estimated and the species composition is given here above.



Estimated fishing effort and catch in the gill nets



Estimated species composition in gill nets (%).

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

Scientific Personnel: T. T. Paul (Sub-project Leader) and D. Sudheesan

Trophic and productivity estimates

The trophic status estimates of 66.7 indicated mid-eutrophic condition of Vembanadlake. The average productivity of the lake is estimated at 141.9 mgC/m^3/hr. The gross primary productivity was estimated at 192.0 mgC/m^3/h during pre-monsoon and 91.9 mgC/m^3/h during monsoon. Average BOD levels of the lake were estimated at 2.48 mg/l during pre-monsoon and 1.2 mg/l during monsoon which may be attributed to the fresh water influx during monsoon.

Plankton diversity

24 genera of plankton belonging to 6 (six) groups were recorded from 6 sampling stations across Vembanad estuary. Cyanophyceae (30.77%) was dominant in terms of abundance. During pre-monsoon, 22 species belonging to 22 genera and 5 groups of phytoplankton were identified. During monsoon 15 species belonging to 15 genera was identified. During monsoon, Cyanophyceae (25.6%) dominated plankton diversity.

Quantitative abundance of phytoplankton ranged from 20 to 260 nos/l, highest being at medium saline station (Aroor, Aroorkutty). During pre-monsoon and monsoon, Cyanophyceae was found to be the dominant group which constituted 35% and 33.4% of the total phytoplankton respectively.

Salinity gradient based plankton

In Vembanadlake, salinity-wise gradient of plankton study indicated that zooplankton (copepoda) dominated the low saline zone. Desmidaceae (47.1%) dominated the medium saline zone.

Zooplankton density

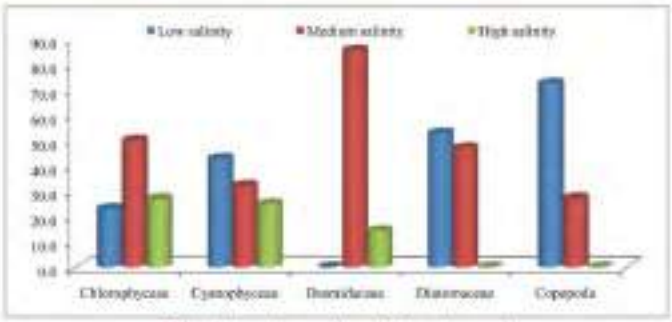
The quantitative abundance of zooplankton ranged from 20 to 220 nos/l in Vembanadlake. Copepoda (25.6%) dominated the plankton diversity during monsoon.

Plankton diversity index

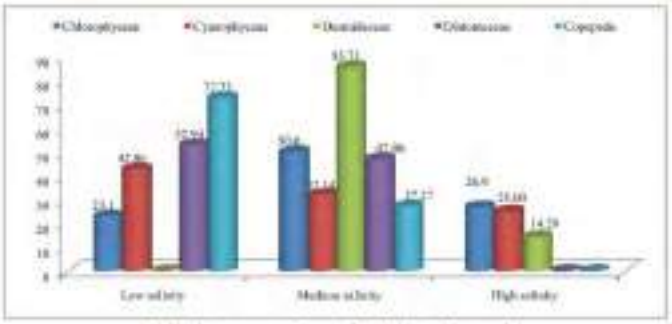
Plankton diversity indices indicate that richness index and Shannon diversity index is high in medium saline stations which may be attributed to the high nutrient influx from marine environment.

Finfish and shellfish diversity

Seasonal differences in the diversity of finfish and shellfishes were observed in Vembanad estuary. Many freshwater fish species were abundant during the monsoon season. Threatened fishes like the *Anguilla bengalensis*, *Horabagrus brachysoma*, *Channa diplogramma*



Plankton diversity of Vembanad



Salinity zonewise plankton diversity

were recorded. The exotic species *Oreochromis mossambicus* was recorded from all the sampling stations and forms one of the major contributors to the fishery of Vembanad.

Table: Plankton diversity indices in Vembanad estuary

	Margalef's richness index	Pielou's evenness index	Shannon diversity index
Low Saline	0.27	0.73	1.36
Medium Saline	0.23	0.78	1.59
High Saline	0.39	0.61	1.07

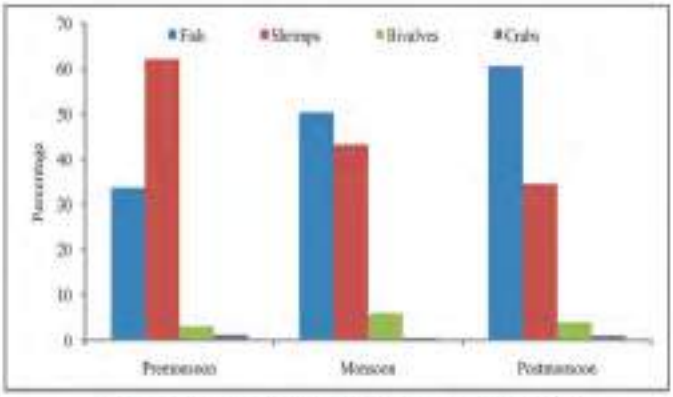
Fishery of Vembanad lake

In pre-monsoon, shrimps contributed to 62.1% while fin fishes were 33% of the total catch. During monsoon and post-monsoon, fishes dominated the catch with 50.3% and 60.5% respectively. Among finfishes, *Etroplus suratensis* (20-25%) was the major contributor, and other important species were *Ambassis* spp. (18%), and *Oreochromis mossambicus* (18%), *Hyporhamphus limbatus, Amblypharyngodon mola, Arius maculatus, A. subrostratus, Megalops cyprinoides, Stolephores indicus*, mullets, etc. In monsoon, *Horabagrus brachysoma* is a lucrative fishery forming 12% of the catch from the low saline area. *Dawkinsia filamentosa, Systomus sarana, Anabas testudineus, Channa* spp., *Wallago attu* are other important species contributing to catch from the low saline zone.

Table: Seasonal diversity of finfish and shellfishof Vembanad lake

Group	Pre-monsoon	Monsoon	Post-monsoon
Finfish	55 species belonging to 35 families	51 species belonging to 30 families	53 species belonging to 32 families
Shrimps	*Metapenaeus dobsonii* *M. monoceros* *Fenneropeneaus indicus* *Penaeus monodon* *P. semisulcatus* *Macrobrachium idella*	*M. dobsoni* *F. indicus* *M. monoceros* *M. idella* *P. semisulcatus*	*M. dobsoni* *M. monoceros* *F. indicus* *P. monodon* *Macrobrachium rosenbergii* *M. idella*
Crab	*Scylla serrata* *Portunus pelagicus*	*Scylla serrata* *Portunus pelagicus*	*Scylla serrata* *Portunus pelagicus*
Bivalve	*Villorita cyprinoides*	*Villorita cyprinoides*	*Villorita cyprinoides*

Among shrimps, *Metapenaeus dobsoni* is the dominant species forming 60-90% of the catch, followed by *Fenner openaeus indicus* (10-20%). Other important species include *M. monoceros*, *Peneaus semisulcatus*, *P. monodon*, *Macrobrachium rosenbergii* and *M. idella*.



Seasonal contribution of fishery groups (%)

Project Title: Assessment of ecological impact of dams and barrages in selected rivers of India

Project Code: REF/20-23/12

Duration: April 2020 - March 2024

Principal Investigator: A. K. Sahoo

Scientific Personnel: S. K. Das, M. H. Ramteke (upto 31.03.2021), R. Baitha (upto 31.03.2022), Sangeetha M. Nair (w.e.f. 01.04.2021)

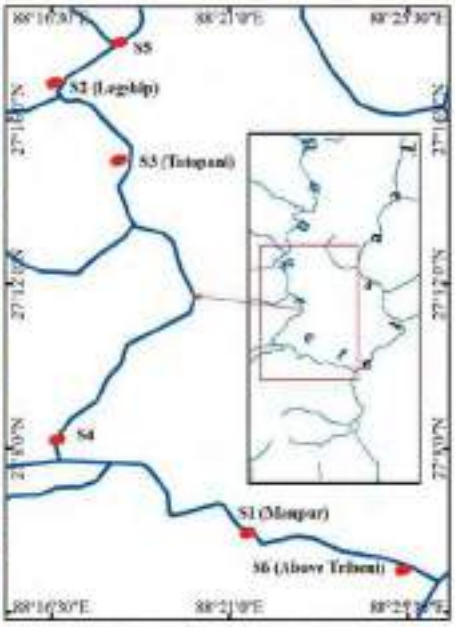
Sampling was performed in six sites to understand the impact of Rangit dam on fish diversity. Rangit River is one of the major tributary of Teesta river basin located in Sikkim.

Fish diversity of River Rangit

During survey, a total of 8 fish species

Rangit Dam, Sikkim

Dam under construction on River Rangit



Sampling sites in Rangit River

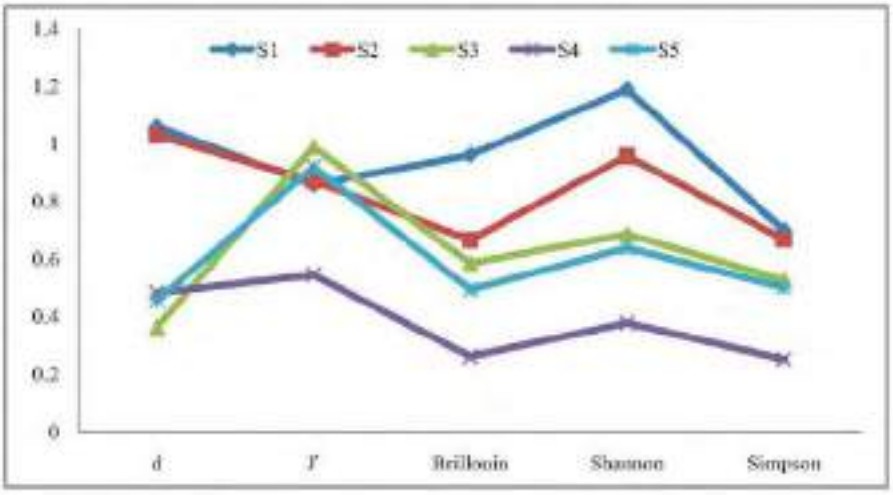
Neolissochilus hexagonolepis

were recorded from the selected six stations of River Rangit. The Near Threatened species, *Neolissochilus hexagonolepis* and vulnerable species *Schizothorax richardsonii* was recorded from Manpur and Tatopani respectively highlighting the importance of the study to formulate guidelines for fish species conservation with special reference to dams as river barricades. Study also recorded the abundance of juveniles of *Schizothorax progastus* from Manpur. The species composition data revealed the dominance of Cyprinids followed by silurids from the river. *Danio equipinnatus* was recorded from Legship which indicates the potential of hill stream rivers for development of ornamental fishery.

The biodiversity indices tabulated for the various sampling sites (S1 to S5) reflected marked variations in fish diversity with regard to different sites. Pielou's evenness (J') values indicated the ecologically disturbed fish community structure at S4 which had the lowest evenness value (0.544) due to the dominance of *Barilius bendelisis* (Indian hill trout) which constituted 87.5 % of the fish community. Though only two species were recorded from S3, the site recorded the highest evenness value (0.989) since both species were more evenly distributed. But, the Simpson's diversity index (1 – D) was highest for S1 (0.699) which can be attributed to the high species richness of the site. The same pattern was followed in case of Brillouin, Margalef (d) and Shannon indices where the site S1 recorded the highest value.

Plankton

In the river Rangit, Bacillariophyceae is the dominant class of phytoplankton followed by



Fish diversity indices of River Rangit

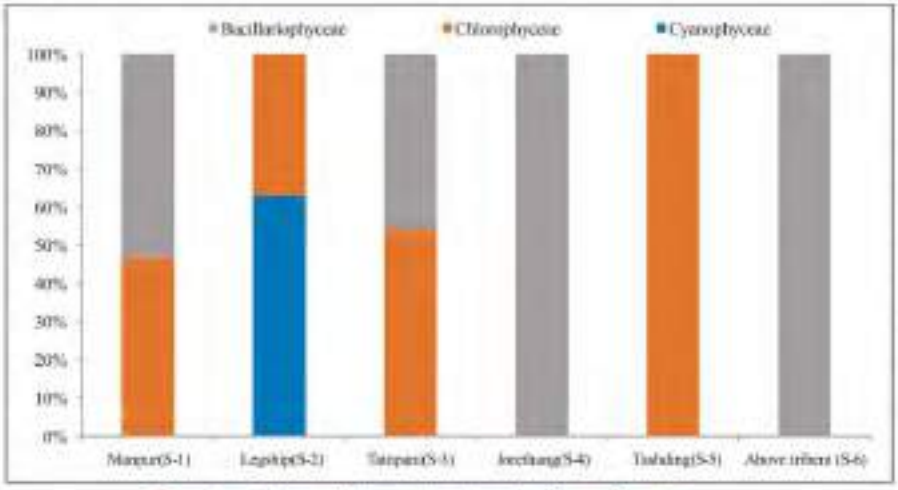
Chlorophyceae and Cyanophyceae. *Oedogonium* sp. and *Cladophora* sp. belonging to Chlorophyceae and *Navicula* spp. belonging to Bacillariophyceae and *Oscillatoria* spp. belonging to Cyanophyceae were the dominant species.

Diversity index i.e. Simpson (1-D) was highest (0.6078) in the upstream of the dam under construction. While, lowest Simpson index was recorded in the site 4 indicating the most degraded ecosystem. Site 4 situated below the dam under construction. Therefore, this indicates the hydropower plant that is under construction is having significant impact on the river ecology.

Hydrological impact

In entire stretch, water was slightly acidic with normal specific conductivity. The reason for lower pH might be the presence of higher concentration of free carbon dioxide and also lower values of total alkalinity. The upstream water was hypoxic (DO 3.6 mg/l) due to stratification and heterotrophic consumption besides lack of filling from oxic surface; the impact was extended to two downstream stations just next to the dam site, which were also oxygen deficient. There was not much variation in nitrate (0.01-0.015 mg l^{-1}) and phosphate (0.10-0.12 mg l^{-1}) contents; at Tatopani, sulfate content was found significantly higher than other stations. There was a hot spring in Tatopani and the sampling station on Rangit was near to that; the reason for higher sulfate content might be attributed to this proximity.

Sediment from all stations were neutral (pH 7.1-7.7), low in organic carbon (0.1-0.3%). All downstream sediments are sandy in nature, but the upstream sediment containing 40% silt might be due to accumulation of finer particles above the dam. The study showed lower dissolved oxygen in the selected stretches might be of several reason as explained. In addition, the hydropower plant under construction might have impact on the water quality parameters. Results indicated that the dam under construction has significant impact on the ecology.



Dominant class of phytoplankton in River Rangit

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

Project Code: REF/20-23/13

Duration: April 2020 - September 2023

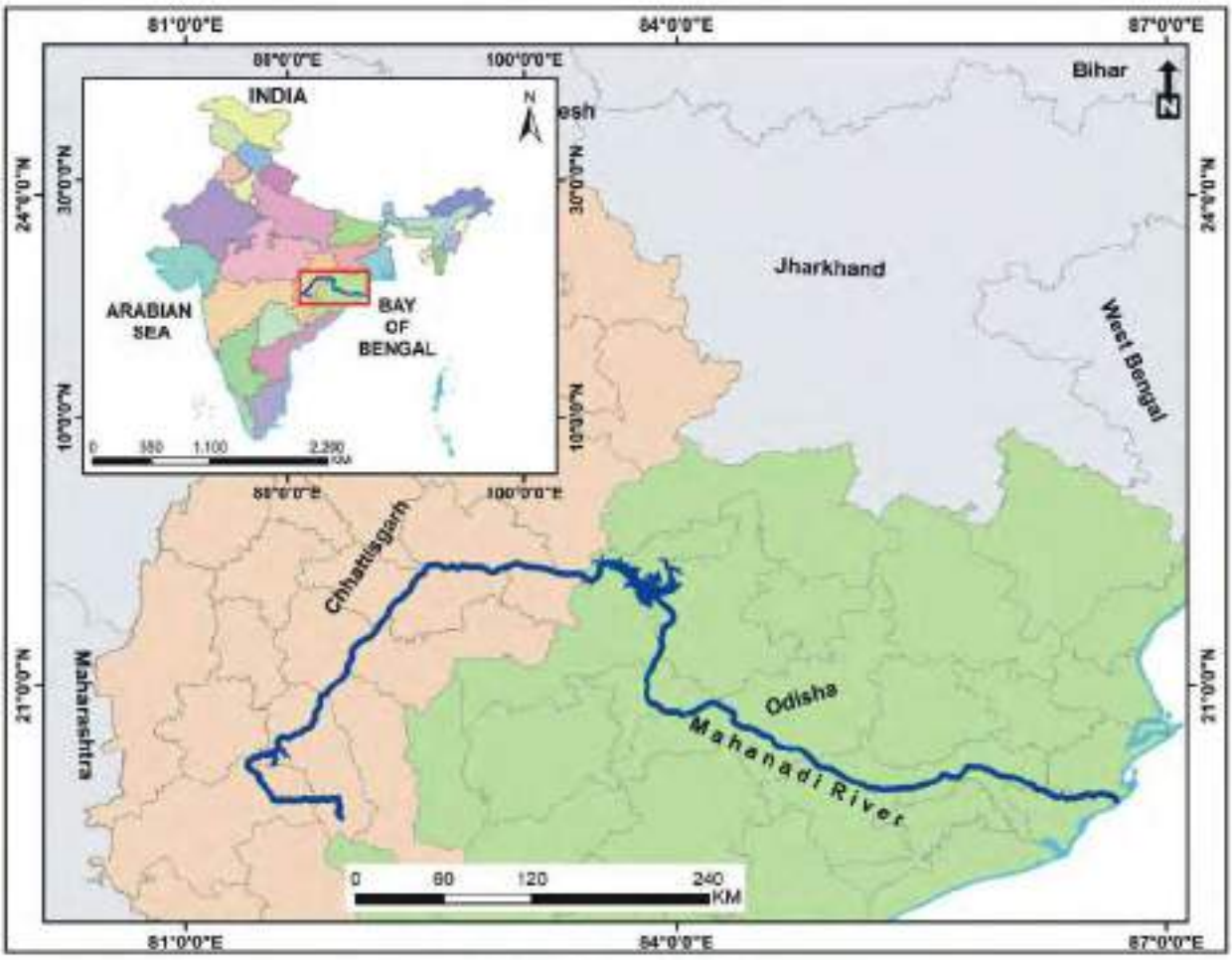
Principal Investigator: B. K. Das (PI) (w.e.f. 01.04.22), Rosith C. M. (PI upto 31.03.22)

Scientific Personnel: Arun Pandit, C. Jana (upto 31.03.22) L. Kumar,R. Baitha, N. Sharma (w.e.f. 01.04.22), M. H. Ramteke (w.e.f. 01.09.2021), C. Johnson (upto 31.03.22)

River Mahanadi

ICAR-CIFRI has conducted an exploratory study across the river Mahanadi and surveyed a total of 146 fishing villages in which, 90 fishing villages were from 8 districts of Chhattisgarh and 56 fishing villages were from 6 districts of Odisha. The river was divided into three regions, namely the upper stretch in Chhattisgarh, middle and lower stretches in Odisha.

During the present study, the data on fish landings was collected from the local fishermen and the fish markets along the bank of river Mahanadi. In addition to that, data on fishermen population, different types of fishing gear, craft and their modes of operation were collected village-wise and region-wise. The fish catch structure in river Mahanadi revealed that catfishes namely, *Wallago attu*, *Sperata aor*, *S. seenghala*, *Eutropiichthys vacha* and *Silonia silondia* were dominating (36.4%) followed by major carps (22.6%), murrels (12.5%), minnows (9.3%), other small indigenous fishes (8.5%), exotics (8.3%) and prawns (2.4%). In recent period, there is an increment in the landings of exotic species such as *Oreochromis niloticus* and *Pangasianodon hypophthalmus*, which may be due to the escape from the culture sites nearby river bank.



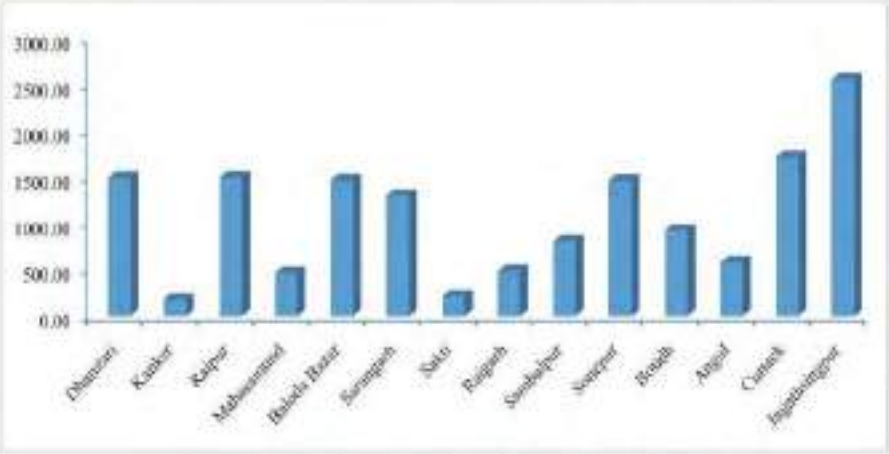
Map of river Mahanadi

The data collected on the species landing were used to study the seasonal patterns in fish landings and and catch per unit effort (CPUE). The annual fish landing ranged from 169.93t (Kanker, Chhattisgarh) to 2560.95t (Jagatsinghpur, Odisha) and total catch from river Mahanadi was estimated as 15134.43 tonnes per annum. The average CPUE from river Mahanadi varied from 0.18 to 9.84 kg/fisher/day during summer; 1.89 to 6.87 kg/fisher/day in winter and 1.83 to 18.88 kg/fisher/day in monsoon.

The fishing crafts operated in river Mahanadi were wooden boats (plank built and dug out) locally known as *Donga* or *naav* and inflated tyre tube. The tube fishing was mainly observed in the upper stretch of the river Mahanadi in Chhattisgarh. The inflatable rubber tube is operated by single fisherman, mainly in the shallow region of the river. Majority of these crafts are employed for the operation of gill nets.

Fishing gears operated along river Mahanadi comprised of gillnet, trammel net, cast net, dragnet, scoop net, hook and line and traps. In the upper stretch, the traditional scoop net, locally known as *pelna* is mostly used for the prawn fishing. Spear

Data collection from the fishers of river Mahanadi



District wise fish catch tonnes from River Mahanadi

Inflated tube fishing in upper stretch of river Mahanadi

Fish catch from river Mahanadi River

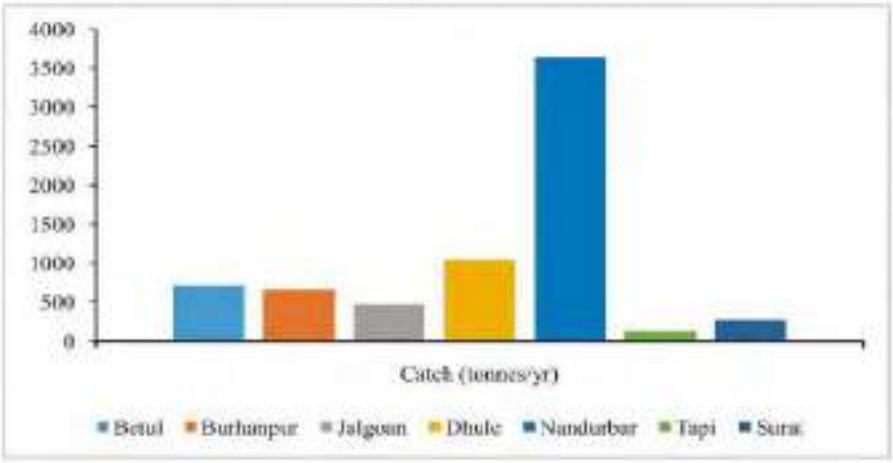
fishing locally called as *chiran* or *loha* is an indigenous gear used in middle stretch of river in Odisha. The fishes like *Bagarius* sp., *Channa* sp. and other catfishes are caught by using the spear. Traps are very common gear used in the entire stretch of the river during monsoon and post-monsoon seasons. Bamboo made traps is cylindrical, rectangular, square, and truncated cone-shaped baskets, which are predominantly used for prawn fishing and catching small fishes. The destructive fishing method such as dynamiting and poisoning water bodies was observed in middle and lower stretch of Mahanadi. Such fishing methods destroy aquatic wildlife habitats, killing animals indiscriminately and reducing fishing catches.

River Tapti

In River Tapti, atotal of 35 villages were sampled. Fishing was not carried out during June to September due to fishing ban and turbulent waters due to incessant rains in Madhya Pradesh (Betuland Burhanpur). The period from October - February constituted good season for fishery followed by March - May. There was no fishing ban during the monsoon in the Maharashtra stretch (Jalgoan, Nandurbar and Dhule), fishing was carried out round the year in this stretch. August to January was the good fishing months in Jalgoan district while it was November to May in Dhule district. In contrast, June to October was the peak fishing season in the Nadurbar district because of the presence of many

Map of river Tapti

Survey in Wathode village, Dhule district, Maharashtra



District-wise estimated fish catch from river Tapti

dams that slowed down the water flow making it congenial for fishing. Gill net was the most common gear used for fishing inthe entire stretch of the river followed by drag net and hook and line. Cast net was used when water were turbid. Traps were used in Dhule district. The middle stretch of the river comprised of Nandurbar (3643 t) and Dhule (1045 t) districts were most productive. Tapi district reported lowest fish catch from the river because major stretch of the riverin Tapi district was converted into lentic environment due to Ukai dam. The estuarine stretch of the river in Surat district had multiple impoundments leading to absence of a true estuary.The total fish catch of the river Tapti was estimated as 6946 tonnes/year. The average CPUE from river Tapti varied from 1.52 to 6.06 kg/fisher /day during summer; 2.86 to 9.45 kg/ fisher/day in winter and 0.69 to 3.44 kg/fisher/day in monsoon.

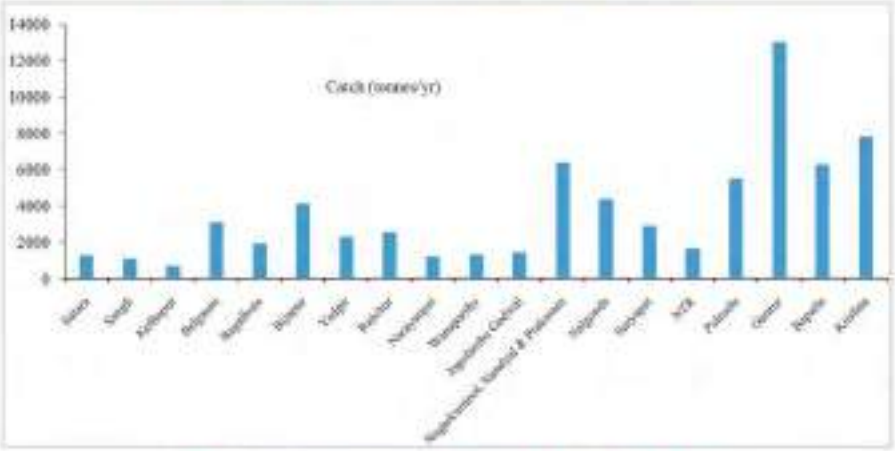
Fishery resources contributing to the fishery were *Labeo rohita, L. catla, L. calbasu, L. fimbriatus, L. boggut, Cirhinus mrigala, C. reba, Notopterus notopterus, Mystus bleekeri, M. cavasius, Anguilla bengalensis, Tor tor, Chanda nama, Paramabasis ranga, Coricas obrana, Osteobrama cotio, O. vigorsi, Devario aequipinnatus, Systomus sarana, Glossogobius guirius, Garra mullya, Amblypharyngodon mola, Channa striata, C. marulius, Sperata aor, Macrobrachium rosenbergii* and *Salmostoma* spp.

River Krishna

In total, 77 villages were sampled in River Krishna encompassing the 21 districts. Through the monsoon fishing ban was not in place in the Maharashtra stretch however, fishing was not carried out during June to

Map of river Krishna

Interaction with fishers in Atkur village, Karnataka



District-wise estimated fish catch in Krishna River

September due toheavy rain conditions. The peak fishing season in this stretch was from October-February. In the rest of the stretch in Karnataka, Telangana and Andhra Pradesh, the state governments have imposed monsoon fishing ban, hence fishing was not carried out during June and July. The peak fishing season was from February-May followed by August-September. However, in most stretch of the river, fishing continued in areas just downstream of the reservoirs even during the monsoon season as the flow was regulated due to the presence of dams.

Gill net was the most common gear operated in the entire stretch of the river followed by cast net, hook and line and traps. Innovative fishing crafts made of thermocole was abundant in Maharashtra while coracles were prominent in Belgaum stretch of Karnataka. Boats made of metal were observed in Bagalkote and Bijapur district of Karnataka. Boats made of wood and metal were prominent in the lower stretch of the river Krishna. The total estimated fish catch of the river was 18902 tonnes per annum. The zones in the lower stretch of the Krishna River such as Palnadu, Guntur, Krishna and Bapatla were most productive followed by the middle stretch. The average CPUE from river Krishna varied from 4.83 kg to 6.84 kg/fisher/day during summer; 3.83 kg to 6.84 kg/fishermen/day in winter and 2.0 kg to 4.93 kg/fisher/day in monsoon.

Important fishery resources contributing to the fishery were *Labeo catla, L. rohita, L. fimbriatus, Notopterus notopterus, Cirhinus mrigala, Mystus bleekeri, Anguilla bengalensis, Systomus sarana, Glossogobius guirius, C. reba, Amblypharyngodon mola, Channa striata, Sperata aor, M. cavasius, Lates calcarifer, Oreochromis mossambicus, O. niloticus, Arius arius, Mugil cephalus, Gerres filamentosus, Tor* spp., *Salmostoma* spp., *Macrobrachium* spp.

River Barak

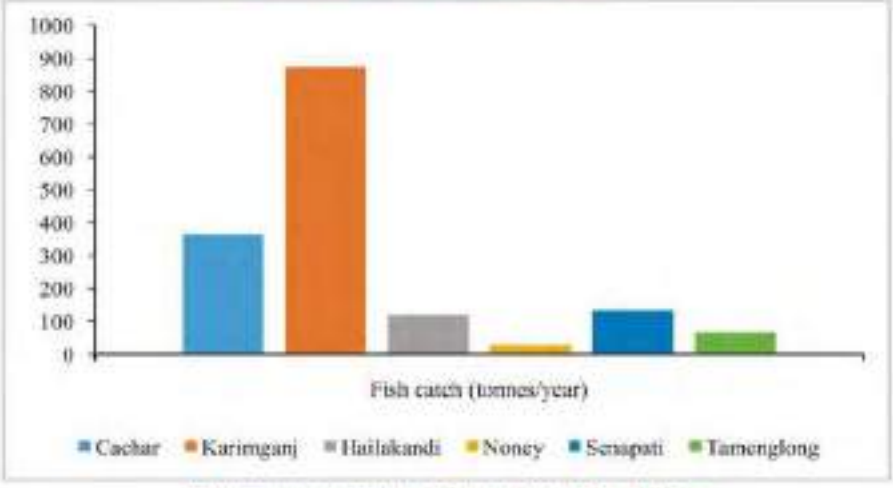
Barak River is one of the major river of Northeast India after River Brahmaputra. The study was

Map of river Barak

Discussion with fishers of River Barak

Holar Jal (Purse seine net) for Hilsa fishing at River Barak

Bamboo traps use in River Barak



District-wise estimated fish catch in Barak River

conducted in the Barak River, covering 3 districts (Cachar, Hailakandi and Karimganj) of Assam and surveyed 18 fishing villages (lower stretches) and 3 districts (Senapati, Noney and Tamenglong) of Manipur and covered 9 fishing villages (upper stretches) to collect fish catch data and fish landing.

Data on fish landings, catch structure, craft and gear were collected through personal observation and interaction with fishermen of Barak valley. The result showed that fishing gear such as gill nets, seine nets (shore seine, purse seines), hook and lines, bamboo traps and cast nets were commonly operated gears. Gill nets and seine nets are mostly used for fishing in the River. The peak fishing season in River Barak is during May-August months.

The total average monthly fish catch was estimated to be 125.0 kg in the study area with an average CPUE of 0.64 kg/fisher/day. During peak fishing season CPUE goes upto 1.82 kg/fisher/day. The total estimated fish catch of the river was 1,593 tonnes/yr.

A total of 66 fish species under 46 genus and 18 family were recorded from Barak River during the study. Fish catch dominated by Cyprinidae (36.93%) followed by Bagridae (10.77%), Sisoridae (7.70%), Nemacheilidae and Channidae (6.15%), Siluridae and Mastacembelidae (4.62%), Ailiidae, Clupeidae, Notopteridae, Schilbeidae (3.07%) and others

Fish diversity and catch composition of River Barak

(about 1%). *Tenualosa ilisha*, *Gudusia chapra* and *Eutropiichthys vacha* are the major species caught from the lower stretches of River Barak, while in upper stretches *Tor putitora*, *Neolissochilus hexagonolepis* and SIFs. Although fishing in Barak River provides livelihood to the fishers, the River is facing several threats such as illegal fishing (electric fishing, fish poisoning, etc.), anthropogenic activities.

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

Principal Investigator: R. K. Manna

Sub project 1: Aquatic biodiversity assessment and priority fish habitat identification in protected and less-explored inland water bodies (Bhitarkanika National Park, Jaldapara National Park, Panna National Park, major waterfalls region of Chhota Nagpur plateau

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

Project Code: REF/20-23/14

Duration: April 2020 - March 2023

Sub-Project 1:
Aquatic biodiversity assessment and priority fish habitat identification in protected and less-explored inland water bodies (BhitarkanikaNational Park, JaldaparaNational Park, Panna National Park, major waterfalls region of Chhota Nagpur plateau)

Scientific Personnel: R. K. Manna (Sub-Project Leader), D. Bhakta, Sangeetha M. Nair, D. N. Jha, A. Alam, J. Kumar (Study leave 05.03.22-07.11.22)

In 2022, survey was made at selected five stations in Panna National Park, Madhya Pradesh during August and five stations in Jaldapara National Park, West Bengal in September. Fishery exists in the Rivers and other water bodies in the fringe areas of both the National Park. Good fishery exists in River Ken passing through Panna National Park. Sampling was performed to understand ecology and fishery of the studied protected habitats.

Water quality of studied protected aquatic habitats

Turbidity

Water was turbid (129 NTU) at Madla station in River Ken during monsoon (August) survey in and around Panna National Park. In Jaldapara National Park, higher

Sampling at Pandav falls in Panna National Park

Plankton sampling at Rampura dam in Panna National Park

Dundhwa falls in Panna National Park

Highly turbid condition caused by run-off from dolomite mining at Holong River (5 No. Bridge)

turbidity (300-357 NTU) was observed during September in stations of Torsha River. Higher turbidity (364 NTU) in Holong River 5 no. bridge may be attributed to the impact of dolomite mining upstream of Holong River.

Specific conductance

In Panna National Park, higher conductance (236 µS/cm) and TDS (104 mg/l) were recorded in Hinota dam located beside diamond mining areas and hence can be considered as an impact of mining. In Jaldapara National Park, significantly higher conductance was recorded in Holong River (390-409 µS/cm) and Chirakhawa River (339 µS/cm) as compared to that of Torsha River (93.4-124.7 µS/cm).

Water pH

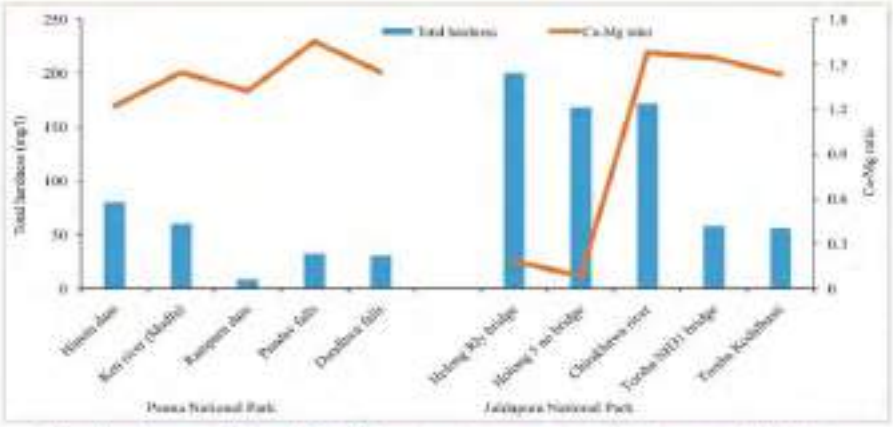
All the sampling stations observed alkaline pH (7.44 – 8.98), a congenial environment for fish. Slightly lower pH was recorded in Hinota dam at Panna National Park. Higher water pH (8.73-8.98) was recorded in Holong and Chirakhawa River, a possible impact of dolomite mining. Significantly higher total alkalinity in Holong and Chirakhawa River (156-188 mg/l) may also be attributed to the loading of surface run-off from dolomite mining areas.

Dissolved oxygen & BOD

All the stations of Panna National Park and Jaldapara National Park observed sufficient dissolved oxygen (>6 mg/l) except Hinota dam (4.0 mg/l) in Panna National Park. BOD was low at all the sampling stations in Jaldapara National Park whereas Hinota and Rampura dam in Panna National Park recorded higher BOD (3.6-4.4 mg/l).

Total hardness & Ca-Mg ratio

Total hardness was low (8-80 mg/l) at all the stations of Panna National Park, whereas significantly higher total hardness (168-200 mg/l) was



Total hardness (TH) and Ca-Mg ratio of water of studied protected habitats

recorded in Holong and Chirakhawa Rivers of Jaldapara National Park which might be due to surface run-off from dolomite mining areas located at upstream of those two Rivers. Ca-Mg ratio in water was recorded at 1.2-1.6 except at two stations of Holong River where it was 0.08-0.18.

Soil quality of selected protected habitat

Soil pH was alkaline at all the stations in Panna National Park and Jaldapara National Park with the highest value (8.33) in Ken River and lowest value in Pandav falls in Panna National Park. Organic carbon (%) was low (0.18-0.51%) except for significantly higher organic carbon (2.58%) at Pandav falls in Panna National Park. Accumulation of detritus from forest litter fall around Pandav falls may be attributed to the higher organic carbon at bottom sediment.

Plankton, periphyton and benthos diversity of Panna National Park

A total of 32 species of plankton were recorded from Panna National Park. Phytoplankton population consists of Chlorophyceae (28.45%), Bacillariophyceae (26.79%), Desmidacaea (18.43%), Cyanophyceae (11.43%) and Dinophyceae (1.75%). Zooplankton comprises of 11.38% of the total plankton population with an abundance of Naupli and *Brachionus* sp. The density of phytoplankton was found higher in Pandav falls (618 U/l) and lowest in Ken River at Madla (398 U/l).

Periphyton population consists of three varying classes, viz. Bacillariophyceae (46.86%), Chlorophyceae (16.14%) and Cyanophyceae (3.15%). The maximum density was found in Rampura dam (5163 no/cm^2) and minimum was found in Ken River at Madla (1453 no/cm^2). *Spirogyra* sp. (650 no/cm^2) from Pandav falls and *Navicula* sp. (591 no/cm^2) were the most dominant genera recorded from Panna National Park.

A total of 4 species of macrobenthic fauna belonging to four families were recorded from Ken River (Madla) and Hinota dam. The recorded species are *Filupaludina bengalensis*, *Indoplanor bisexutus* and *Parreysia caerulea* and *Gabbia* spp.

Plankton, periphyton and benthos diversity of Jaldapara National Park

The phytoplankton diversity study during September 2022 recorded 18 species with a contribution of 90 % of total plankton population. The zooplankton population comprises only naupli and rotifers which contributes 10 % of plankton population. The phytoplankton community was contributed maximum by Bacillariophyceae (84%) followed by Cyanophyceae (12.5 %) and Chlorophyceae (3.5%). During September 2022, the phytoplankton density was found highest in Chirakhawa river (597 U/L) and the least from Holong river (45 U/L). The phytoplankton composition consists of Bacillariophyceae (15 species), Cyanophyceae (1 species) and Chlorophyceae (2 species). The major species of phytoplankton are *Fragillaria* spp, *Nitschia* spp., *Pinnularia* spp., *Amphora* spp., *Caloneis* spp., *Cyclotella* sp. and *Diploneis* spp.

Bacillariophyceae is the major class contributing significantly to the total periphytic population among the studied sites. The maximum periphytic algal density was found in Chirakhawa river (1453 units/cm^2) where the minimum was found in Holong River (5 no Bridge). *Fragillaria* spp. was found abundant among the periphytic populations.

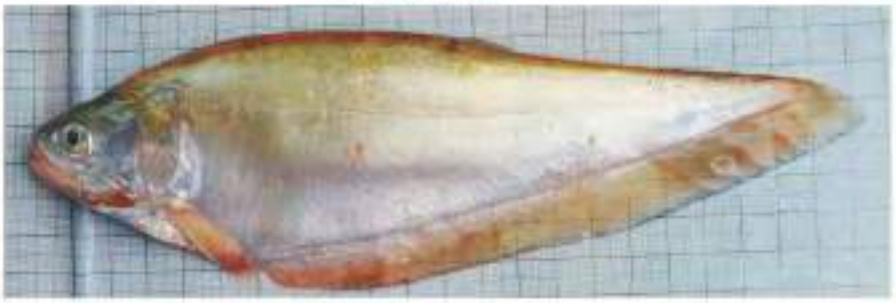
Thiara scabra

Brotia costula

Tarebia lineata

Dominant macrobenthic fauna collected from Chirakhawa River in Jaldapara National Park

Chitala chitala



Notopterus notopterus

IUCN Red Listed finfish species recorded in Panna NP during monsoon

The maximum diversity of benthos was recorded from Chirakhawa river with the dominance of *Tarebia lineata*. The other benthic fauna are *Indoplanorbis exustus, Physella acuta, Brotia costula, Gabbia* sp and *Mieniplotia scabra.*

Finfish diversity of Panna National Park

Monsoon sampling was done at five stations such as Hinauta dam, Madla and Ranguwan sites under Ken River, Rampura dam (Itwan Kalan) and Pandav falls inside Panna National Park for the fish diversity studies. During the survey, a total of 46 finfish species belonging to 09 orders, and 19 families were recorded from the Panna National Park complex. Order Cypriniformes was found to be the most dominant group (20 species) followed by Siluriformes (13 species), Beloniformes, and Anabantiformes (3 species each), etc. Family wise Cyprinidae was found to be the most species-diverse group (17 species), followed by Bagridae (5 species), Channidae, Danionidae, and Siluridae (3 species each), etc. As per IUCN Red List Status, 36 species fall under Least Concern (LC) category, 1 species as Near Threatened (NE), 3 species as Endangered (EN), 2 species as Vulnerable (VU), and 2 species as Data Deficient (DD), (Figure). Species *Bagarius bagarius, Chitala chitala,* and *Ompok bimaculatus,* were observed to be the Near Threatened (NT) species in the studied systems. *Tor putitora, Clarias magur,* and *Pangasianodon hypophthalmus* were the Endangered species. We could record 4 species of exotics from the water bodies under Panna National Park complexes such as *Cyprinus carpio, Oreochromis niloticus, Hypophthalmichthys nobilis* and *Pangasiodon hypophthalmus.*

Finfish diversity of Jaldapara National Park

During the monsoon survey, a total of 47 finfish species belonging to 08 orders, and 17 families were recorded from the Jaldapara National Park complex. Order Cypriniformes was found to be the most dominant group (27 species) followed by Siluriformes (7 species), Anabantiformes (5 species each), Synbranchiformes (3 species), etc. Family wise Cyprinidae was found to be the most species-diverse group (13 species), followed by Danionidae (9 species), Channidae, and Bagridae (3 species each), etc. As per IUCN Red List Status, 40 species fall under Least Concern (LC) category, 2 species as Near Threatened (NE), 2 species as Endangered (EN), 1 species as Vulnerable (VU), and 2 species as Data Deficient (DD). Species *Ompok pabo,* and *Ompok pabda,* were observed to be the NT species, *Hypselobarbus mussullah* and *Tor putitora* were the EN species, and *Cyprinion semiplotum* was the VU species.

Hypselobarbus mussullah

Cyprinion semiplotum

IUCN Red Listed finfish species recorded in Jaldapara NP

Doksa, a conical trap used by tribal fishers around Jaldapara National Park

Burung, a trap recorded at Kodalbasti area of Jaldapara National Park

ITKs recorded in studied protected habitat

In Jaldapara, locally made fishing traps like a conical trap (Doksa) and box trap (Burung) are observed to be used in low-lying areas.

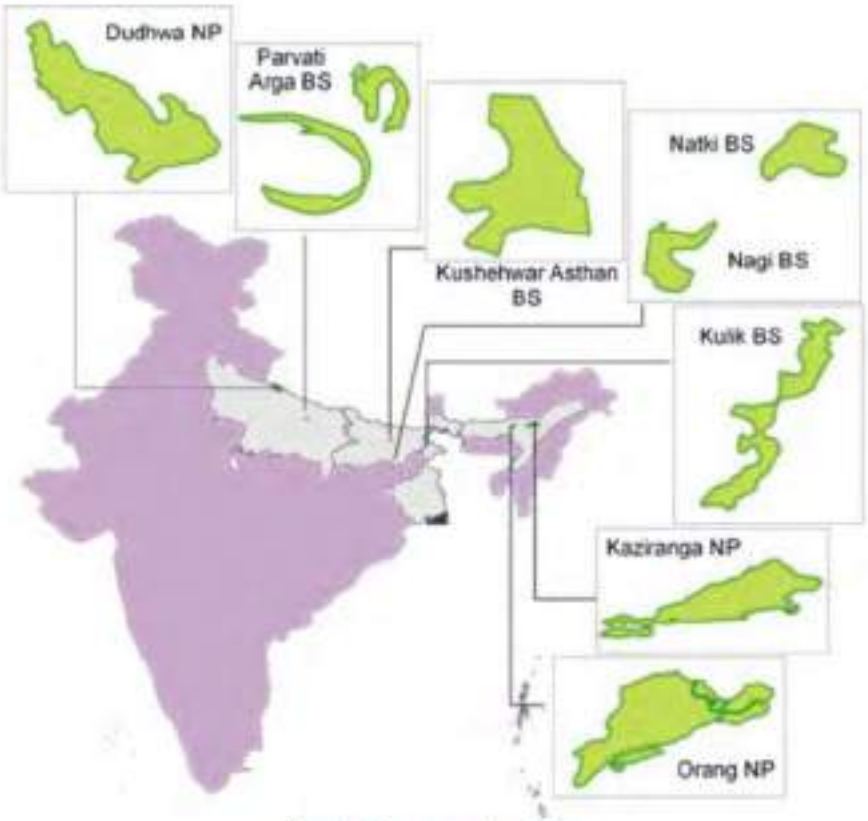
Sub project 2:
Assessment of fish diversity and identification of priority habitat in protected and less-explored inland water bodies of different eco-regions

Scientific Personnel: S. Kumari (Sub -Project Leader), Sajina A. M., B. K. Bhattacharjya, S. Bora, A. Alam, D. N. Jha, J. Kumar (till March 2022), N. S. Singh (upto 30.04.22)

Ecology and fish diversity of eight protected areas in four states was carried out to find the status of fish fauna under protected habitat and ecological services. Two sampling was done from each site during wet and dry season.

Water quality parameters of protected area

Water depth is highly variables for different protected habitats. Water depth of Nagi and Nakti bird sanctuaries are higher compared to Kushehwar Asthan and Kulik. Nagi BS and Nakti BS are constructed on Nagi river and Nakti River which provide permanent water storage throughout the year. Dissolved oxygen is recorded significantly higher in Nagi and Nakti than the other PA. Impact of bird nesting is highly noticeable by increase in total phosphate concentration during end of winter season. In Kusheshwar Asthan, water residential period is 6-7 months; water get almost dried up during the dry season (May to June). Salinity of water is increased 0.065 to 0.212 ppt from wet season (September) to dry season. Total dissolved solids (TDS) increased from 91.8 to 343 mg/l for the same period in Kusheshwar Asthan.



Protected area under study

Table : Eco-hydrological parameter of four protected area studied during wet and dry season

Water quality parameters	Nagi BS	Nakti BS	Kulik BS	Kusheshwar BS
Depth (cm)	1.5-10.4	1.9-7.9	1.43-1.57	0.33-350
Transparency (cm)	152-230	165-336	66-72	15-108
Water Temp (°C)	20.7-32.4	20.1-33.8	30.6-31.3	22.1-30.8
pH	7.07-9.17	7.26-8.5	7.2-7.43	6.72-7.91
Specific conductivity (µs/cm)	210-248	233-276	132.2-156.9	129.3-485
Dissolved Oxygen (mg/l)	7.2-8.8	5.2-8.1	4.5-5.1	5.1-7.6
Nitrate-N (mg/l)	0.23-0.33	0.13-0.36	0.21-191	0.1-0.53
Total Phosphorus (mg/l)	0.25-0.58	0.09-0.24	0.96-1.01	0.06-0.22
Net Primary productivity mg(C/m^3/hr)	51.96-68.35	41.54-56.34	4.16-6.42	28.97-79.65
Phytoplankton abundance (cells/l)	12300-118900	13080-95810	60-120	11560-47690
Zooplankton abundance (ind/l)	140-1945	390-1130	5-7	265-2270

Nagi and Nakti bird sanctuaries, Jamui district, Bihar

The twin bird sanctuaries, Nagi and Nakti, are two protected small reservoirs lying close to each other located in Jamui district of Bihar. It was declared as bird sanctuaries in 1984 and implemented in 2009. Fishing activities are not allowed in both the bird sanctuaries. Fish stocking were done occasionally for the purpose of feeding of migratory birds. The two sanctuaries have been the home of a wide variety of indigenous and migratory birds that turn up during the winters from distant places. Residential period for the birds is for 3-4 months (mid-November to mid-February). Water is used for irrigation purpose only for rest of the periods. Fish diversity is recorded under eight families consisting of 29 fish and 2 prawn species. Most dominant family was Cyprinidae (52%) followed by Ambassidae (14%), Channidae (10%), Trichogasteridae (7%), Mastacembelidae (7%), Cichlidae (4%), Cobitidae (3%) and Gobeidae (3%). Other than the stocked species, most native species were small sized (viz. *Chanda nama, Parambas sislala, Pseudambassis ranga, Macrognathus* spp., *Puntius* spp., *Pethia* spp., *Salmophasia* spp., *Amblypharyngodon* sp, *Rasbora* spp, *Aplocheilus* spp., etc.) fishes, and many of them have ornamental value.

Kulik Bird Sanctuary, West Bengal

Kulik Bird Sanctuary is located in Raigunj, Uttar Dinajpur district of West Bengal. The 1.3 km^2 completely protected bird sanctuary support roosting and nesting of around 1 lakh birds; the major 4 migratory species being Open bill storks, great white egrets, little cormorants, and night herons. There is a network of man-made canals within the Sanctuary, which is connected to River Kulik through sluice gates and these canals support the feeding of birds while they roost and nest on the tree tops in the Sanctuary. The canals are being stocked with fishes and apple snails to support the feed requirement of birds. The fish diversity within the canal system consists mainly of Tilapias (*O. niloticus* and *O. mossambicus*), *Amblypharyngodon mola, Puntius* spp., *Pethia* spp., *Notopterus notopterus, Catla catla, Labeo rohita, Wallago attu, Channa* spp., *Mystus* spp., etc. The fish diversity of connected rivers, River Kulik and River Nager were explored and 62 and 41 fish species were recorded respectively, though most of the fishes were small-sized and the fish catch from the river is meagre and do not form a commercially viable fishery.

Water sample collection at Kulik BS

'Dhol' trap to catch mostly prawns and spiny eels

Experimental fishing at Kulik BS

Fish catch from 'Dhol' trap of Kulik River

Channa punctata

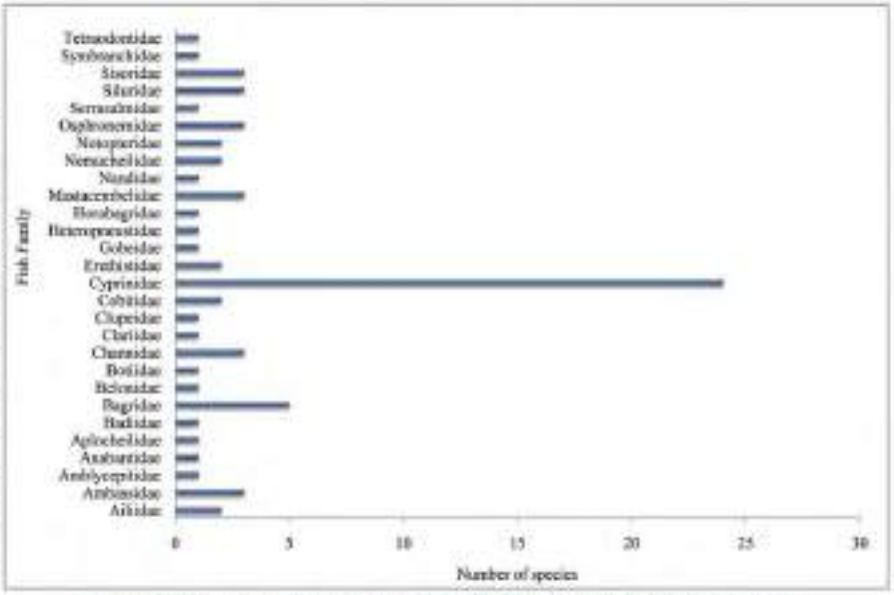
Wallago attu

Mastacembelus armatus

Most dominant fish species found in post monsoon (November) at Kusheshwar Asthan Bird sanctuary

Kusheshwar Asthan Bird Sanctuary

Kusheshwar Asthan *chaur*s under Kosi-Gandak basin has been highly significant from fisheries and biodiversity point of view and notified as a Bird Sanctuary by Govt. of Bihar in 1994 under Wild Life Protection Act, 1972. The chaur is rainfed wetland and monsoon run off with flow from a network of rivers like Kamala, Balan, Bagmati and Kareh are the prime source of water for the chaurs. This Bird sanctuary received very less migratory bird and is a highly vulnerable ecosystem. Water retention period is highly variable; totally depend on the river flow to these wetlands.



Fish diversity of wetlands of Kusheshwar Asthan Bird Sanctuary

In the study, a total of 72 fish species under 28 families, 2 prawn species and 2 crab species were recorded. The major large-sized fishes in the capture landings were *Wallago attu, Channa punctata, Mastacembelus armatus, Labeo catla, Labeo rohita, Cirrhinus mrigala, Systomus sarana* etc. Kusheshwar Asthan BS is highly vulnerable and anthropogenically threatened ecosystem. The cluster of wetlands faces serious threats from rising urbanization, agricultural expansion, and population explosion. Those are shrinking at an alarming rate without any proper regulatory framework and action plan to combat this environmental emergency. Proper assessment and monitoring of ecological, fisheries and other biodiversity components will provide us with insights into long-term ecological solutions and mitigating measures. A strong legal framework with enforceable rules for the regulation of wetland-related activities will be crucial for restoring the declining biodiversity especially of avifauna and fishery to their best forms and will support the sustainable livelihoods for the local population.

Parvati Arga Bird Sanctuary and Dudhwa Tiger Reserve, UP

Parvati Arga Bird Sanctuary is a permanent freshwater environment consisting of two oxbow lakes namely Arga and Parvati. Two wetlands Majihar and Jainagra were selected under Dudhwa National Park. A total of 51 fish species belonging to 35 genera, 20 families

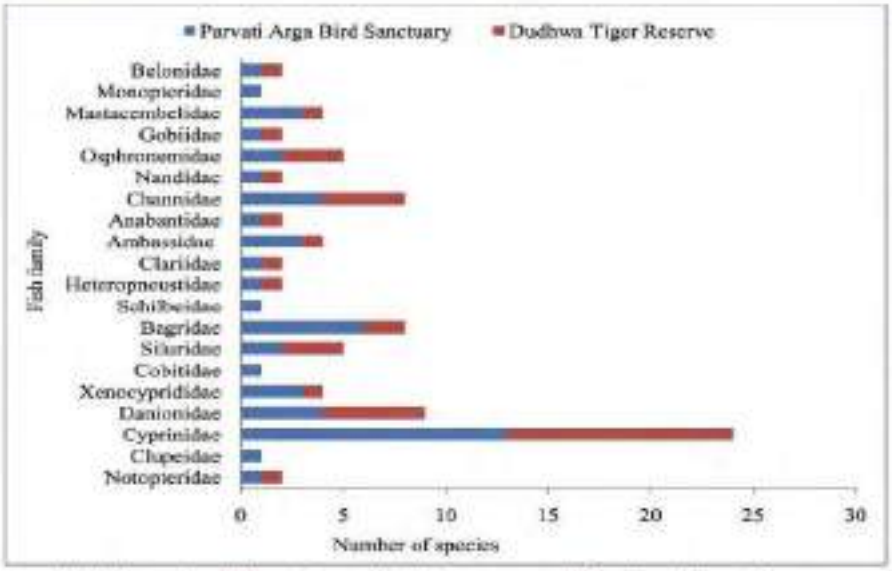
Water get dried up in summer and fishes hide in deep pools

Small indigenous fish drying during dry season

Alternate crop 'Maize' for five months

Table: Water quality parameters of Parvati Arga Bird Sanctuary and Dudhwa Tiger Reserve

Water quality parameters	Parvati Arga Bird Sanctuary	Dudhwa Tiger Reserve
Air Temperature (°C)	32.87	35.77
Water Temperature (°C)	29.57	29.79
Transparency (cm)	209.50	143.89
pH	8.20	8.24
Turbidity (NTU)	1.29	2.39
Chloride (ppm)	5.50	7.78
Dissolved Oxygen (mg/l)	8.47	8.89
Specific conductivity (µS/cm)	172.67	260.17
TDS (ppm)	91.0	121.72
Total hardness (ppm)	142.67	170.11
BOD (ppm)	1.3	2.66
COD (ppm)	92.31	58.88
Phosphate (µg/l)	BDL	BDL
Silicate (mg/l)	1.5	3.42
Dissolved organic matter (mg/l)	3.44	4.18
Total phosphorous (mg/l)	0.03	0.11
Total nitrogen (mg/l)	0.34	1.07



Fish diversity of Pavati Arga Bird Sanctuary and Dudhwa Tiger Reserve

and 9 orders were documented for the first time in the Parvati and Arga Bird Sanctuary and of these 5 are threatened, 1 Endangered (*Clariasmagur*), 3 Near Threatened (*Ompok bimaculatus*, *Hypophthalmichthys molitrix*, *Parambassis lala*) and 1 Vulnerable (*Wallago attu*).The family with highest number of species was Cyprinidae followed by Danionidae (5) and Channidae (4), etc. under

Some benthic fauna of Parvati Arga Bird Sanctuary A. *Aphylla*, B. *Lymnaea luteola*, C. *Branchiura sowerbyi* D. *Chironomous*

Parvati Arga Bird Sanctuary while 38 fish species belonging to 16 families were recorded from Dudhwa National Park.

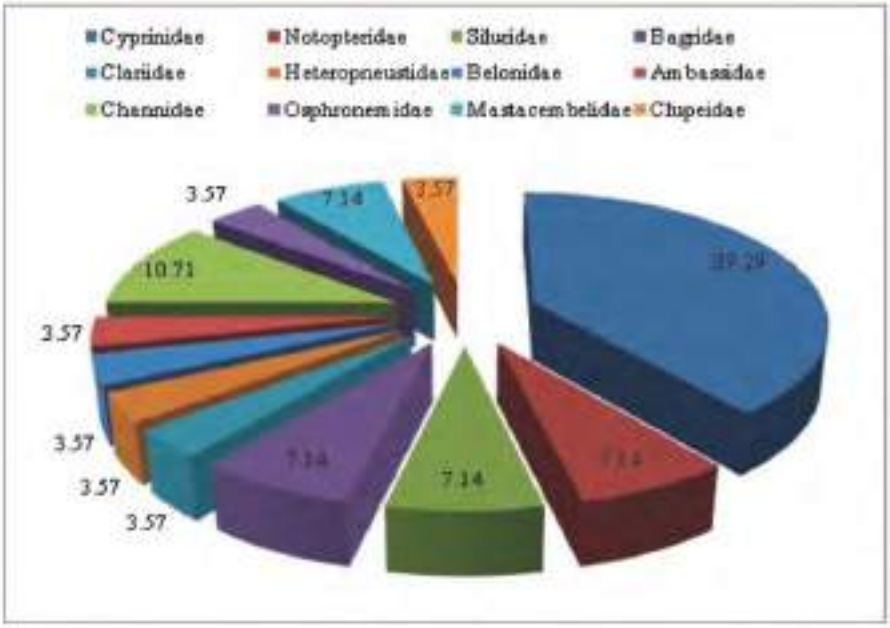
Report of Freshwater Jellyfish from Parvati Bird Sanctuary

A new report of *Craspedacusta sowerbii* (a freshwater jelly fish) was reported from the water body of Arga-Parvati bird sanctuary. The medusae of *Craspedacusta* genus was observed at the flooded tributary of Parvati waterbody. During survey to bird sanctuary in April 2022, the medusae were observed in large numbers. Medusae were collected from the upper 0.5 m of water surface.

Craspedacusta sowerbii, a freshwater Jelly fish recorded from Arga-Parvati bird sanctuary

Kaziranga National Park, Assam

Kaziranga National Park with an area of 430 kilometre^2 area is located in the edge of the Eastern Himalayan biodiversity hotspots in Golaghat and Nagaon districts of Assam. Declared as World Heritage Site by UNESCO in 1985, this National Park is the home to diverse flora and fauna. The



Fish diversity recorded in floodplain wetlands of Kaziranga National Park

National Park is also blessed with rich floodplain wetland resources, which harbours rich aquatic life including numerous indigenous fish species. During survey, a total of 28 indigenous fish species have been recorded from Mihibeel located in Kohora Range of the National Park. These 28 indigenous species belonged to 12 families under 7 orders. Percentage contribution of different families to total species diversity revealed that Cyprinidae is the most dominant family contributing 39.29% of the total number of species, followed by Channidae (10.71%). Study revealed that floodplain wetlands inside Kaziranga National Park are one of the major contributors to wild fish population.

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

Project Code: REF/20-23/15

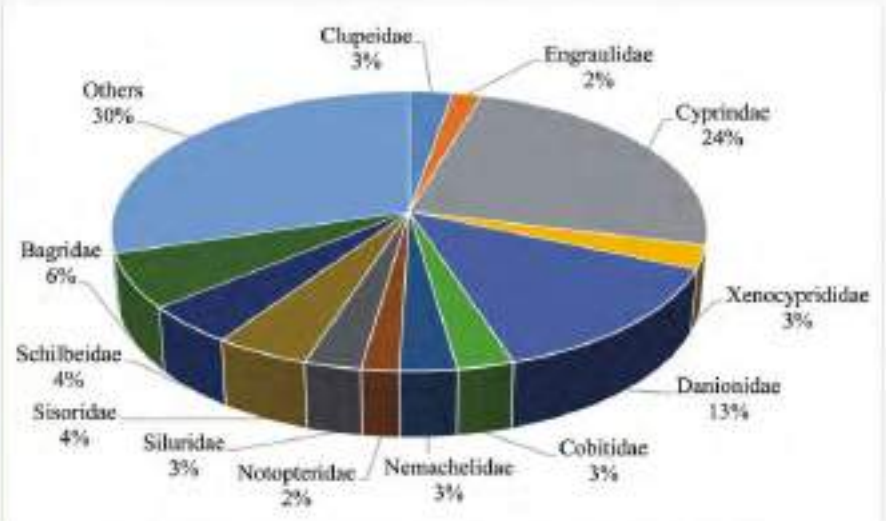
Duration: April 2020 - March 2024

Scientific Personnel: D. N. Jha (P.I.), A. Alam, J. Kumar (Study leave 05.03.22-07.11.22), V. R. Thakur, M. Gupta (upto 08.10.21)

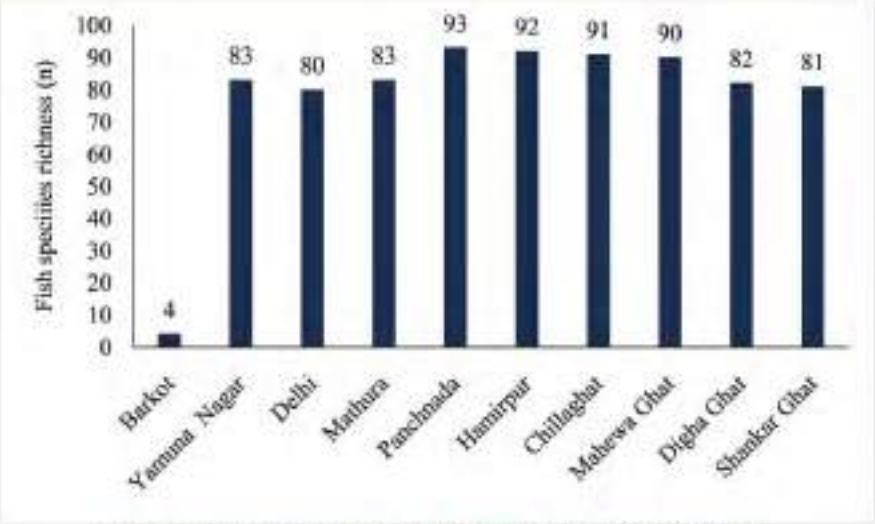
Fish Species Diversity

Fish diversity study in the river Yamuna recorded 111 fish species belonging to 13 orders, 32 families and 76 genera. Of these, 8 are exotics fish species viz. *Oreochromis niloticus*, *Cyprinus carpio*, *Clarias gariepinus*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Ctenopharyngodon idella*, *Pangasianodon hypophthalmus* and *Pterygoplichthys disjunctivus*. Two varieties of common carp were observed viz. *Cyprinus carpio var communis* and *Cyprinus carpio var specularis*. Fish species richness at Barkot, Yamunanagar, Delhi (Wazirabad), Mathura, Panchnada, Hamirpur, Chillaghat and Prayagraj (Mahewaghat) was 4, 83, 81, 83, 92, 91, 91 and 90, respectively . As per IUCN red list, out of the 111 species recorded from the river, 13 are threatened. One species, *Tor putitora* is endangered (EN), 4 vulnerable (*Naziritor chelynoides, Schizothorax richardsonii, Wallago attu and Cyprinus carpio*) and 8 Near threatened (*Anguilla bengalensis, Parambassis lala, Ompok bimaculatus, Ompok pabda, Ailia coila, Bagarius bagarius, Labeo pangusia*) requiring urgent attention for their conservation of germplasm and maintenance of their habitat.

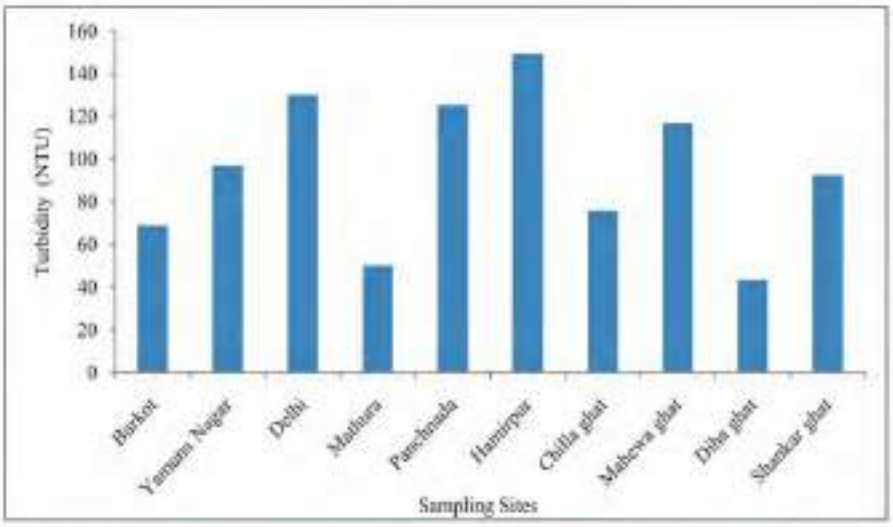
Zoo-geographically, the extant of freshwater fishes in the river Yamuna are mainly Gangetic and therefore tropical and sub-tropical with admixture of Himalayan and peninsular forms. Orders with highest number of families were Perciformes and Siluriformes. Cypriniformes was the dominant order represented by 51 species belonging to 5 families and 33 genera. Most species rich family was the Cyprinidae comprising 27 species followed by Danionidae (11 genera and 15 species), and Bagridae (3 genera and 7 species). *Pterygoplichthys disjunctivus*, and *Pangasianodon hypophthalmus* exotic catfish was documented at



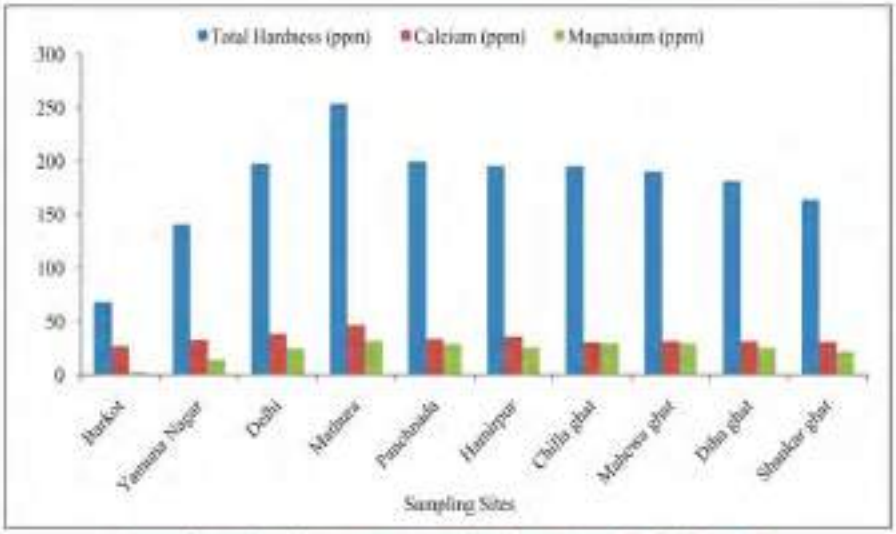
Family wise fish species richness along the different sites of river Yamuna



Fish species richness along the different sites of river Yamuna



Sampling site wise average turbidity (NTU) of water in the Yamuna River



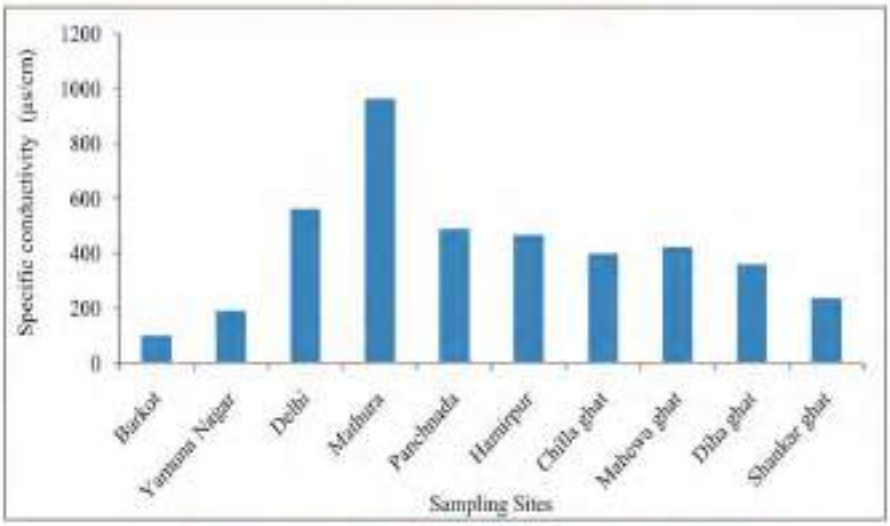
Sampling site wise average total hardness (mg/l), Ca^{++} (mg/l), Mg^{++} (mg/l) in the water of the Yamuna River

Panchnada and Delhi. *Pangasianodon hypophthalmus* was documented for the first time. Indian major carp fishery has considerably declined in the system while exotic especially *Cyprinus carpio* and *Oreochromis niloticus* are showing an increasing trend in the middle and downstream stretches. At Barkot, the fishery is dominated by *Schizothorax richardsonii* and *Naziritor chelynoides*. At Yamunanagar, *Labeo dyocheilus* and *L. dero* followed by *Wallago attu* were the dominant fish species in the landing. The contribution of the IMCs ranged between 30% and 85% and being maximum at Delhi followed by Mathura. *Tenualosa ilisha* and *Clarias magur*, an endangered fish has not been recorded from the entire stretch of the Yamuna River. Composition of miscellaneous group of fishes to the total fish catch was observed to vary from 45% to 60%. This clearly indicated that economically and biologically desirable species have given ways to low value species pointing towards eco-aberration of the river Yamuna.

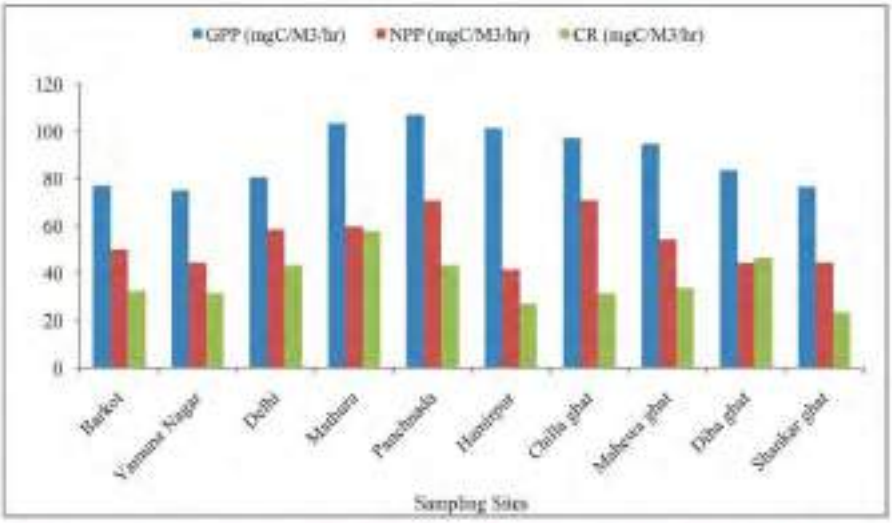
Physico-Chemical parameters of water

The average water temperature of all the sampling sites were ranged from 14.33 to 27.33 °C with minimum average temperature recorded at Barkot and maximum at Hamirpur. The slight variations were noticed in the temperature at Hamirpur, Chilla ghat, Mahewa ghat and Diha ghat. Average air temperature ranged from 19.47 to 33.27 °C. Minimum water temperature was recorded at Barkot station that is at higher altitude near to the origin and higher was recorded on plains of Hamirpur, Chilla ghat and Panchnada.

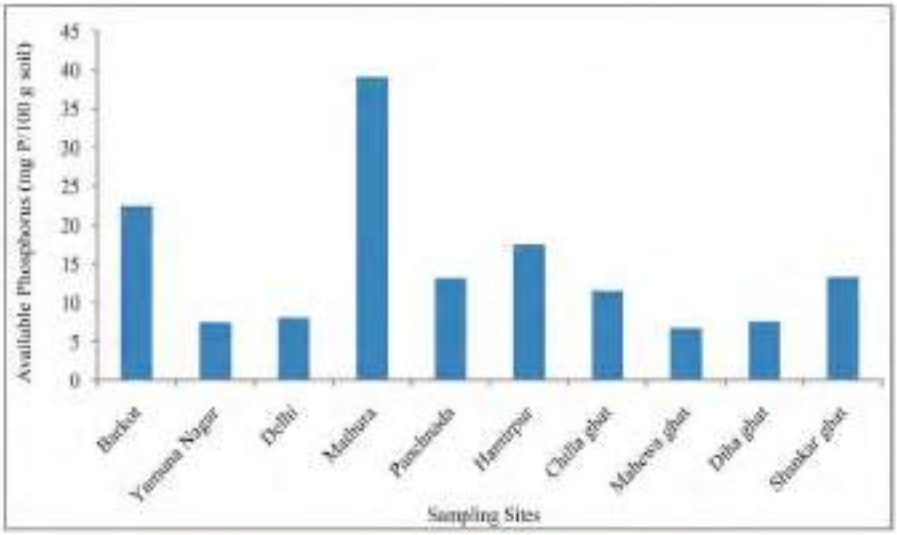
The flow of water was high in hilly region and showing decreasing rate in the plain area but water flow at slightly higher rate after joining Ganga River. The average rate of flow of water was maximum at Barkot and minimum at Mahewa ghat i.e before confluence with Ganga River.



Sampling site wise average specific conductivity(µs/cm) in the water of the Yamuna River



Sampling site wise average GPP, NPP and CR in the water of the Yamuna River



Sampling site wise available phosphorus (mg P/100 g soil) in the sediment of the Yamuna River

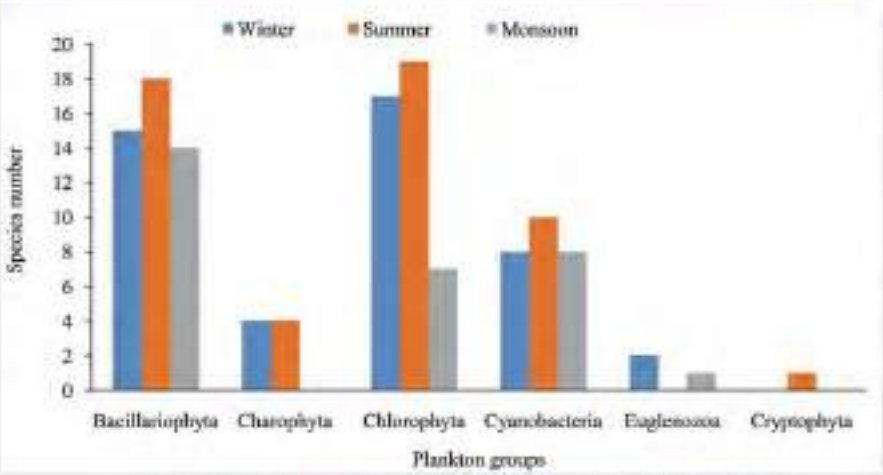
The average turbidity of water was observed maximum at Hamirpur and minimum at Diha ghat during the year.

Total hardness showed the increasing trend from Barkot to Mathura then it was showing a decreasing trend in the lower stretch of Yamuna River. Maximum average total hardness as well as calcium and magnesium ion were recorded at Mathura while they were lowest at Barkot. Calcium ion concentration was highest at Mathura i.e, 46.49 mg/l that may be because of lime areas found near the station.

The dissolved oxygen (D.O.) was highest at Barkot (8.67ppm) whereas the lowest was recorded at Mathura (3.72 ppm) in the Yamuna River, which may be because of high torrential water effects at a higher altitude at the upper stream, including Barkot station. D.O. in the Ganga River was recorded as 8.68 ppm at Shankar ghat (before Sangam) while it was 8.39 ppm at Diha ghat (after sangam). This indicates that Yamuna water has lower D.O. values in comparison to Ganga water in Prayagraj.

The biochemical oxygen demand (BOD) and dissolved organic matter (DOM) values were highest at Mathura (3.0 ppm and 3.8 ppm respectively) that may be due release of partially or untreated sewage discharge through drains in Mathura while they were minimum at Barkot .Total nitrogen was also highest at the same Mathura site. The reason for this was also the high macrophytes and TDS at Mathura site.

The highest transparency was recorded at Yamuna Nagar (39 cm) because of its pristine environment and low turbidity and higher water flow. The pH of all the sites was more than 8 i.e., in the alkaline range ranging from 8.01 to 8.47 with maximum at Shankar ghat.



Season wise average number of plankton in the Yamuna River

The specific conductivity was highest at Mathura (963.8 µs/cm) and lowest at Barkot (100.07 µs/cm) that showed the pristine environmental condition of Barkot and higher domestic and agricultural waste disposal at Mathura. Bicarbonate's ion was also highest recorded at Mathura (261 ppm)

The average value of Gross Primary Productivity (GPP) was higher in the middle stretch of the river. It was highest at Panchnada (106.95 mgC/M^3/hr) and lowest at Yamuna Nagar (75.00 mgC/M^3/hr), while average value of Net Primary Productivity (NPP) was also higher at pachnada and the lowest was at Hamirpur.

Physico-chemical parameters of sediment

Sand percentage at all sampling sites was more than 75% along the river Yamuna. The silt concentration was observed as highest at Panchnada (20.17%) followed by Chilla ghat (18.83 %) due to merging of the runoff from all other rivers that merge at these sites.

The free calcium carbonates were reported highest at Panchnada (15.33 %) while lowest at Diha ghat (4.5%) sampling site.The available average nitrogen was also highest at Panchnada site whereas the lowest was at Hamirpur. The available average phosphorous was reported highest at Mathura whereas the lowest was at the Yamuna nagar and Mahewa ghat.

Plankton and Periphyton

A total of 61 plankton species belonging to six phyla namely Bacillariophyta, Charophyta, Chlorophyta, Cyanobacteria, Euglenozoa and Cryptophyta were identified in three seasons (winter, summer and monsoon) in 2022 from river Yamuna at 10 sampling places. The highest species richness (52 no.) was recorded in the summer season followed by winter (46 sp.) and monsoon season (30 sp.), respectively. The lowest species richness was recorded in the monsoon season possibly due to precipitation and dilution of water. Bacilariophyta was the dominant phyla in the monsoon season only while Chlorophyta was dominant in the other two seasons. The lowest species richness was recorded in Yamuna Nagar during the winter season, Mathura during the summer season and Barkot during the monsoon season. The highest species were recorded in Shankarghat during the winter and summer seasons and Mathura during the monsoon season, respectively.

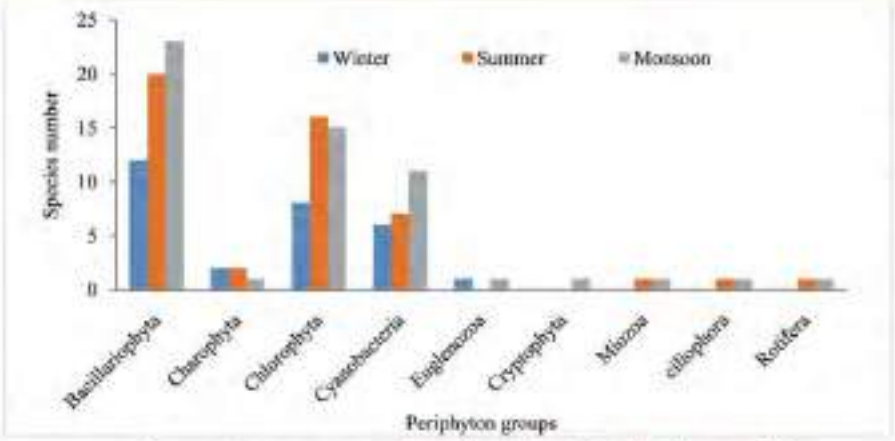
The range of density (no./l) was recorded from 28,800 to 7,08,000 during the sampling period of 2022. The lowest density was recorded during the winter season (73,000 no/l) and summer season (84,000 no./l) in Yamuna Nagar while Chilla ghat (28,800 no./l) in the monsoon season, respectively. The highest density was recorded in Panchnada (6,30,000 no/l) during the winter season, Shankarghat (7,08,000 no./l) during the summer season and Mathura (28,0000 no/l) during the monsoon season, respectively. The lowest density was recorded during the monsoon season while the highest density was recorded during the summer season.

Diversity Indices of Plankton

Shannon's diversity index of plankton ranged from 0.796 to 2.668 (Mathura) recorded during the sampling period of 2022. Shannon's diversity index ranged from 1.335 (Mahura) to 2.283 (Chillaghat) during the winter season, 0.796 (Mathura) to 2.252 (Chillaghat) during the summer season and 1.655 (Mahewaghat) to 2.668 (Mathura) during monsoon season, respectively. The lowest Shannon's diversity index was recorded at Mathura during the winter and summer seasons and at Mahewaghat during the monsoon season. The highest Shannon's diversity index was recorded at Chillaghat during the winter and summer seasons, and at Mathura during the monsoon season, respectively.

The Simpson's diversity index ranged from 0.4105 (Mathura) to 0.9215 (Panchnada) during the sampling period. Seasonal variation of Simpson's index was 0.585 (Mathura) to 0.853 (Chillaghat) during the winter season, 0.4105 (Mathura) to 0.8517 (Chillaghat) during the summer season and 0.7773 (Mahevaghat) to 0.9215 (Panchnada) during monsoon season. The highest value of both diversity indices was recorded at Chillaghat and the lowest value was recorded at Mathura during the winter and summer seasons.

A total of 72 periphyton species belonging to nine phyla namely Bacillariphyta, Charophyta, Chlorophyta, Cyanobacteria, Cryptophyta, Miozoa, Ciliophora and Rotifera were identified during the sampling period of 2022 from



Season wise average number of periphyton in the Yamuna River

river Yamuna. The highest species richness was recorded in the monsoon season (55 sp.) followed by winter (48 sp.) and summer season (29 sp.), respectively. The lowest species richness was recorded during the summer season while the highest species richness was recorded during the monsoon season. Based on spatial variation, the species richness ranged from 9 (Cillaghat) to 26 (Panchnada). The species richness ranged from 14 (Barkot) to 22 (Shankarghat) during the winter season, 12 (Mahevaghat) to 21 (Panchnada) during the summer season and 9 (Chillaghat) to 26 (Panchnada) during the monsoon season, respectively.

The density (no./cm^2) ranged from 23600 (Mahewaghat) to 7,78,600 (Barkot) during the sampling period. The density ranged from 61,000 (Mahewaghat) to 2,57,400 (Barkot) during the winter 36,200 (Delhi) to 7,78,600 (Barkot) during summer season and 23,600 (Mahewaghat) to 1,02,800 (Hamirpur) during the monsoon season.

Diversity indices of Periphyton

The Shannon's diversity index for periphyton in river Yamuna ranged from 0.99 (Shankarghat) to 2.86 (Mathura) during the sampling period. The Shannon diversity ranged from 2.379 (Barot) to 2.86 (Mathura) during the winter season, 0.99 (Shankarghat) to 2.576 (Barkot) during the summer season and 1.489 (Barkot) to 2.653 (Delhi) during monsoon season, respectively. The lowest Shannon diversity index was recorded at Barkot during the winter and monsoon seasons while at Shakarghat during the summer season. The highest Shanon diversity index was recorded at Mathura during the winter season, at Barkot during the summer season and at Delhi during the monsoon season, respectively.

The Simpson's diversity index ranged from 0.3735 (Shakarghat) to 0.9375 (Mathura) during the sampling period. The Simpson diversity ranged from 0.8905 (Barkot) to 0.9375 (Mathura) during the winter season, 0.3735 (Shankarghat) to 0.9089 (Barkot) and 0.6303 (Barkot) to 0.9115 (Delhi) during monsoon seasons, respectively. The lowest Simpson diversity index was recorded at Barkot during the winter and monsoon seasons and at Skankarghat during the summer season. The highest Simpson's diversity index was recorded at Mathura during the winter season, at Barkot during the summer season and at Delhi during the monsoon season, respectively.

Season wise chlorophyll-a in the Yamuna River

Chlorophyll-a

The chlorophyll-a (mg/m^3)ranged from 1.068 to 98.23 during winter, 1.068 to 119.61 during summer and 0 to 12.81 during monsoon season, respectively. The lowest chlorophyll-a value was recorded at Barkot in all seasons while the highest chlorophyll-a value was recorded at Shankarghat during the winter and summer seasons and Mathura during the monsoon season, respectively.

Diversity of Macrobenthos

A total of 16 species of macrobenthos species (Mollusc 06, Bivalves 04 and Insects-06) belonging to nine order and 13 Family were documented from the selected sites of river Yamuna covering whole stretch of river for the first time. The benthos varied from 50-210 N/m^2, 60-810 N/m^2 and 10-110 N/m^2 during winter, summer and monsoon respectively. The *Chironomous* was observed at almost all sites downstream indicating organic pollution. The only freshwater sinistral gastropods i.e *Physaacuata* were found in Wazirabad site which prefer polluted water and indicator of inorganic pollution. The insect component was dominant in upstream of river Yamuna at Barkot site (*Rhyacophila sp., Agabus spetc*) which favours clear, cold and fast running water of streams and found associated with bottom sediments. In the downstream Gastropods such as *Filupaludina bengalensis* and bivalves *Corbicula striatella*were dominant during summer and monsoon period respectively.

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

Project Code: REF/20-23/16

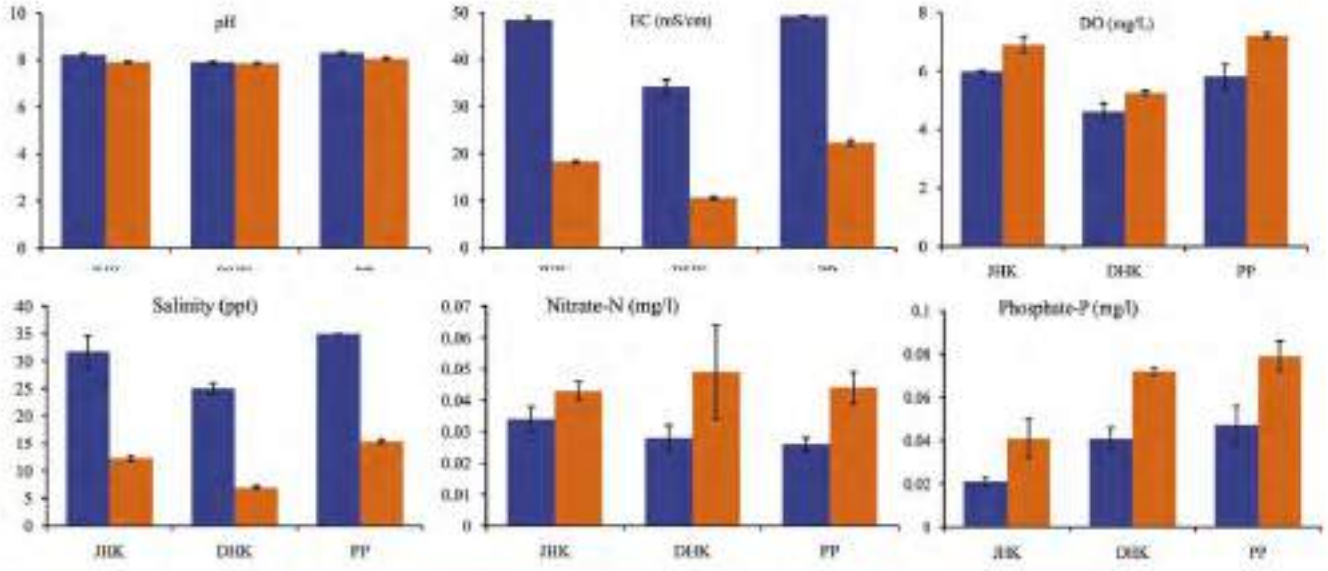
Duration: April 2020 - March 2023

Scientific Personnel: B. K. Das (P.I, w.e.f. 01.04.22), S. Dam Roy (P.I, upto 31.03.2022), Roshith C.M. (Study leave 07.04.22-09.11.22), L. Kumar (upto 08.12.22), T. N. Chanu(upto 31.03.22), H. Chowdhury (upto 31.3.2021) A. Saha (w.e.f. 01.04.22), P. J. Majhi (w.e.f. 01.04.22), P. Gogoi (w.e.f. 01.04.22)

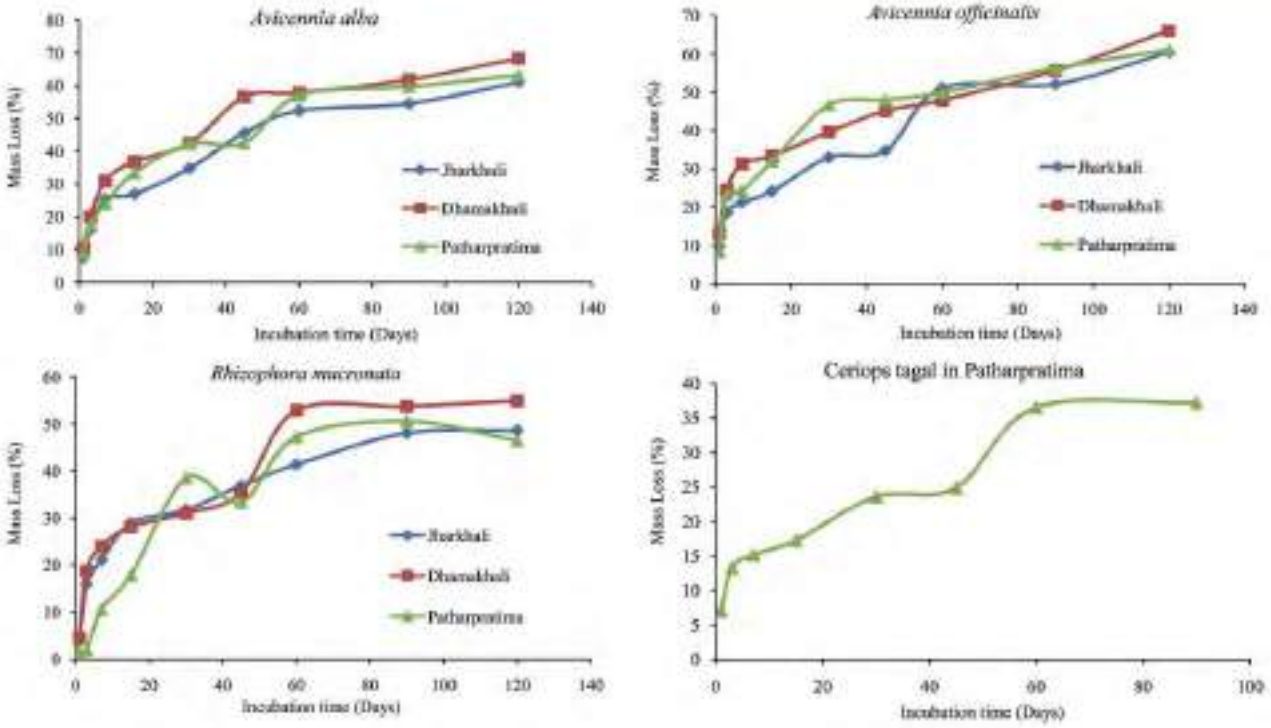
Surveys were conducted in pre-monsoon (May, 2021) and monsoon (September, 2022) season at Jharkhali, Dhamakhali and Patharpratima stations of Indian Sundarbans ecoregion on environmental parameters, mangroves and other biota. Basic environmental parameters are given below to understand the characteristics and the potentials of mangrove leaf litter in supplying organic carbon and nutrients to the coastal waters, major mangrove species (*Avicennia officinalis*, *Avicennia alba*, and *Rhizophora mucronata*) form different mangrove ecosystem (Jharkhali, Dhamakhali and Patharpratima) of Indian Sundarbans (*Ceriops tagal* only from Patharpratima), West Bengal, India, were examined in controlled environmental conditions. This was to determine the possible species-specific and habitat based differences during the decomposition of mangrove leaf litter through 120 day laboratory leaching process. Leaf mass decreased in all four species. Dry mass loss at the end of incubation study was 61.1-68.4% of initial dry mass in *A. alba*, 60.5-66.1% in *A. officinalis*, 46.5-54.9% in *R. mucronata* and 39% for *C. tagal*. Habitat water quality has role on decomposition of mangrove leaf litter, as Dhamakhali water showed slightly higher decompositions which may be due to low water salinity.

Incubated water analysis indicates the significant increase of electrical conductivity (EC) in the leachate which may be due to the rapid leaching of water soluble inorganic and organic substances. Whereas, pH of the leached water was slightly lower . The decomposition rates for *Avicennia* sp. were much higher than those of the other two species. The amounts of bioavailable nutrients dissolved in the water were also measured. Although minimal increase in Nitrate-N content was observed in water phase, for the dissolved Phosphate-P, all litter types showed increased concentration. This is because N is largely stored in the non-soluble organic form notably proteins in leaves while P is in the form of Phosphate-P. Inter-specific variations were observed for leachable fractions of nutrients and they appeared to be in proportional relation with % of mass loss.

A total of sixty-six species of phytoplankton were recorded from the studied stations with the higher density at Patharpratima (4,449±2,046 u/l). Species richness exhibited higher (44 species overall dominated by diatoms) in Patharpratima especially in the mangrove stands of *A. marina*. While comparing the plankton population at Jharkhali and Dhamakhali, revealed that a total of 54 species were recorded. The samples collected from the mangrove stands of *Avicenia marina/Aegicerops* sp., and *Ceriops tagal*, revealed that all were dominated by Bacillariophyceae. However, the Cyanophyceae community also contributed significantly from *Ceriops tagal*



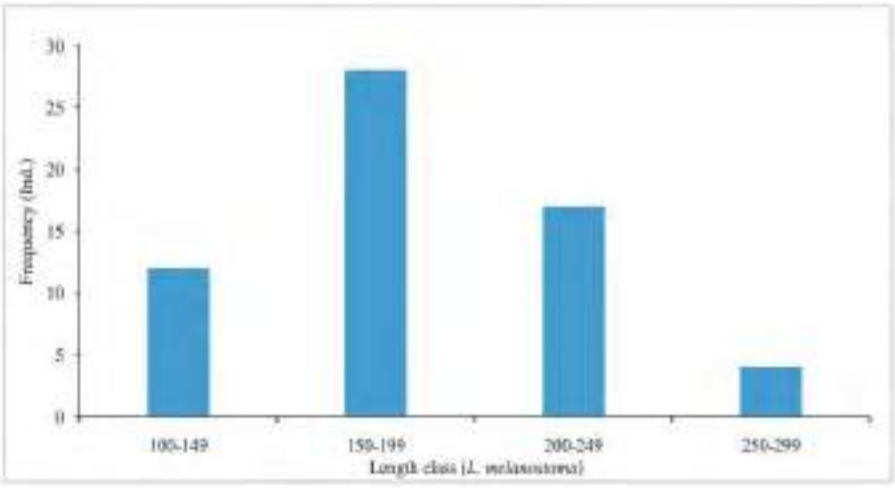
Variation in water quality parameters in selected stations of Indian Sundarbans; JHK:Jharkhali, DHK: Dhamakhali, PP: Patharpratima



Mangrove leaf litter mass loss (in 120 days) from the incubation experiments

mangrove stands. Overall, the quantitative abundance of phytoplankton ranged between (3,746 to 12,244 u/l). The major percentage contributors of zooplankton were Copepoda (42%), copepod nauplii (27%), rotifera (13%), cladocera (10%), mysids (7%). Small-bodied copepods *viz. Oithona* sp. and *Bestiolina similis* ranked their maximum abundance of the total Copepoda population. Altogether, holoplankters contributed maximally to the range between 42-65%, and meroplankters 35-58% of the total zooplankton population.

The relationship between the gastropods (*Littoraria melanostoma, L. scabra, Nerita articulata*) and the selected mangrove species (*A. marina, A. alba, C. tagal and Aegiceras corniculatum*) was investigated at Patharpratima and Frazerganj station. The attachment/ association of the species *L. melanostoma* with mangrove species *A. marina* (9 - 65 nos./tree) was found to be maximum at both the sites and their attachment was recorded at a maximum climbing height of 1.67 m. However, a lower abundance (2 – 8 nos./ tree) of *Nerita articulate* was observed at a height of <1.0 m, regardless of the species-specific association of mangrove species. The highest *L. melanostoma* distribution (frequency) was for the length group 150 – 159 mm followed by 200 – 249 mm, while *N. articulata* was for the length group 249 – 300 mm. The species-specific interactions of *L. melanostoma* with the mangrove species *A. marina*/ *A. alba* can be correlated to living on a dry substrate surface (climbing on the leaf, tree trunk) above the high tide line. Overall, mangrove associated macrobenthic abundance ranged between 26 – 68 ind./m^2 with dominated by *Pirenella cingulate*.



Distribution of *L. melanostoma*

The seasonal assessment of Juvenile fish assemblage collected from the mixed mangrove stands was also performed. In total, 35 juvenile fish species belonging to 22 families were recorded with dominated by Order Perciformes (15%). The species

L. melanostoma attached in leaves

L.melanostoma in tree trunk

richness was maximum in the monsoon season (35 species) followed by the pre-monsoon (22 juvenile fish species). Overall, maximum dominance was for *Oryzias dancena* accounted for 15.22% followed by *Anodonto stomachacunda* (12.18%) and *Mystus gulio* (5.58%). The length range of *O. dancena*, *Anodontostoma chacunda* and *Mystus gulio* varied from 8.86 to 18.57 mm, 8.70 to 10.51 cm. and 9.3 cm to 14.5 cm, respectively. The pattern of seasonal juvenile fish abundance showed subtle variation with a maximum contribution from *Planiliza tade* (10%) where the length range recorded between 14.5 cm and 18.98 cm in the monsoon season. In pre-monsoon, *O. dancena* (27.52%) made the highest contribution followed by *Anodonto stomachacunda* (20.18%). Station Patharpratima exhibited maximum diversity (H= 3.46) as compared to Jharkhali (H=2.41) and Dhamakhali (H= 1.61).

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: April 2020 - March 2024

Principal Investigator: U. K. Sarkar (upto 19.10.22), A. K. Das (since 20.10.22)

Sub-project 1: Understanding spatio-temporal variations of large reservoir ecosystems (Hirakud, Panam & Idukki) and developing improved fisheries management strategies

Sub-project 2: Development of ecosystem-based fisheries management strategies for medium reservoirs (Kodar, Upper Manair, Poondi, Serlui B) in different eco-regions

Sub-project 3: Refinement of culture based fisheries for small reservoirs (Gayatri, Beko, Upper Khaguria & Sunei) in different ecoregions

Sub-project 4: Tropho-dynamic modeling of reservoirs for ecosystem-based fisheries management

Sub-project 1: Understanding spatio-temporal variations of large reservoir ecosystems (Hirakud, Panam & Idukki) and developing improved fisheries management strategies

Scientific Personnel: A. K. Das (Sub-project Leader), C. Johnson (upto 31.03.22), D. Sudheesan, T. T. Paul, A. Meetei (upto 31.03.22), Vaisakh G., S. K. Koushlesh (w.e.f. 01.04.22)

Hirakud reservoir, Sambalpur district, Odisha

Hirakud reservoir (21°30' & 21°50' N, and 83°30' & 84° 05' E) with a water spread area of 71,963 ha (FRL) and productive area 54,076 ha is being utilized for fisheries enhancement through cage culture. The sampling was carried out at five sampling points namely, Jarimuli (Tamdei), Birenbandh, Kurla, Mahamadpur and Zeropoint (Dhorrakusum) in monsoon season.

Limnology and fisheries

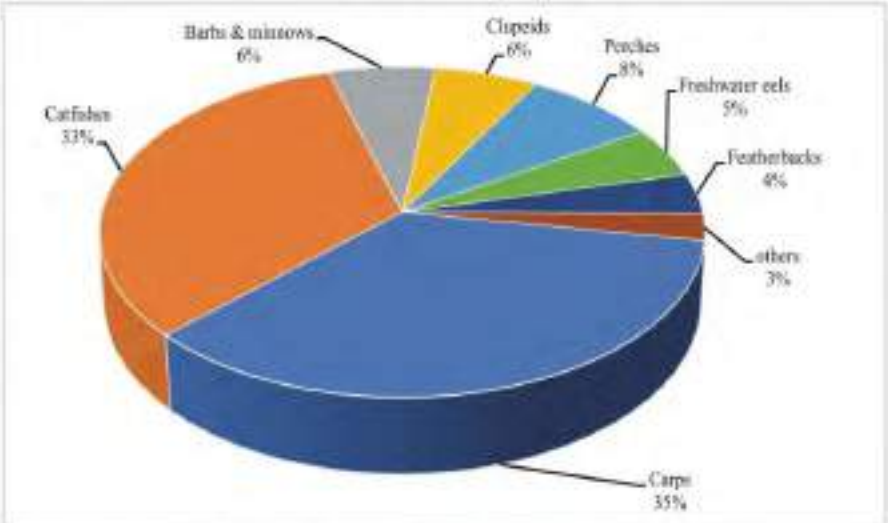
The transparency of reservoir water measured via Sechhi depth ranged from 21.0-169.0 cm, pH ranged from 7.2 – 8.3 with an average of 7.9, which is slightly alkaline. The average DO value was found to be 7.07 mg/l, average total alkalinity was 70.9 mg/l, average specific conductivity was 202.42 µs/cm and total dissolved solids (TDS) was 142 mg/l. The average nutrient contents nitrate-N and total phosphorus were found to be 0.01 and 0.0418 mg/l respectively indicating moderate productivity of the reservoir. The gross primary productivity of Hirakud reservoir was estimated at 145.6 mgC/m^3/hr while the net primary productivity was 83.2 mgC/m^3/hr. Dominance of Cyanophyceae was observed in the reservoir during post-monsoon season.

The CPUE ranged from 1.5 – 19.4 kg/day/fisher for gill net fishing while it was 100-150 kg/day for drag nets. Hooks and lines were also operated especially in the lotic zone of the reservoir with variable CPUE. Catfishes contributed around 33% of the fish catches while carps including IMC contributed to the tune of 35% of the fish catch of Hirakud reservoir during monsoon. A total of 68 fish species under 18 families and 8 orders were recorded from the commercial catches in Hirakud reservoir. Indigenous species include carps, catfishes, freshwater eels, etc. *Oreochromis niloticus, Clarias gariepinus, Pangasianodon hypophthalmus, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis, Cyprinus carpio* and *Pterygoplichthys disjunctivus* were exotics recorded from reservoir.

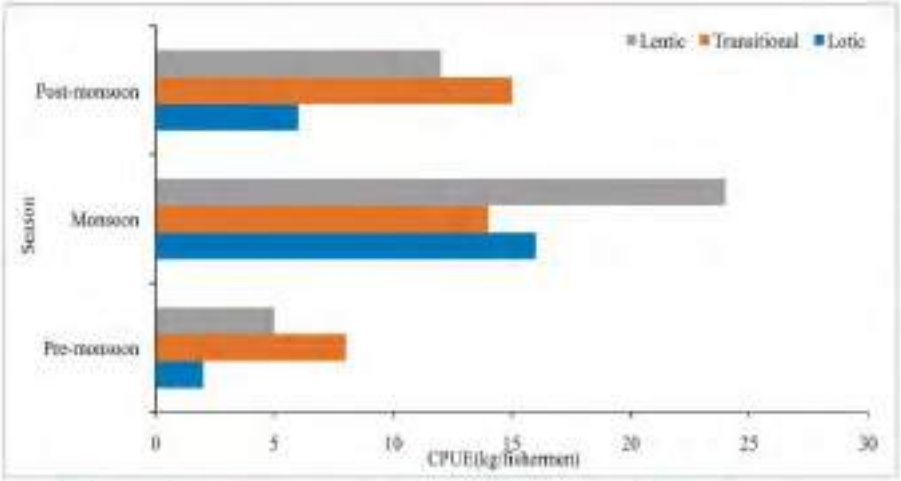
Panam reservoir, Panchmahal district, Gujarat

Salient features of the reservoir

Panam dam is constructed in the year 1971 over the Panam River (Tributary of Mahi River) in the Mahi



Fish catch composition of Hirakud reservoir



Mean CPUE (gillnet) recorded from different zones of Panam reservoir

River basin. The reservoir is located at the geographical coordinates 23.053 N; 73.716 E in village Kel Dezar; Taluka: Shahera; District: Panchmahal in the state of Gujarat. The reservoir is spread over a catchment of 2314.46 km^2 and its area at FRL is 8,980 ha.

Ecology and fisheries

The shoreline development index of Panam reservoir is on higher side in comparison to other major reservoirs of country, which indicate a more irregular shoreline. Water temperature of the reservoir ranges from 24-29°C during the pre-monsoon season and 28-31°C during the monsoon season. High shoreline index and low mean depth (<18 m) could be considered as augmenting features in reservoir productivity. About 25 fish species were documented from different zones of Panam reservoir during the study period. *Sperata seenghala*, *Cirrhinus mrigala*, *Labeo rohita*, *Systomus sarana* and *Cirrhinus reba* were reported as the major catch from the reservoir. Among SIFs catch group *Corica soborna*, *Osteobrama cotio*, *Parambassis ranga* and *Amblypharyngodon mola* were recorded as dominant in the seine nets operated at the lacustrine zone of reservoir. The mean CPUE shows spatial and seasonal difference in the reservoir, with highest value recorded during the monsoon season. The CPUE of the bag net fishery ranged from 10-50 kg/fishermen and was observed mainly during the pre-monsoon. The plankton community mainly comprised of 24 phytoplankton genera under nine classes while four genera were found dominant among zooplankton community. Bacillariophyceae was identified as most diverse with six genera followed by Cyanophyceae (four genera) and Dinophyceae (three genera).

Idukki reservoir, Idukki district, Kerala

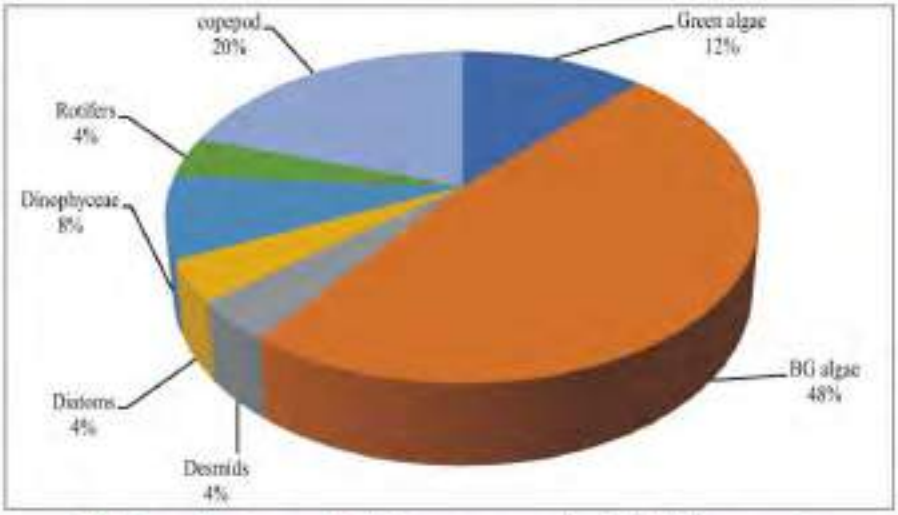
Salient features of Idukki reservoir

The Idukki reservoir (9.839°N, 76.973°E) is situated in Idukki district, Kerala having a catchment area of 64 km^2 with a mean water depth of 32m and a morphoedaphic index of 0.262. The indices based on morphometric indicated the suitability of reservoir for fishery enhancement using cage and pen culture system.

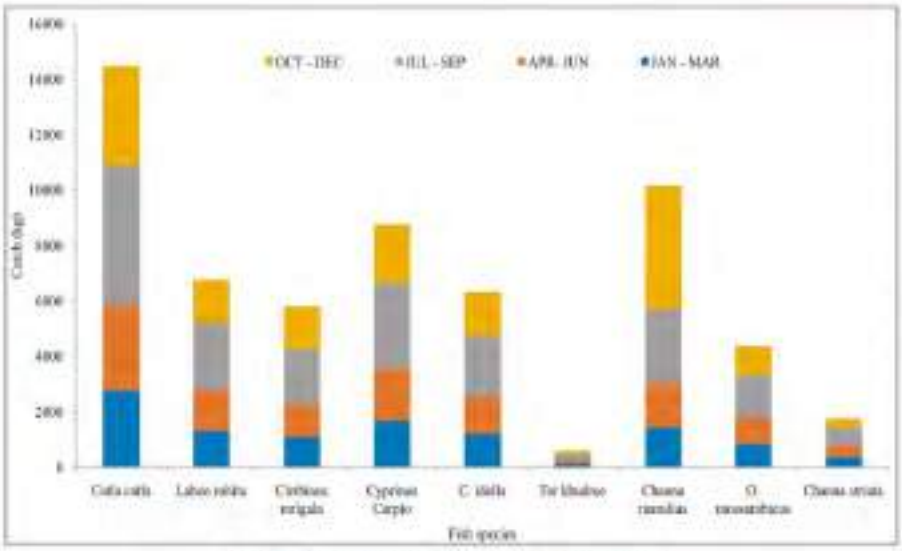
Ecology and fisheries

The mean water depth in the reservoir is high (32 m), pH ranged from 6.9 – 8.1, which is near neutral to slightly alkaline. The average DO value was found to be ranging from 7.8-8.7 mg/l, average total alkalinity was very low 0.6-1.1 mg/l, average specific conductivity was 40.3-71.8 µs/cm and total hardness (TDS) was 16-36 mg/l indicating low productivity of the reservoir. The gross productivity of Idukki reservoir was estimated at 37.2mgC/m^3/hr which indicates scope for culture-based fishery enhancement programmes. Further, the trophic estimates of 41.93 of Idukki reservoir indicates oligotrophic water body further substantiating the relevance of fishery enhancement activities in the reservoir.

A total of 13 species, belonging to 13 genera were found in the plankton groups. Average algal count recorded was 500 nos./l from 6 (six) sampling stations across Idukki reservoir. Out of the five algal groups, blue green algae (48%) were dominant in terms of abundance. During pre-monsoon season, blue green algae were found to be the dominant group (160 nos./l)



Relative abundance of plankton community in Idukki reservoir



Fish catch composition in Idukki reservoir

which constituted 57.14% of the total plankton. Zooplankton was dominant to the tune of 33.3% during monsoon.

Eighteen fish species belonging to 9 families were recorded from the reservoir. Indigenous fish species of the reservoir include *Ompok bimaculatus, O. malabaricus, Channa marulius, Tor* spp., *Mastacembelus armatus, Heteropneustes fossilis, Mystus* spp., *Anabas testudineus, Barilius bakeri, Garra mullya, Pethia punctata, Mesonoemacheilus triangularis, Etroplus maculatus* etc. Exotics recorded from the reservoir were *Cyprinus carpio, Ctenopharyngodon idella* and *Oreochromis mossambicus*.

Catla catla contributed maximum (24.5%) to the total annual catch from Idukki reservoir, followed by *Channa marulius* (17.2%), *Cyprinus carpio* (14.9%), *Labeo rohita* (11.5%) and *Ctenopharyngodon idella* (10.7). The maximum catch was recorded during July-September months.

Gill nets were recorded as the most popular fishing gear among the native fishers. *Labeo catla, Labeo rohita, Cyprinus carpio, Channa marulius, Ctenopharyngodon idella* are the major fish species caught in gill nets. Hook and line are occasionally used by the fishers. Among crafts three types of fishing crafts are used by the fishermen - bamboo raft, canoe, and plank-built boat. Bamboo raft is 15 feet long and manned by a single person. Canoe of size 18 ft x 1.5 ft is operated by 1 person and that of 18 ft x 2 ft size is operated by 2-3 persons. Plank built boat used for fishing has a size of 21 ft x 2.5 ft.

Sub-project 2:
Development of ecosystem based fisheries management strategies for medium reservoirs (Kodar, Upper Manair, Poondi & Serlui B) in different eco-regions

Scientific Personnel: M. A. Hassan (Sub-Project Leader upto 31.03.22), Sajina A. M. (Sub-Project Leader w.e.f. 01.04.22), M. Karthikeyan, P. Panikkar, D. Debnath, S.C.S. Das, Ramya V. L., S. K. Koushlesh, A. Saha, Jesna P. K. (w.e.f. 01.04.22)

Three medium reservoirs, viz. Kodar reservoir of Chhattisgarh, Poondi of Tamil Nadu and Serlui-B of Mizoram, were studied with an objective to develop eco-region-specific fisheries management strategies.

Primary productivity and Trophic status

Gross primary productivity (GPP) of Poondi reservoir was 140.62 mgC/m^3/hr and the net primary productivity (NPP) was 37.5 mgC/m^3/hr. Total fish catch of the reservoir was 139.48 kg/ha/yr and the fish production gap was estimated as 43.38 kg/ha/yr during 2021-22. The GPP calculated for Serlui-B was 45 mgC/m^3/hr., The production potential of the reservoir was estimated to be 118.26 kg/ha/yr. The average GPP & NPP of Kodar reservoir was found to be ranging from 93.75 to 156.25 mgC/m^3 and 41.66 to 83.33 mgC/m^3/hr respectively. Based on Trophic state index (TSI) Poondi reservoir is can be categorized as oligotrophic whereas Kodar reservoir varied from Oligotrophic to mesotrophic state.

Plankton and Macrophytes diversity

The phytoplankton community of Poondi reservoir was dominated by Oscillatoria and Merismopedia genera and the zooplankton was dominated by the rotifer, *Brachionus* spp. A total of 38 phytoplankton and 11 zooplankton genera were recorded from this reservoir. Macrophytes were present at all the zones of the reservoir, with dominance in riverine zone. A total of 12 species of macrophytes were identified from Poondi reservoir.

Chlorophyceae (42-44%) dominated the plankton community in Serlui-B reservoir followed by Bacillariophyceae (20-24%), Cyanophyceae (16-19%), Euglenophyceae (9-13%) and Zygnematophyceae (6-8%). Total plankton population ranged from 757-1500 units per litre. Commonly observed plankton genera were *Chlorella, Microcystis, Ankistrodesmus, Navicula, Diatoma, Scenedesmus, Euglena, Melosira, Nitzschia, Cymbella, Cyclotella and Gonatozygon.*

Major genera belonging to emergent macrophytes were *Alternanthera, Colocasia, Cyperus, Commelina, Ipomea, Polygonum* and *Scirpus.*

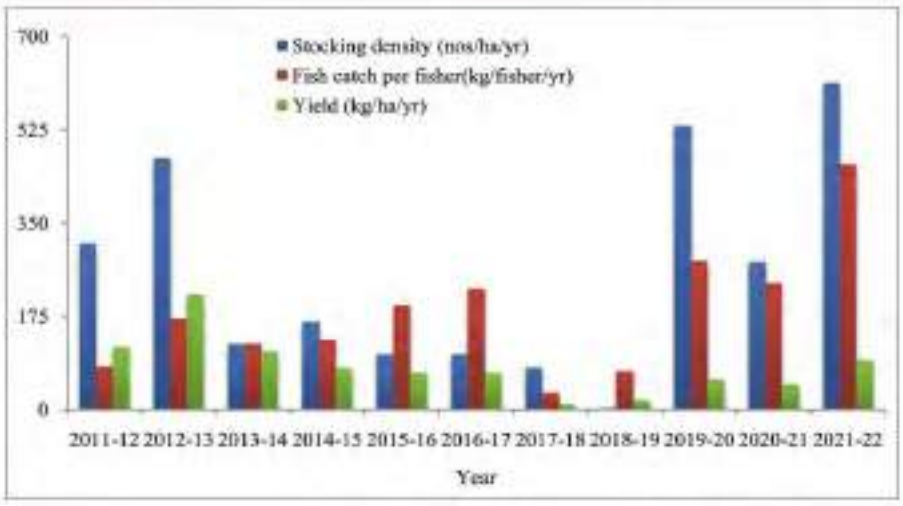
Rooted floating macrophytes belonged to *Ludwigia*, *Neptunia* and *Nymphoides* genera. Free floating macrophytes were *Eichhornia crassipes* and *Pistia stratiotes*. The only submerged macrophyte recorded was *Hydrilla verticillata*.

In Kodar reservoir, infestation of aquatic plants in the reservoir was observed forming a thick bed in the shallow areas causing a problem during fishing and navigation of boats. Around 10-15% of the reservoir was covered by aquatic plants. The common aquatic plants were *Hydrilla verticillata*, *Vallisneria* sp., *Ceratophyllum* sp., *Potamegeton crispus*, *Potamegeton* sp., *Ipomea carnea* etc. The plankton community of Kodar reservoir indicated that blue-green algae (*Microcystis* sp.) was the most dominant among the phytoplankton and Diaphanosoma sp. was the most dominant among the zooplankton.

Fish Diversity

Poondi reservoir has been reported to have 47 species from 17 families and 7 orders. Species richness and diversity were high in the pre-monsoon season, with values of 46 and 3.01 (Shannon index), respectively, and low in the summer, with values of 29 and 1.351 (Shannon index). In the spatial scale, species richness was more in riverine zone compared to transitional and lacustrine zone and the values were 47, 42 and 40 respectively. Exotic fishes like *Cyprinus carpio*, *Ctenophryngodon idella*, *Oreochromis niloticus*, *O. mossambicus*, *Clarias gariepinus*, *Pangasianodon hypophthalmus*, *Pterygoplichthys pardalis* exist in the reservoir.

A total of 46 species belonging to 18 families and 6 orders were recorded from Serlui-B reservoir. Five exotic fish species viz., *Oreochromis niloticus*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Pangasianodon hypophthalmus* and



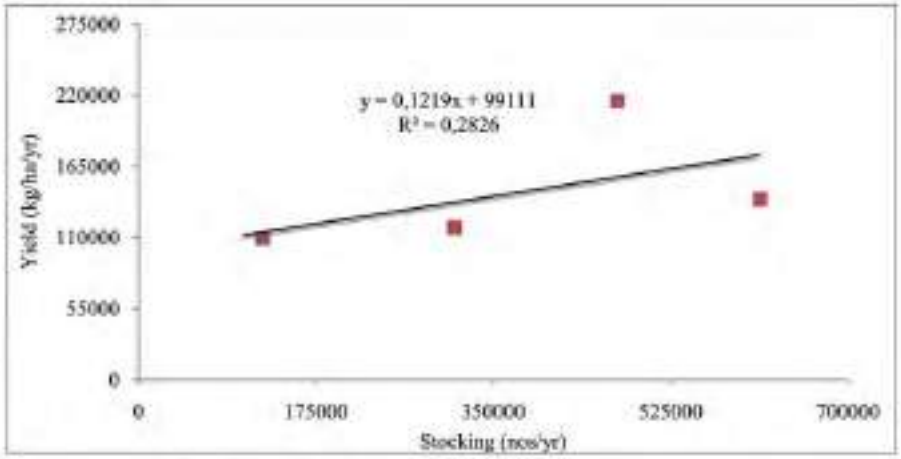
Stocking density and fish yield in Poondi reservoir during 2011-22

Ctenopharyngodon idella were also recorded. Among all the species, one species (i.e., *Clarias magur)* was listed under Endangered and four species (i.e, *Wallago attu*, *Ompok bimaculatus*, *Ompok pabda*, *Chitala chitala*) were found to be Near Threatened. Dominant fish species by weight caught from the reservoir were *Labeo catla* (76-86 cm range; 6.00-11.06 kg range), *Cirrhinus mrigala* (57-68 cm; 2.10-3.00 kg), *Labeo rohita* (25.5-60 cm; 0.17-3.50 kg), *Notopterus notopterus* (22-274 cm; 0.09-0.23 kg) *and Channa marulius* (25-82 cm; 0.18-3.50 kg). However, dominant fish species by number were *Rasbora daniconius*, *Osterobrama cotio*, *N. notopterus*, *Chanda nama* and *Xenentodon cancila*.

42 species under 15 families and 6 orders were recorded from Kodar reservoir, out of which, four species were exotic, viz. *C. carpio*, *C. idella*, *H. nobilis* and *O. niloticus*. The major landing species were *Sperata aor*, *S. seenghala*, *Labeo gonius*, *Osteobrama vigorsii*, *Wallago attu*, *L. calbasu*, *Cirrhinus mrigala*, *L. rohita*, *Notopterus notopterus*, *Systomus sarana* and *Oreochromis niloticus*.

Practice of CBF and impact of fish seed stocking

In the three studied reservoirs, culture-based fisheries (CBF) management was in place. The state fishery department annually stocks the Poondi reservoir with major carps and common carp seeds from July to



Relationship between stocking and yield in Poondi reservoir

A view of cage culture set up in Serlui-B reservoir, Kolasib, Mizoram

A view of Serlui-B reservoir, Kolasib, Mizoram

Sampling at Poondi reservoir, Tamil Nadu

September. Currently, 809 licences are provided for a monthly charge of ₹ 100. The reservoir was stocked primarily with *Labeo catla*, *L. rohita*, *Cirrhinus mrigala*, and *Cyprinus carpio*. Using regression analysis, the relationship between stocking density and yield was determined to be $y = 0.1763x + 43.85$ ($R^2 = 0.3963$). The Pearson correlation study revealed a substantial positive relationship between stocking density and fish yield ($r = 0.60$). Serlui-B reservoir is under the Department of Fisheries, Govt. of Mizoram. Reportedly, during 2009-11, the Department stocked 50 lakh fingerlings of Indian major carps and exotic carps in the reservoir. The reservoir is leased out to individuals and groups for fishing on annual lease system. The annual lease amount was ₹ 1.2 lakh during 2021-22. The lessee engages about 20 number of fishers' groups who catch fish by gill net (7 and 19 cm mesh size) and hook and lines. Fishes caught are gathered by fish vendors (usually from Silchar, Assam), weighed at the dam site in front of the lessee, packed in ice in thermocoal boxes and transported to Silchar in the evening.

The Kodar reservoir is under the management of Chattishgarh Matsya Mahasangh Maryadit (CG Co-operative Fisheries Federation Ltd.) which periodically carries out stocking of Indian Major Carp fingerlings to enhance the fish production and productivity of the reservoir. At present, the fishing right of the reservoir is given on a leased to Jai Patai Mata primary fisheries cooperative society Ltd. for 10 years.

Ecosystem based fisheries management of medium reservoirs

The fish catch analysis and studies on impact of stocking pointed towards inadequate stocking of reservoirs. Hence, there is need of strengthening of CBF management of medium reservoirs with proper stocking of IMC fingerlings in ideal stocking density as per the carrying capacity of reservoir. Macrophyte management was an important issue in Poondi and Serlui-B reservoirs as it affects fishing operations and focus to be given to reduce their entry to reservoir area from the river or channels.

The study recommended to increase the lease period In Serlui B reservoir which will indirectly reduce fishing pressure in the reservoir; to prevent prevalent destructive fishing methods such as dynamite and electric fishing; repair and utilization of cages

Sampling work in Kodar Reservoir, Chhattisgarh

installed during 2013-15 under NMPS scheme; provide training to departmental officers and fishers of Mizoram on reservoir fisheries management in general and cage culture technology in particular and to control the disposal of domestic waste generated from nearby settlements strictly.

For Poondi, it is recommended to practice target fishery of murrels at riverine site of the reservoir, since this zone is dominated by murrels. The stocking of IMCs to be strengthened in both Poondi and Kodar, to reduce the dominance of exotic species especially Nile tilapia. Advanced fingerling stocking (~120 mm in size) is essential, which may ensure better survival and sustainable yield. In Kodar reservoir, the stocking of grass carp in higher numbers than major carps is not recommended as the macrophyte cover in the reservoir is insufficient to enhance the fishery. Further ensuring the sustained fishing effort via engaging native fishers is essential in order to achieve the potential yield from the reservoir.

Sub-project 3:
Refinement of culture-based fisheries for small reservoirs (Gayatri, Beko, Upper Khaguria, & Sunei) in different ecoregions

Scientific Personnel : Lianthuamluaia (Sub-Project Leader), A. Saha (upto 31.03.22), Sibina Mol (leave since 28.11.22), Sajina A. M., S. Kumari, H. S. Swain (upto 31.08.22), H. Chowdhury, Mishal P., P. Parikkar, Jesna P. K. (w.e.f. 01.04.22), P. J. Majhi (w.e.f. 01.04.22)

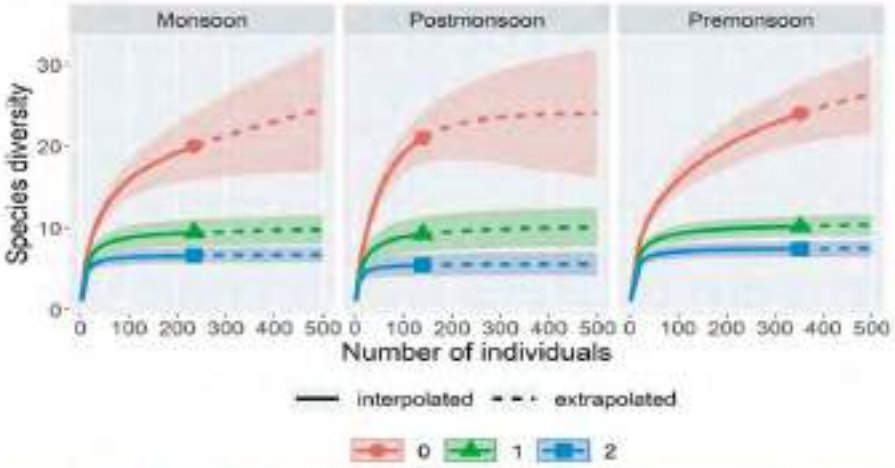
Seasonal sampling was carried out in 8 reservoirs covering 5 reservoirs (Beko, Patloi, Loharsol, Muruguma, Futiyari) in West Bengal, 2 reservoirs (Sunei, Kalo) in Odisha and 1 reservoir (Gayatri) in Karnataka to assess the ecology and fisheries.

Fisheries status

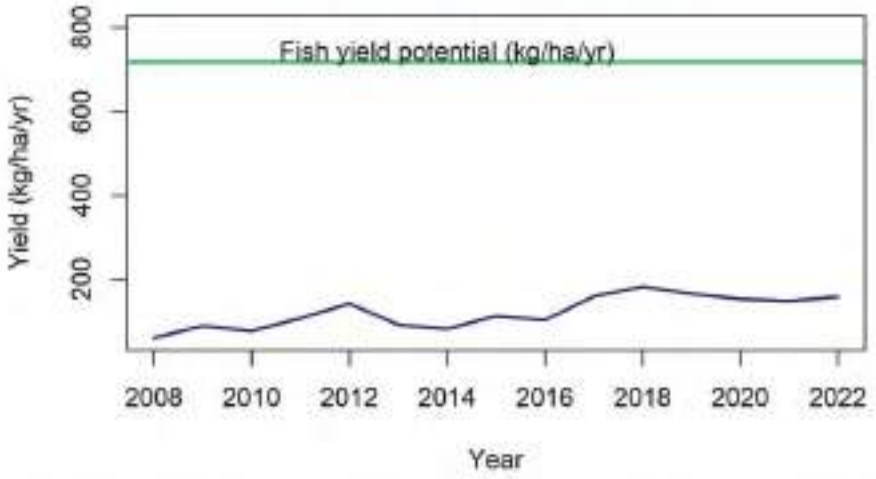
In Gayatri reservoir 32 fish species were observed during the sampling period. Among the indigenous fishes *Notopterus notopterus, Salmophasia belachi* and *Ompok bimaculatus* were commonly observed in Gayatri reservoir. *Oreochromis niloticus* was the most abundant exotic fish in the reservoir. Some predatory fish *like Channa striata, Channa marulius* and *Wallago attu* were available in the reservoir. As per the rarefaction curve of the fish abundance data of Gayatri reservoir the fish species richness and diversity were higher in premonsoon season. The average fish yield for the last 15 years (2008-2022) was 122 kg/ha/yr. The estimated fish yield potential calculated using MEI was 718 kg/ha/yr, which indicated a significant difference between the actual fish yield and the estimated fish yield potential.

Kalo reservoir of Odisha harbor diverse small indigenous fishes among which *Salmophasia phulo, Chanda nama* and *Amblypharyngodon mola* were the most commonly available species. Gill net was the main fishing gear operated in Kalo reservoir for catching small indigenous fish as well as the large fish. The estimated fish yield potential in Kalo reservoir was around 365 kg/ha/yr which indicated a huge gap between the actual fish yield and the estimated yield potential providing a good scope for further enhancement of fish production in the reservoir. The stocked fish (IMC) contributed around 90% of the fish production which clearly indicated that culture-based fisheries (CBF) have a profound impact on the fish production. Apart from the stocked fish many indigenous fishes are available in the reservoir. The most common small indigenous fish were *Salmophasia phulo* and *Chanda nama*. Among the minor carps *Systomus sarana* contributed significantly. The peak fishing was mainly in the month of May, June and July.

The fish species richness in the selected reservoirs of Purulia, West Bengal was ranged from 21 in Futiyari reservoir to 27 in Beko and



Rarefaction curve showing seasonal the fish diversity pattern in Gayatri reservoir



Fish yield of Gayatri reservoir for the last 15 years and the calculated fish yield potential

Small indigenous fish catch from Kalo reservoir using gill net

Loharsol reservoir. The fishery of the selected reservoirs of Purulia was not managed scientifically, no proper stocking was done in the reservoir and the fish catch was depending on the natural fish of the reservoir. Ample scope are available to harness the natural productivity of the small reservoirs of Purulia through scientific interventions.

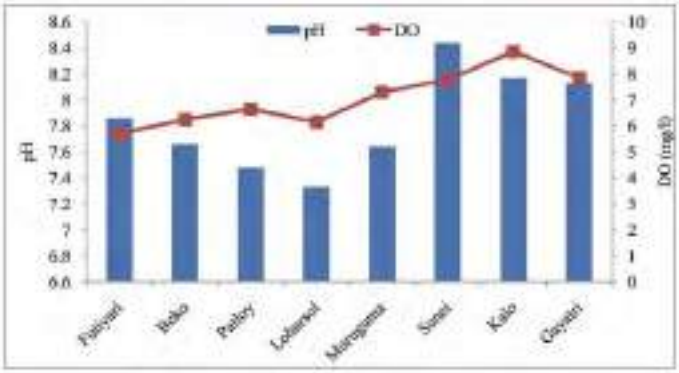
Environmental parameters

Seasonal sampling in the studied wetlands indicated that the water of the reservoirs was neutral to slightly alkaline with the pH ranged from 7.33 in Loharsol reservoir to 8.44 in Sunei reservoir. All the reservoirs were well oxygenated to support good fisheries with the dissolved oxygen (DO) value ranged from 5.7 mg/l in Futiyari reservoir to 8.8 mg/l in Kalo reservoir. Alkalinity was comparatively lower in the Sunei and Kalo reservoir of Odisha but higher in Gayatri reservoir with 107 mg/l. Specific conductivity which is one of the most commonly used parameters for productivity estimation was higher in Gayatri reservoir (465 µs/cm) but was lower in Sunei and Kalo reservoir. Nutrients like nitrate-N and phosphate-P value indicated that most of the reservoirs were enriched with nutrients for enhancing plankton density which is the main natural food for most of the commercial fish.

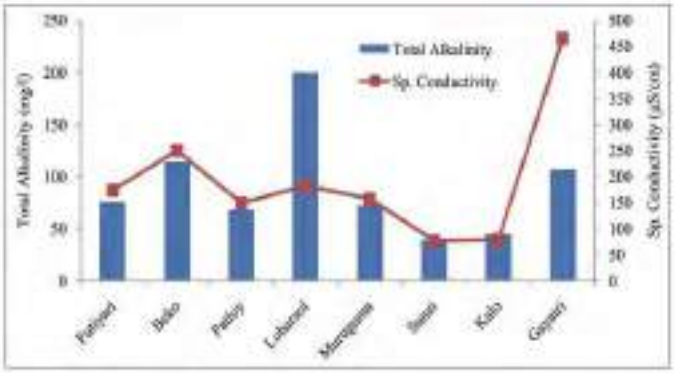
This study examined the distributions of phosphorus fractions in the sediment of macrophyte-dominated mesotrophic Gayathri reservoir, Karnataka, India. Sampling was carried out during monsoon, post-monsoon and pre-monsoon season from non-infested, moderately infested and moderate to heavily macrophyte infested sites. Exchangeable-P did not differ among sites. Iron bound (Fe-P) was less affected by the macrophyte, may be due to the formation of Fe plaques in the root zone of macrophytes. It was observed that macrophyte communities along with dissolved oxygen concentration in bottom water can effectively control the sediment P fractions in the reservoir.

Plankton diversity and abundance

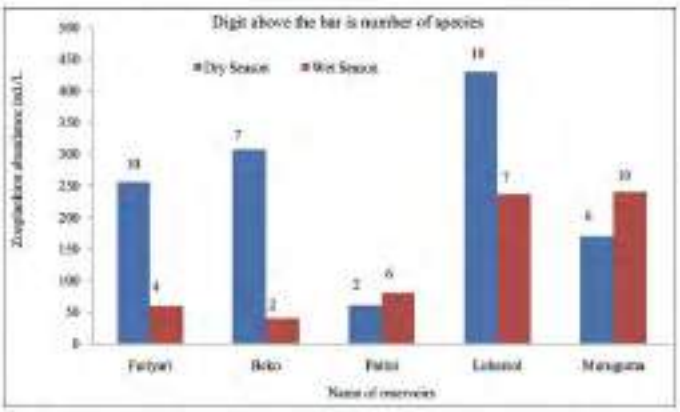
In total, 98 species of phytoplankton were recorded (91 species belonging to 82 genera in Kalo reservoir; 83 species belonging to 74 genera in Sunei reservoir) from the two reservoirs of Odisha. Four algal groups, viz. Chlorophyceae, Cyanophyceae, Bacillariophyceae



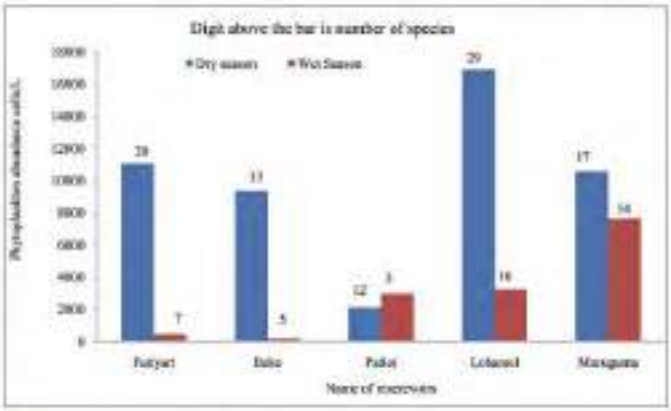
DO and pH in selected small reservoirs



Total alkalinity and sp. conductivity in selected small reservoirs



Zooplankton abundance in 5 selected reservoirs of Purulia



Phytoplankton abundance in 5 selected reservoirs of Purulia

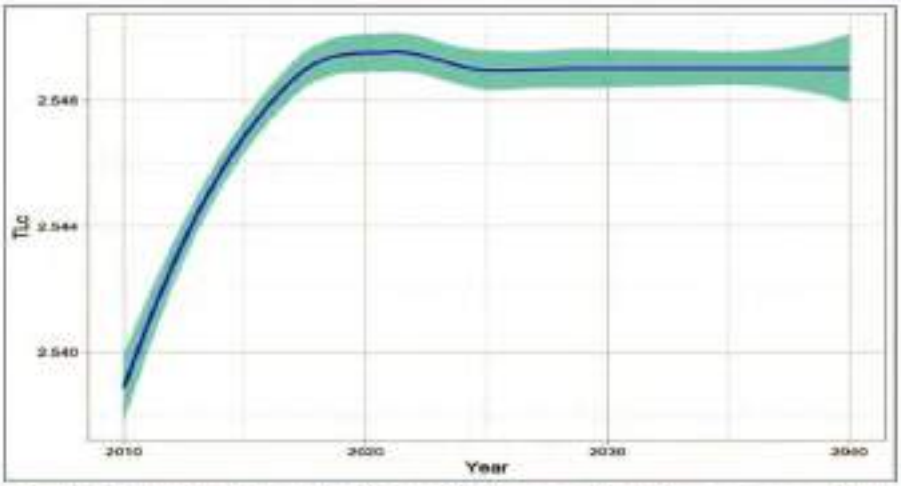
and Trebouxiophyceae dominated the total phytoplankton population in both the reservoir, contributing~87% of total phytoplankton. In Kalo reservoir, the mean phytoplankton density was maximum during pre-monsoon (3.51×10^4 cells/l) followed by post-monsoon (2.46×10^4 cells/l). However, Sunei reservoir, the mean abundance was at the maximum during post-monsoon (2.45×10^4 cells/l) followed by monsoon (1.86×10^4 cells/l). The Chlorophyta was ranked first in terms of species richness and numerical abundance in both the reservoir. Concurrently altogether 28 zooplankton taxa were recorded throughout the study period with the predominance of Rotifera. A total of 10 species and 6 genera of Rotifera, 2 orders of Copepoda, 4 genera of Cladocera, 5 genera of Protozoa and Crustacean Nauplii were identified from the studied reservoirs. Rotifera was the most important fraction among four major zooplankton groups in terms of species richness and numerical abundance in both the reservoir. The mean seasonal zooplankton abundance was at the maximum during pre-monsoon 1022.75 ± 144.10 ind/l and minimum in the post monsoon season 830.25 ± 152.42 ind/l in Kalo reservoir. However, in the Sunei reservoir, the mean abundance was maximum in post-monsoon 984.63± 121.10 ind/l and minimum in the monsoon season 635.25 ± 112.36 ind/l.

A total of 31 phytoplankton genera/species belonging to Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae and Dinophyceae were recorded from the five reservoirs of Purulia. Highest density of phytoplankton was recorded in Loharsol with the abundance of 16920 cells/l followed by Futiyari 11065 cells/l and Muruguma 10560 cells/l during dry season. Most dominant phytoplankton recorded during monsoon was *Westella* sp. in Futiyaria and *Microsystis* in other reservoirs. Zooplankton abundance was at the highest in Loharsol reservoir during dry season and in Muruguma during wet season. Most dominant zooplankton species was *Keratella cochlearis* and *Brachionus falcatus*.

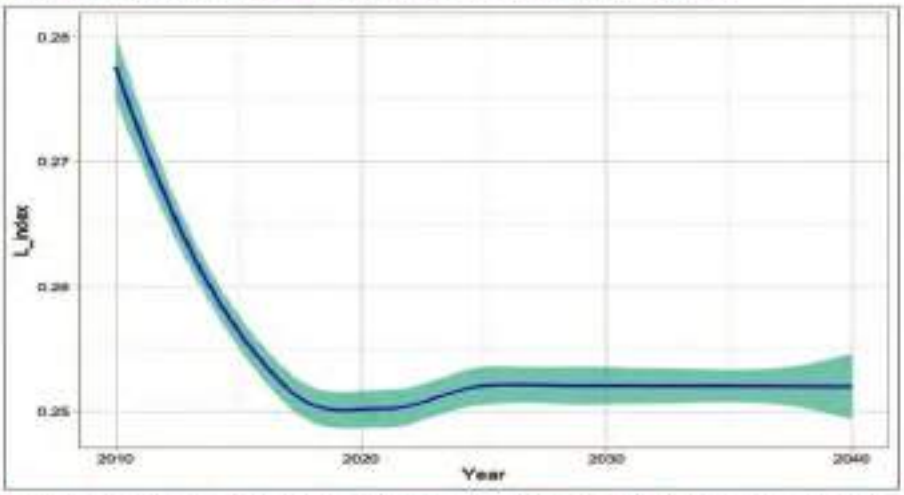
Sub-Project 4:
Trophodynamic modelling of inland open water bodies for ecosystem based fisheries management

Scientific Personnel: Preetha Panikkar, Feroz Khan, Sibina Mol S.(Leave since 28.11.22), S. K. Koushlesh

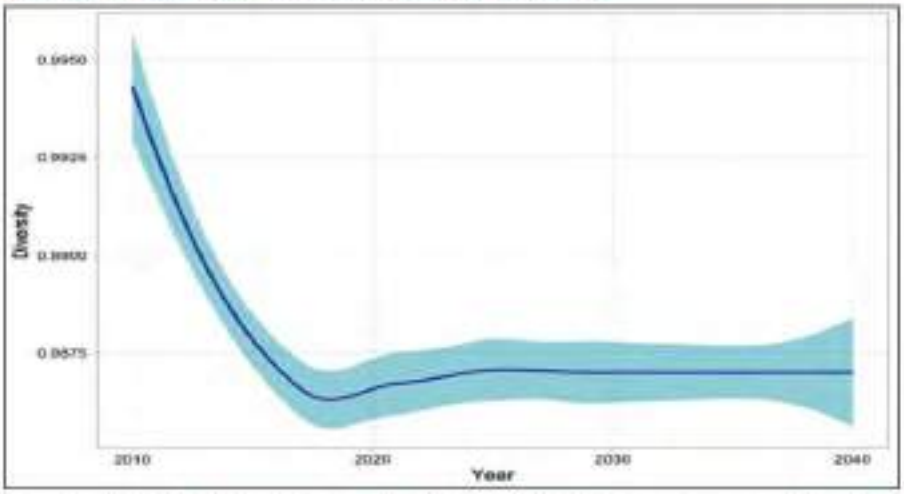
Modelling tools for ecosystems can help analyze and identify potential appropriate options so that sustainable fisheries and the protection of healthy aquatic ecosystems coexist. Given the fact that changes associated with fishing activities in Karapuzha, the reservoir ecosystem showed a slight rise in the mean trophic level of the catch during the decade 2010 - 2020. The basic input parameters of Karapuzha that



Mean Trophic level of the catch at Karapuzha Reservoir. Predictions are surrounded by 95% confidence intervals calculated using a Monte Carlo approach, generating 30,000 model runs within the range of plausible iterations of the Karapuzha Model



L-index at Karapuzha Reservoir. Predictions are surrounded by 95% confidence intervals calculated using a Monte Carlo approach, generating 30,000 model runs within the range of plausible iterations of the Karapuzha Model. The shaded area indicates 95% confidence intervals based on Monte Carlo simulations varying Ecopath basic input parameters (Biomass, Production/Biomass and, Consumption/Biomass)



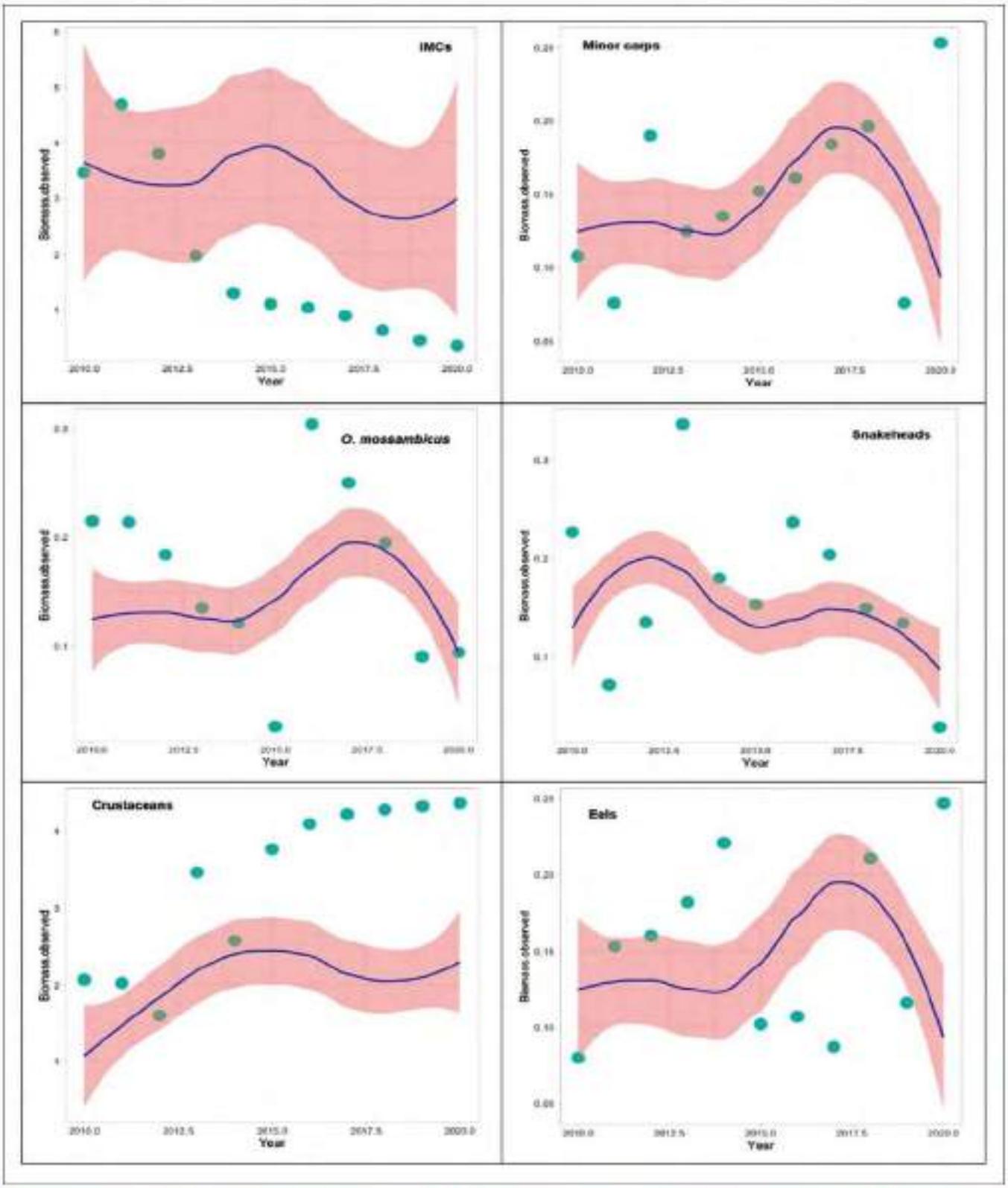
Kempton Diversity Index at Karapuzha Reservoir. Predictions are surrounded by 95% confidence intervals calculated using a Monte Carlo approach, generating 30,000 model runs within the range of plausible iterations of the Karapuzha Model. The shaded area indicates 95% confidence intervals based on Monte Carlo simulations varying Ecopath basic input parameters (Biomass, Production/Biomass and, Consumption/Biomass)

had data-based on uncertainty, confidence intervals were assigned to reflect the plausible range of parameter estimates. Thirty thousand mass-balanced model runs were produced for each scenario using the EcoSampler plugin and 95% confidence intervals. After addressing the uncertainty, simulation to the next two decades with ecosim revealed that the mean trophic level has shown similar pattern and continued the trend although there was no steep rise. Large piscivore and invasive catfish such as *Clarias gariepinus* was among the main species caught at the beginning of the time series and was replaced by two other indegenous piscivores such as *Channa marulius* and *Channa punctatus* that also occupied high trophic levels., resulting in no much change in the mean trophic level of catch. Furthermore, from 2010 onward, there were no expressive alterations in the composition of the main species caught in the Karapuzha Reservoir that could explain the stable mean trophic level of the catch. The decline of mean trophic level of the catch higher than 0.15, indicates ecologically significant fishing down the food web process, which was not observed in the Karapuzha Reservoir.

The L index depicts the theoretical loss in secondary production due to fishing or climate. Though this indicator did not change considerably throughout the years, it signals that there is considerable risk in terms of ecosystem effects due to overfishing (between 25 and 50%).The L-index trend shows that the scenario in future shows ecosystem is not to be sustainably fished over the years.

With regard to the slight increase in biomass diversity (Kempton's index), such increase probably happened because of a decrease in some dominant species, which increased biomass evenness. The Kempton index (Q) is a measure of biomass

diversity that describes the slope of a cumulative group abundance curve. The Q index measures the effects of mortality, from fishing or climate, on biomass diversity in ecosystem simulation models.



Biomass trends for commercially important stocks in the Karapuzha EwE model. Solid lines indicate model predictions and dots represent observed data. Predictions are surrounded by 95% confidence intervals calculated using a Monte Carlo approach, generating 30,000 models within the range of plausible input estimates. Model predictions were generated using field data collected. The shaded area indicates 95% confidence intervals based on Monte Carlo simulations varying Ecopath basic input parameters (Biomass, Production/Biomass and, Consumption/Biomass)

Project Title: Eco-orientation approach for fisheries enhancement of floodplain wetlands in diverse ecoregions of India

Project Code: RWF/20-23/11

Duration: April 2020 - March 2024

Principal Investigator: A. K. Das

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

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

Scientific Personnel: D. Debnath (Sub-project Leader), S. Borah, S. Yengkokpam, S. C. S. Das, P. Das, A. K. Yadav, B. K. Bhattacharjya, N. Sharma (w.e.f. 01.04.2021)

Baseline information, fisheries ecology, macrophytes, primary productivity, fish production potential, major issues, management guidelines and fishers' socio-economics were documented from four floodplain wetlands (beels) of Assam during the past couple of years. Dandua(50 ha) and Lakhanabandha (16 ha) beels were 'closed' and 46-Morakolong (60 ha) and Rupahi(75 ha) beels were 'seasonally open' beels. Dandua beel of Morigaon and Lakhanabandha beel of Nagaon district lost their riverine connectivity and hence they are categorized as closed beels. On the other hand, 46-Morakolong beel of Morigaon and Rupahi beel of Nagaon are flooded during the monsoon season and hence are seasonally open beels.

The air temperature varied from 22.73 to 35.50 °C, whereas the water temperature varied from 20.27 to 34.60 °C, pH of the beels was nearly neutral except in Lakhanabandha beel, in which it varied substantially between seasons (5.47 to 8.24). The range of other parameters considering all the beels was: dissolved oxygen 5.09-8.58 mg/l, electrical conductivity 11.33-158.67 µS/cm, total dissolved solids 6.67-102.67 mg/l, total alkalinity 26.67-136.67 mg/l, Secchi disc transparency 0.33-1.52 m and water depth 1.37-6.81 m.

The phytoplankton diversity analysis indicated that Bacillariophyceae dominated in all the beels and its contribution was higher in seasonally open beels (46-Morakolong and Rupahi beels) compared to the closed ones (Dandua and Lakhanabandha beels). On the contrary, Cyanophyceae contributed more in closed beels compared to the seasonally open beels. Average number of plankton per litre of water was also higher in closed beels compared to the seasonally open beels apparently because of more stable condition in closed beels. *Eichhornia crassipes* was the dominant floating macrophyte covering 3-10% of the surface in the beels. The bottom of Dandua beel was completely covered with *Vallisneria*, *Ceratophyllum* and *Hydrilla* species as also Rupahi beel.

The maximum number of fish species, number of orders and number of families were: Dandua beel – 51, 9, 21; 46-Morakolong beel – 45, 8, 16; Rupahi beel – 55, 12, 20 and Lakhanabandha beel – 50, 10, 18. Average gross primary productivity (GPP) and fish production potential were estimated in the four beels over three seasons. This GPP was calculated purely based on plankton using dark and light bottle method. Considering 1% of this GPP, fish production potential was estimated.

Table. Primary productivity (based on phytoplankton) and fish production potential of four floodplain wetlands (beels)of Nagaon and Morigaon, Assam (Mean±SD)

Parameters	Dandua beel	46-Morakolong beel	Rupahi beel	Lakhanabandha beel
Gross primary productivity ($mgC/m^3/hr$)	150.24±10.0	103.34±12.0	211.32±89.4	117.29±18.1
Present fish production (2020-21) (kg/ha/y)	1047	462	505	534
Fish production potential (kg/ha/y)	391.76±30.9	269.26±30.9	647.91±274.1	308.24±47.6

Table. Major issues faced and prevalent management interventions practiced in four floodplain wetlands (beels)of Nagaon and Morigaon, Assam

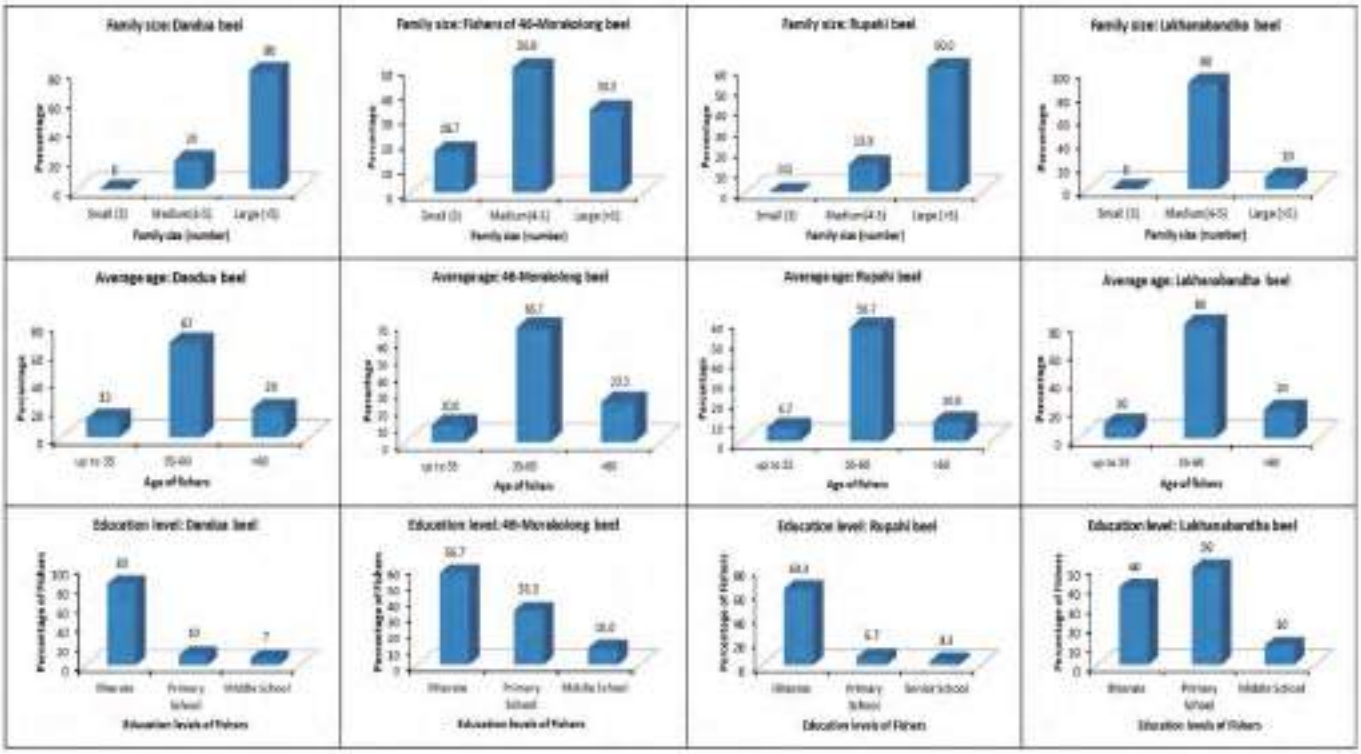
Parameters	Dandua beel	46-Morakolong beel	Rupahi beel	Lakhanabanda beel
Major issues	Submerged macrophyte *Vallisneria* covering the bottom of the beel	Occurrence of frequent floods during monsoon season leading to escapement of fish	Escapement of fish during monsoon floods through an unbanked side of the beel	Accumulation of silt/ mud/ muck (up to 4-5 ft depth) in the bottom hindering fishing in the beel
Mitigation/ adaptation measures	Need-based desilting can be done in shallower areas	Rearing of seed in pen/ cage for stocking after floods	(i) Rearing of seed in pen/ cage for stocking after floods and (ii) erecting bamboo/ net screens for stock protection	Need-based desilting

Production potential estimated in the present study based on phytoplankton only; these values would be higher if macrophyte and detrital food chainswere considered.

The major issues faced (and mitigation/ adaptation measures) and prevalent management interventions practiced by the fishers in four floodplain wetlands of Assam are presented in the table.

Socio-economics of wetland fishers

The figures presented below show the salient socio-economic and demographic parameters of fishers operating in the four floodplain wetlands (beels) of Assam. Family size, average age and education levels were different for fishers operating in the four beels. Majority of the fishers were earning up to ₹ 20,000/- per month from fishing and subsidiary occupations.



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

Scientific Personnel: A. K. Das (Sub-project Leader), U. K. Sarkar (upto 19.10.22), A. K. Bera, Md. Aftabuddin, Lianthuamluaia, P. J. Majhi (w.e.f. 01.04.22)

Fish diversity and Fisheries

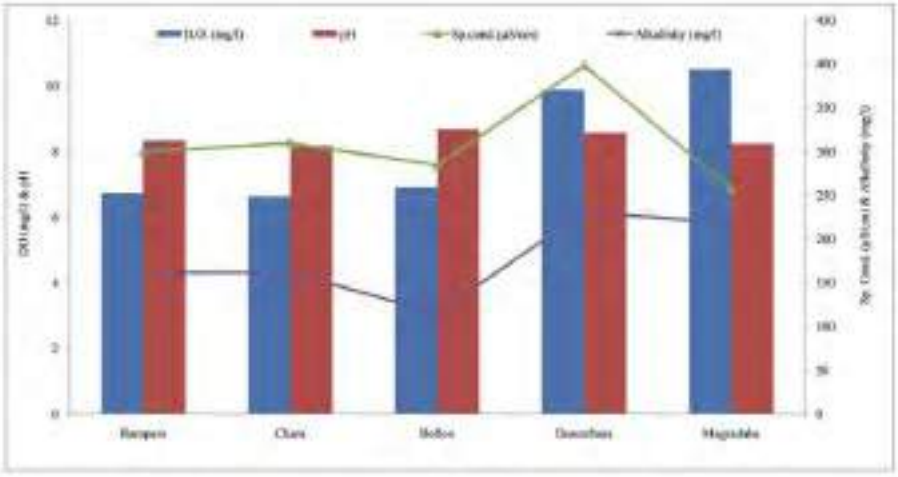
Assessment of ecology and fisheries of the five wetlands viz. Rampara, Chhar, Beloon, Daserchak and Magradaha of Murshidabad, West Bengal was carried out during 2022. Rampara wetland was managed by stocking by the leasee of the wetland Shaktipur Rampara Fisherman Cooperative Society Ltd. The species stocked in Rampara wetland were *Hypophthalmichthys molitrix* (average size 200g), *Labeo bata* (20 g), *Labeo rohita* (30g), *Labeo catla* (30g) and *Cirrhinus mrigala* (25 g). In this wetland 50-60 members are actively fishing in the wetland. Stocking is carried out during post-monsoon and completely harvested during April-May. The average fish yield in the wetland was around 450 kg/ha/yr. *Hypophthalmichthys molitrix* (Silver carp) dominated the fish catch in the wetland. The main fishery or the commercial fishery is mainly dependent on the stocked fish; however, the wetland also harbors a rich diversity of indigenous fishes. Some of the important indigenous fishes observed during the sampling were *Amblypharyngodon mola*, *Parambassis lala*, *Macrognathus pancalus*, *Gudusia chapra*, *Glossogobius giuris*, *Puntius sophore*, *Channa punctata*, *Trichogaster lalius*, *Pethia phutunio* and *Badis badis*. Chhar beel is also managed by Shaktipur Rampara Fisherman Cooperative Society Ltd. The average fish yield was around 600 kg/ha/yr in Char beel. The main fish stocked in the wetland were *Ctenopharyngodon idella* (grass carp) and Indian Major Carps. The commercial fishes was entirely dependent on the stocked fishes. Grass carp dominated the fish catch in the wetland. The fish were generally stocked in the post monsoon and complete harvesting was mainly done during May to June. Drag net is the main fishing gear operated for catching the fish catch in Rampara and Char wetland.

Beloon wetland is a large wetland having an area of 335 ha. There was no proper fish stocking management where the fisheries are mainly dependent on the natural fish stock. Due to the high infestation of the wetland with marcophytes gill net is the main fishing gear operated in the wetland. The most common floating macrophyte in the wetlands was *Eichhornia crassipes*. Since the wetland exhibited high fish yield potential (1967 kg/ha/yr) there is a good scope of introducing the culture-based fisheries by scientifically stocking the fish to increase the fish production in a sustainable manner. Stocking of grass carp is recommended as the wetland is highly infested with aquatic macrophytes.

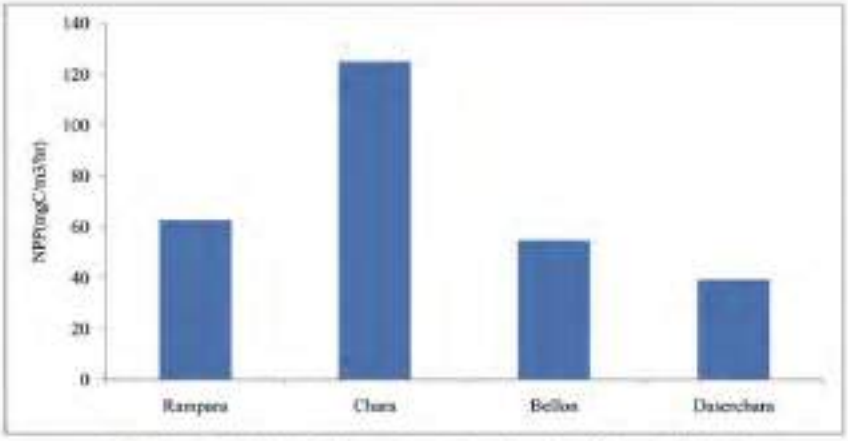
Daserchak wetland is a closed beel with an area of around 42 ha. It is a productive wetland having a fish yield potential of around 1691 kg/ha/yr based on the MEI. The wetland fishery is managed by the local fisheries cooperative society Daserchak Matsyajibi Samabay Samiti. Around 100 members were fishing regularly in this beel. Besides major carps, important indigenous fish observed during the sampling were *Pethia phutunio*, *Badis badis*, *Parambassis ranga*, *Macrognathus pancalus*, *Puntius sophore*, *Glossogobius giuris*, *Pethia conchonius*, *Parambassis lala*, *Parambassis ranga*, *Aplocheilus panchax*, *Channa punctata* and *Leiodon cutcutia*. Macrophytes cover approximately 30% of the water, making drag net operation difficult. Gill nets and traps are frequently used with no mesh size regulation. Stocking of fish was done at the size of 100 to 200 g for major carp and 30 g for minor carp (*Labeo bata*). Among the fish catch *Hypophthalmichthys nobilis* (big head), silver carp (*Hypophthalmichthys molitrix*), bata (*Labeo bata*), catla (*Labeo catla*) and rohu (*Labeo rohita*) were the major fish contributing the fish catch.

Environmental parameters

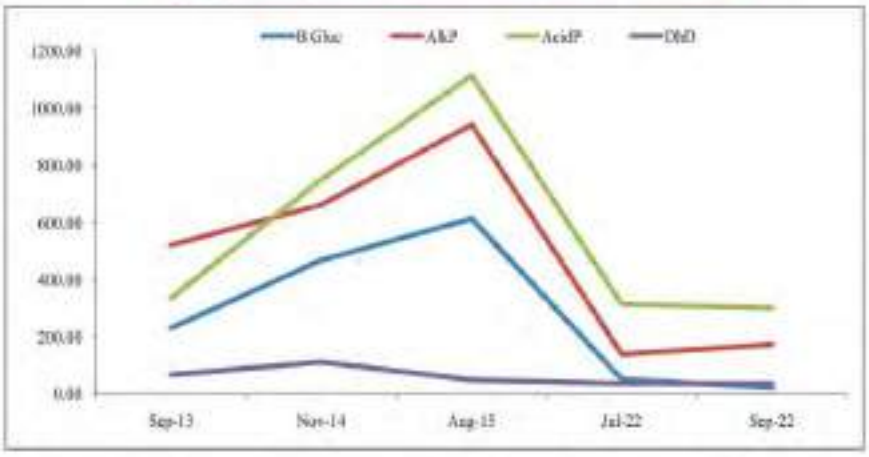
The analysis of water quality parameters indicated that the studied wetlands were suitable for fisheries. Dissolved oxygen (DO) which is the most important parameter was above 5 mg/l in all the wetlands indicating good quality and productivity of the water for fisheries. The pH of was around 8 in all the wetlands which



Critical water quality parameters of the selected wetlands of West Bengal



NPP (mgC/m^3/hr) of the selected wetlands of Murshidabad



Changes in sediment enzyme activities in wetlands of West Bengal

also indicated the productive and healthiness of the wetlands for fisheries. Specific conductivity, an important parameter for productivity was also above 250 µS/cm in all the wetlands indicating the productive nature of the wetland. The alkalinity was also above 100 mg/l in all the wetlands which clearly indicating the buffering capacity of the pH fluctuation. The available phosphate (0.03-0.2 mg/l) clearly indicated sufficient nutrients to support the proliferation of the plankton population which is the main food of the commercial fishes. Net primary productivity (NPP) analysis using light and dark bottle method clearly indicates the productive nature of the wetlands. The NPP was higher in Chhar wetland as compared to the other wetlands.

Plankton dynamics

Spatio temporal dynamics of plankton were studied in five wetlands namely Chhar beel, Rampara beel (seasonally open), Beloon beel, Daserchak beel and Magardha beel (closed) from Bhagirathi-Hooghly stretch of lower Gangetic basin. In total, 112 species of phytoplankton were recorded (109 species belonged to 91 genera in seasonally open wetland; 86 species belonged to 74 genera for closed wetland). From these, 92 species were common to five wetlands; 27 species occurred only in seasonally open and 14 species only in closed one. In the seasonally open wetland, the mean phytoplankton density was maximum during post-monsoon (3.26 × 104 cells/l) and minimum in monsoon (2.13 × 104 cells/l). However, in the closed wetland, the average abundance was maximum during post-monsoon (2.17 × 104 cells/l) followed by monsoon (1.96 × 104 cells/l). Beloon beel was found with dominance of Cyanophyceae, while Char beel with Bacillariophyceae and Ramparabeel with Chlorophyceae. Concurrently, 46 and 35 zooplankton species belonging to six groups were recorded from seasonally open and closed beel. Among zooplankton, Rotifera accounted maximum in both closed and seasonally open beel. The mean seasonal zooplankton abundance was maximum during post-monsoon 2341.75 ± 168.10/l and minimum in the monsoon season 1022.25 ± 182.42 /l in seasonally open beel. However, in the closed beel, the mean abundance was at the maximum in monsoon 1143.63 ± 145.10 /l and minimum in the post-monsoon season 985.25 ± 123.36 /l. Margalef species richness index indicated higher plankton diversity in the seasonally open beel.

Sediment enzyme activities in wetland ecosystem

Wetland ecosystem is very prone to natural and anthropogenic changes. Long-term changes in wetland ecology are the result of adoption of different fisheries management protocols like stocking management, pen culture and macrophyte management. The present study has been conducted to study the changes in microbial sediment nutrient cycling potential to ascertain decadal changes (2013-2022) in wetland ecosystem using sediment enzyme activities as indicator of changes. The data revealed distinct lower activities of phophatase and glucosidase producing potential of wetland sediment. However, dehydrogenase activities indicating general microbial metabolic activities decreased to lesser extent. This distinct changes in sediment microbial activities may be due to removal of submerged and floating macrophytes to promote fisheries enhancement protocols. The data also indicate less availability of biological material for microbial decomposition.

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

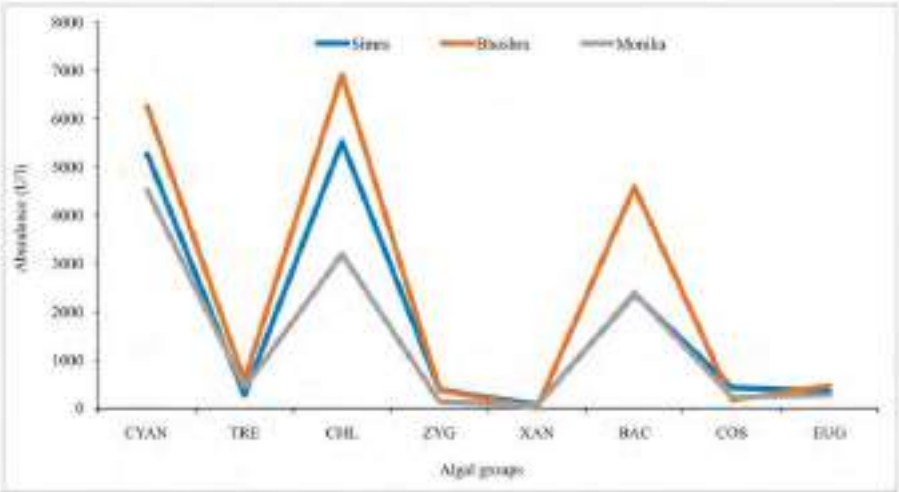
Scientific Personnel: A. Sinha (Sub-project Leader), G. Chandra, P. R. Behera (w.e.f. 01.04.22)

The ecology of three flood plain wetlands (mauns) of Bihar namely Manika, Simra and Bhusra was studied in 2022. Peoples of surrounding villages are dependent on this maun for their livelihood and other needs. Although, the ownership of this water body is with the state fishery department, the lease right is with the Primary fisheries cooperative society of the three blocks. Biotic and abiotic samples were collected from the selected wetlands viz. Simra, Bhoshra, and Manika (selected two stations from each maun).

Manika maun is a seasonally open wetland, during monsoon it is connected to Budhi Gandak River through a narrow channel. This maun is located in the Muzaffarpur district of Bihar with an average water area of 120 ha and a average depth of 3 meter. The recorded fish samples of this maun during experimental fishing were *Cirrhinus reba, Labeo rohita, Hypophthalmichthys nobilis, Glossogobius giuris, Channa striata, Trichogaster fasciata, Parambassis ranga, Macrognathus pancalus, Nandus nandus* and Prawn. Among the benthos samples, gastropods are the dominant groups with *Filopaludina bengalensis* and *Lymnaea acuminate* being two major contributors. The quantitative spectrum of benthos was 50-800 individuals/m^2 with a Shannon diversity value of 1.82. Among the plankton Cholorophyceae and Cyanophyceae are the dominant groups with Coelastrum, Microcystis and Anabaena as the dominant genera.

Simra maun is also a seasonally open wetland having a connection to Budhi Gandak river during the monsoon period. This wetland has water spread of 80 ha with an average depth of 3.5 meter. 160 fishers' families of the surrounding villages were dependent on it. Fishers are generally using drag nets to catch the fishes and the average catch is 25 kg /day/dragnet. Among all the studied mauns, this wetland exhibits a comparatively good biodiversity of fishes. The recorded fishes in experimental fishing were *Labeo rohita, Labeo bata, Labeo gonius, Labeo calbasu, Cirrhinus mrigala, C. reba, Puntius sophore, Puntius chola, Pethia ticto , Puntius terio, Nandus nandus, Anabas testudineus Parambassis lala, Xenetodon cancila, Amblypharyngodon mola, Mystus tengara, Mystus cavasius, Chanda nama, Parambassis ranga, Trichogaster fasciata, Colisa dussumi, Osteobrama cotio, Salmophasia bacaila, Laubuca laubuca, Gudusia chapra, Neotropius atherinoides and Channa striata.* In case of benthos, the quantitative spectrum was 122-634 individuals/m^2 with a Shannon diversity index 2.26. Some of the recorded benthos samples were *Bellamya bengalensis Indoplanorbis exustus, Gyraulus convexiusculus* and Oligochaete worms. Among plankton community Coscinodiscophyceae and Cyanophyceae were the dominant groups with Microcystis and Aulacoseira as the dominant species in Simra maun.

Simra maun



Plankton density in the studied wetlands

Bhusra maun a seasonally open wetland is located along the bank of Baghmati River in the Gayghat block of Muzaffarpur district of Bihar. This maun has an area of 70 ha with a water depth of 2.85 m. Low biodiversity has been observed in this wetland. However, this maun exhibits a good benthic population with a biomass 60 - 500 individuals/m^2 with a calculated Shannon biodiversity 1.9. Although, fish has been stocked in this wetland, especially the carps, but complete harvesting has been practiced by the fishers. Also, sporadic incidences of disease-induced fish kill have been observed in this maun. In case of Plankton Cyanophyceae and Coscinodiscophyceae are the two-dominant class with Coelastrum, and Anabaena as dominant species.

Water Quality

The study indicated that the aquatic environment of two maun (Simra and Manika) were conducive for culture-based fisheries. Dissolved oxygen, one of the most critical water quality parameters for fisheries, ranged from 5.2 to 8.4 mg/l with the highest in Simra and the lowest in Bhusra maun. Similarly, the water of all studied wetlands was neutral to slightly alkaline, with the water pH ranging from 6.9 to 9.1. Other water quality parameters like specific conductivity, total alkalinity, total hardness, salinity and TDS were also calculated and in most of the cases, the highest value of these parameters was found in Manika maun.

Small indigenous fish of selected wetlands of Muzaffarpur, Bihar

ICAR-CIFRI team visited the Manika and Bhusra maun. A considerable loss of important small indigenous fish diversity was observed in catch of local fishermenin Manika and Bhusra mauns. They were interested only to catch major carps for their income and left the small fishes as non profitable fishes. They were not aware about the loss of prized fish of their wetland. A mass awareness programme is highly recommended to arrange in collaboration with Department of Fisheries, Govt of Bihar for conservation of biodiversity of the wetland.

Brahmapura Maun

The Brahmapura Maun is situated in Sikandarpur on North West of the city of Muzaffarpur. The L-shaped wetland of Sikandarpur is the city's largest watercourse. It is connected to the Burhi Gandak River by a sluice gate. The surface area is 60 ha and the length of the shore lane is 8.1 km. The wetland maintains a resource-based integrated practice combining farming and aquaculture which supports the livelihoods of a large, economically deprived population of thousands of lake-dependent families, mainly fish and vegetables. The lake is currently under pressure from various anthropological activities in the area, including water diversion, land use modifications, waste water discharges and dumping. The lake has many environmental problems including eutrophication. It gets untreated sewage and is poorly managed which needs scientific intervention for its development to protect the livelihood of the fishers community.

Fish mortality in Manika maun: in early October 2022, due to run-off water from agricultural field of adjoining catchment area, there was mass mortality of fish in the maun as well as in cages. Fishers of the maun informed us that all the fishes stocked in cage died instantly. Apart from it around 40 quintals of fishes died in maun water. The water of the maun was of pinkish colour for almost two days. It came to its natural state after almost seven days. The stocking in Manika maun was delayed due to this incidence and completed only till 31st October 2022. Stocking with Rohu, Catla, Mrigal, Grass carp was caried out with a stocking rate of 1800-2000 advance fingerlings/ha. The harvesting of fishes will be initiated only after the last week of February 2023.

SIF in Bhusra maun, Muzaffarpur, Bihar

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

Scientific Personnel: A. Alam (Sub-project Leader), M. Gupta (upto 08.10.21), V. Thakur, J. Kumar (Study leave 05.3.22-07.11.22), Shravan K. Sharma (w.e.f. 01.04.22) and V. Kumar (w.e.f. 01.04.22)

Fish Diversity and Catch composition

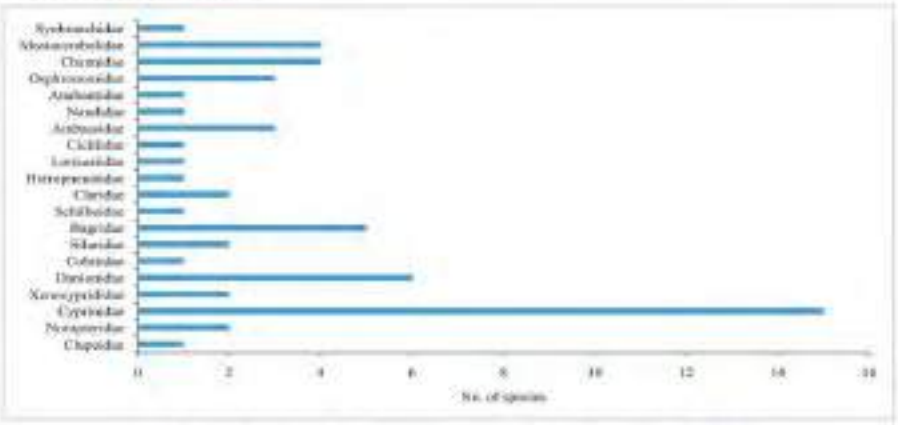
The ecology and fisheries of the four wetlands each in Uttar Pradesh (UP) (Kitaman, Jatiya, Bakwa, and Ramgarhtals) and Madhya Pradesh (MP) (Govindgarh, Devendra Nagar, Lokpal Sagar, and Man Sagar) were investigated in 2022. The fisheries in all these wetlands are managed by cooperative societies except Kitaman and were stocked with fingerlings of Indian Major Carps and exotic carps (*Hypophthalmichthys molitrix, H. nobilis, Ctenopharyngodon idella, Cyprinus carpio*) by the state Department. The stocking rate in wetland of Uttar Pradesh is 4000-5000/ha/year, while the stocking is arbitrary @ 2-3 lakh fingerlings/year in wetlands of Madhya Pradesh.

Fish and Fisheries

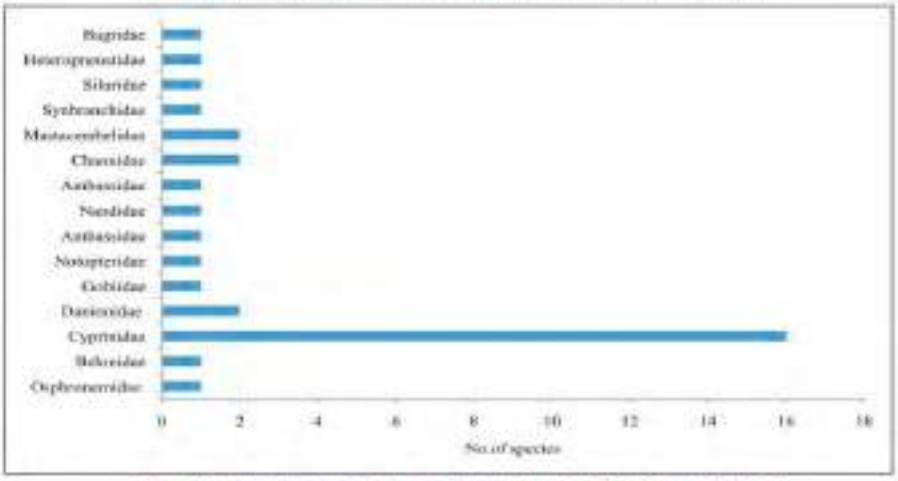
In all the wetlands, the major carps except in Govindgarh dominated the fisheries. *Labeo catla* (80%) dominated the fishery in Ramgarhtal, *Labeo rohita* (40%) in Jatiyatal, *Cirrhinus mrigala* (50%) in Kitamantal and *Hypophthalmichthys nobilis* (45%) in Bakwatal in Uttar Pradesh. In wetlands of MP, IMC's contribution ranged between 47 & 78% barring Govindgarh which was dominated by catfishes (65%). A total of 57 fish species belonging to 37 genera, 20 families and 9 orders were recorded from the wetlands in Uttar Pradesh, and of these, 7 were exotics *Hypophthalmichthys nobilis, H. molitrix, Ctenopharyngodon idella, Cyprinus carpio, Oreochromis niloticus, Pterygoplichthys disjunctivus* and *Clarias gariepinus*. The vermiculated sailfin catfish, *Pterygoplichthys disjunctivus* was recorded for the first time in Ramgarh tal during the summer month. The recent invasion of *O. niloticus* and *P. disjunctivus* has been the threat to the native species of these wetlands. The most species-rich order was Cypriniformes (24), followed by Siluriformes (13). The most species-rich family was Cyprinidae followed by Danionidae (6) and Bagridae (5). The wetlands of MP were documented with a total of 33 fish species belonging to 28 genera, 14 families and 8 orders. Only the *Cyprinus carpio*, an exotic fish species was recorded from the Govindgarh whereas *Ctenopharyngodon idella* & *Hypophthalmichthys nobilis* were recorded from Man Sagar. The most species-rich order was Cypriniformes (18) followed by Perciformes (5) and Synbranchiformes (3).

Water quality

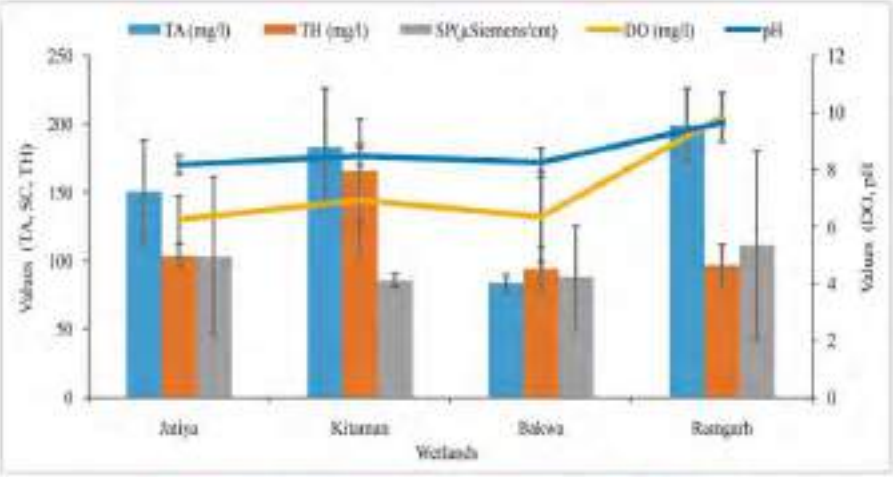
The analysis of water quality parameters in the wetlands of Uttar Pradesh revealed alkaline nature of water with a average pH of 8.6 (7.1-9.9), total alkalinity (TA) 159.3 (70-258) mg/l, dissolved oxygen (DO) 7.3 (2-13) mg/l, total hardness (TH) 115.9 (58-268) mg/l, and transparency of 43.6 (12-115) cm. The other important water quality parameters have been given in the figure.The gross and net primary productivity of these wetlands varied from 49.99-166.7 (av.97.03) $mgC/m^3/hr$ and 25-104.17 (56.9) $mgC/m^3/hr$. The turbidity ranged from 2.96-152 NTU being highest in Ramgarh tal in winter season. BOD was more than $1mgl^{-1}$ in all the wetlands irrespective of the seasons. The Ramgarh tal located in the heart of Gorakhpur city receives both domestic and industrial discharges and showed comparatively higher values of almost all the parameters.



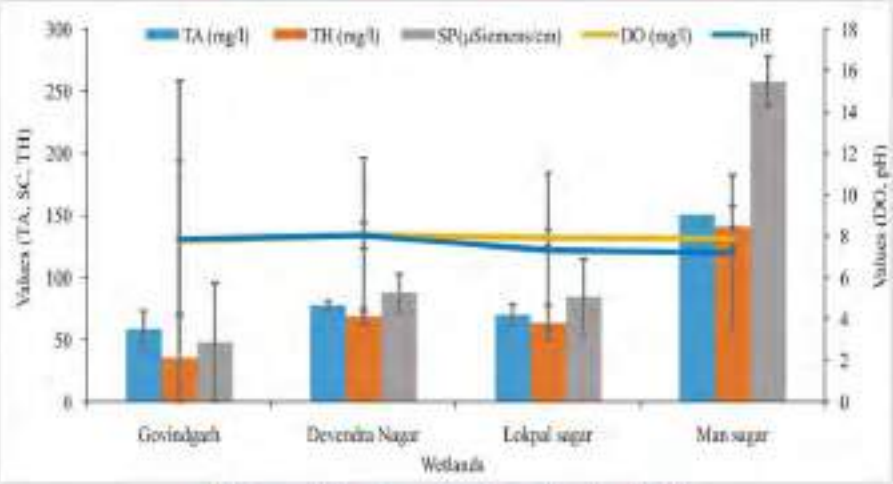
Family-wise species richness in wetlands of Uttar Pradesh



Family-wise specie richness in wetlands of Madhya Pradesh



Water quality parameters in wetland of Uttar Pradesh



Water quality parameters in wetlands of MP

The variations in the key water quality parameters of wetlands of Uttar Pradesh depicted in the Figure.

The examination of water quality parameters in wetland of Madhya Pradesh suggested the alkaline nature of their water with a mean pH of 7.89 (7.2-8.6), TA 102.9 (45-183) mg/l, DO 7.6 (4-11) mg/l, TH 77.19 (30-190) mg/l, and transparency 57.61 (17-133) cm. The other significant water quality parameters, SC, TDS, chloride, DOM ranged from 33-357 (119) µs/cm, 23-165 (55) mg/l, 3.5-58(17) mg/l and 1.2-4.9 (2.4) mg/l. The nutrient status of water of silicate-Si, nitrate-N, Phosphate-P ranged from 0.1-4.0 mg/l, 0.24-15.63 mg/l and 0.10-0.79 mg/l, respectively. The gross and net primary productivity of these wetlands varied from 66-138 (av 84.9) mgC/m^3/hr and 36-99 (57.1) mgC/m^3/hr respectively. The variations in the key water quality parameters of wetlands in MP are depicted in Figure.

Soil quality

The soil analysis indicated alkaline character of the sediment with an average pH of 7.93, being the highest in Ramgarh tal. The texture of the soil predominated with sand as a major component ranging from 64 to 98% suggesting sandy loam nature. The mean values of nutrients in terms of available-N and available-P in soil of Keetaman, Jatiya, Bakwa, and Ramgarh were 344.4 and 266 mgP/kg, 297.9 and 204.4 mgP/kg, 131.92 and 153.4 mgP/kg, 168.4 and 177 mgP/kg respectively. The soil analysis showed the alkaline nature of the sediment with a mean pH of 8.1, being highest in Man Sagar wetland. The texture of the soil was sandy loam in nature with sand content 70 to 97%. The mean values of nutrients in terms of available-N and available-P in the soil of wetlands of MP were 194.3 mgN/kg and 140.4 mgP/kg, 156.3 mgN/kg and 52.6 mgP/kg, 164.6 mgN/kg and 147.3 mgP/kg, 201.7 mgN/kg and 134.3 mgP/kg in Govindgarh, Devendra Nagar, Lokpal sagar and Man sagar, respectively.

Chlorophyll-a

Chlorophyll-a concentration ranged from 5.340-70.067 mg/m^3 in winter, 22.784-101.46 mg/m^3 summer and 5.34-239.588 mg/m^3 in monsoon season in selected wetlands of UP. The highest Chlorophyll-a concentration was recorded at Ramgarh tal in all the season while lowest concentration was recorded at Kitamantal, Jatiyatal, and Bakwatal in winter, summer and monsoon season, respectively.

Chlorophyll-a (chl-a) concentration ranged from 1.602-27.41 mg/m^3 in summer, 2.492-26.700 mg/m^3 in monsoon season in wetland of MP. The highest Chlorophyll-a concentration was recorded in Govindgarh in monsoon season while the lowest concentration was recorded at Man sagar in summer.

Plankton diversity and assemblage

A total of 57 genera of plankton, comprising 23 Bacillariophyta, 22 Chlorophyta and 12 Cyanobacteria with 19 plankton genera in winter, 30 in summer and 48 in monsoon seasons were recorded from the selected wetlands of UP. Plankton abundance ranged from 2,812 to 79,086 u/l. The maximum abundance was recorded in Ramgarh tal in monsoon and the minimum at Jatiyatal in winter. The planktonic population was dominated by Bacillariophyta (17,433 u/l from Bakwatal in summer to 1733 u/l at Jatiyatal). The highest abundance of Chlorophyta and Cyanobacteria (42700 u/l and 79086 u/l) was recorded in Ramgarh tal during monsoon. Bacillariophyta group was

dominated by *Navicula, Cyclotella, Nitzschia, Gomphonema, Melosira, Cymbella, Fragillaria, Frustulia, Synedra,* and *Diatoma,* whereas Chlorophyta groups were dominated by *Monoraphidium, Pediostrum, Desmodesmus, Pleurococcus, Spirogyra, Tetraedron* and *Cosmarium.* Among Cyanobacteria-*Anabaena, Phormidium, Oscillatoria, Geitlerinema,* and *Merismopopedia* dominated.

A sum of 18 plankton genera in winter, 23 in summer and 15 in monsoon season with a total genus being 23 was recorded in selected wetlands of MP. Plankton abundance ranged from 3,560 u/l to 66,415 u/l. The maximum abundance was recorded in Govindgarh in all the seasons. Bacillariophyta was dominated by Navicula, Cyclotella, Melosira, Cymbella, and Fragillaria whereas, Chlorophyta was dominated by Monoraphidium, Pediastrum, *Golenkinia, Kirchneriella,* and Cosmarium. Anabaena, Phormidium, Oscillatoria, *Chroococcus,* and Merismopopedia dominated the Cyanobacterial group.

Periphyton

A total of 55 genera of periphyton belonging to 28 Bacillariophyta, 12 Chlorophyta, 11 Cyanobacteria, 1 Euglenophyta, 1 Rhodophyta, 1 Rotifera, and 1 Arthropoda were recorded in the selected wetlands of UP. The periphytic abundance ranged from 20,200 to 5, 42,067 u/cm^2 with maximum at Kitamantal in the monsoon and a minimum at Ramgarh tal in winter season. Periphytic population was dominated by Bacillariophyta (8200 u/cm^2 from Ramgarh in summer to 3, 16,233 u/cm^2 at Kitaman Tal). The highest abundance of Chlorophyta was recorded in Kitaman Tal (1,15,200 u/cm^2) in monsoon. The highest abundance of Cyanobacteria was recorded at Ramgarh Tal (1, 49,000 u/cm^2) in the summer season. Dominant genera of Bacillariophyta were *Navicula, Cyclotella, Nitzschia, Gomphonema* and *Melosira*, while *Monoraphidium, Pediastrum, Desmodesmus, Pleurococcus, Spirogyra, Tetraedron, Cosmarium, Eudorina,* and *Scenedesmus* was the foremost in *Chlorophyta* and *Anabaena, Phormidium, Oscillatoria, Geitlerinema* and *Merismopopedia* among Cyanobacteria.

A total of 27 genera of periphyton belonging to 10 Bacillariophyta, 12 Chlorophyta, 04 Cyanobacteria, and 1Charophyta were recorded from the selected wetlands of MP. The periphytic abundance ranged from 23,543 to 4,63,533 u/cm^2 with the maximum at Govindgarh in summer and minimum at Man Sagar in winter. The dominant genera of Bacillariophyta were *Cyclotella, Cymbela, Nitzschia,* and *Melosira*, while *Monoraphidium, Pediastrum, Pleurococcus, Tetraedron, Cosmarium,* and Scenedesmus were the dominant in Chlorophyta. Among Cyanobacteria, *Spirulina, Anabaena,* and *Oscillatoria* were dominant.

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 : April 2020 - March 2023

Sub-project1: Monitoring of targeted pesticides and emerging contaminants in selected water bodies

Sub-project2: Monitoring of heavy metals and arsenic in selected inland water bodies

Sub-project1: Monitoring of targeted pesticides and emerging contaminants in selected water bodies

Scientific Personnel : S. K. Nag (P.I. & Sub-project leader), S. K. Manna, S. Das Sarkar (on leave 15.09.22-31.12.22), Md. Aftabuddin, K. Kumari (leave 22.08.22-31.12.22), A. Saha

Pollution status of River Cauvery

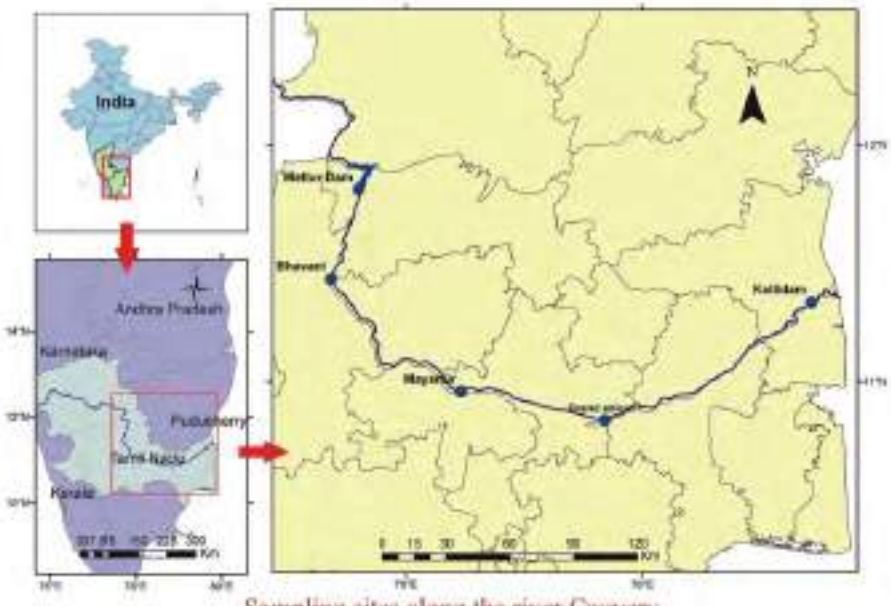
The River Cauvery is one of the major rivers of the Indian Peninsula flowing through the states of Karnataka and Tamil Nadu. The total length of the river is 800 km and the catchment area of the river basin is estimated to be 81,155 square kilometres which extends over states of Tamil Nadu, Karnataka, Kerala and Union Territory of Puducherry. There are many industries in the river basin including steel, textiles, and other engineering projects. Different reports point out about pollution of the river with metals and a range of different emerging contaminants.

Sampling points

Five locations along the middle and lower stretch of the river viz., Mettur dam, Bhavani, Mayanur, Grand Anicut and Kollidam, (N11°48'35" – N11°20'7"and E77°47'56" – E79°42'58", Elevation ranging from 243m to 4m) were selected for sampling.

Characterization of water and sediment quality of Cauvery River, South India

Spatio-temporal variations of physicochemical parameters in the water and sediment quality of Cauvery River was evaluated at Tamil Nadu state covering lower stretch (Mettur Dam, Bhavani, Mayanur, Grand Anicut & Kollidam stations) during pre and post-monsoon. The study revealed that high algal bloom and stimulation of phytoplankton produces more oxygen as a by-product of photosynthesis which resulted in high DO at Mettur dam during post-monsoon period. High BOD at Bhavani station may be due to discharge of temple waste, mass bathing and it is the confluence of Bhavani and Cauvery river. Higher value of hardness, chlorinity and conductivity indicates the anthropogenic influences and influx from its tributaries. High nutrient (Nitrate-N and phosphate-P) content at Bhavani station may be due to recent entry of waste water which gives necessary indication of water quality deterioration. The results suggest that appropriate treatment of urban and industrial wastewater and governance of anthropogenic activities in the Cauvery River catchment are essential for controlling the potential pollution of this important river.



Sampling sites along the river Cauvery

Sediment characteristics of Cauvery River

The pH of the river sediments varied from 8.1 to 8.71and 8.17 to 8.75 during post-monsoon and pre-monsoon season, respectively, implying alkaline nature. Grain size distribution in the Cauvery River suggests that this river is a low gradient and coarse-grained system except Mettur station. The sand fraction is the dominant fraction. USDA textural classification indicates that sediment texture of Bhavani, Mayanur and Kollidam is sandy in nature, while Mettur sediment is loam and Grand-Anicut sediment is loamy sand in nature. Organic carbon content of the sediments showed ranges of 0.12–2.89 % and 0.21–3.04 %, during post-monsoon and pre-monsoon period, respectively. Comparative higher organic carbon content at

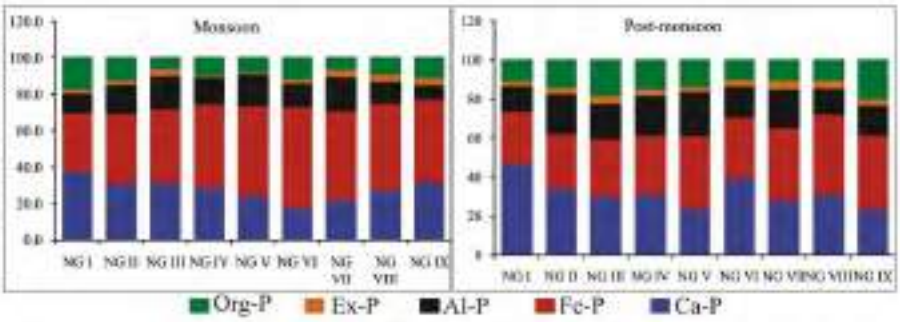
Table: Seasonal and spatial variation in basic water parameters of the Cauvery River

Parameters	Transparency (m)	Water Temperature (°C)	pH	DO (mg/l)	Spc. Cond (µs/cm)	Alkalinity (mg/l)	TH (mg/l)	Ca (mg/l)	Cl (mg/l)	BOD (mg/l)	Si (mg/l)	Nitrate-N (mg/l)	Phosphate-P (mg/l)
Post-monsoon-2022													
Mettur	0.71	27.3	9.0	11.2	379.5	134	174.0	19.2	33.2	4.4	14.3	0.011	0.012
Bhavani	1.10	28.8	9.20	6.4	576.3	162	144.7	20.8	62.2	8.4	15.1	0.037	0.039
Mayanur	0.64	27.3	9.34	7.2	907.5	232	179.0	26.5	111.0	4.2	18.1	0.009	0.012
Kollidam	0.59	27.5	8.97	6	915.7	197	141.3	21.6	101.0	2.4	14.9	0.008	0.005
Pre-monsoon-2022													
Mettur	1.28	28.2	8.1	5.5	435.2	175.5	135	42	44.0	2.85	31.5	0.017	0.040
Bhavani	1.28	27.7	7.3	3.6	480	174.5	141	56	44.5	5.36	35.1	0.057	0.068
Mayanur	1.00	25.6	8.1	8.3	509	190.5	152	62	58.5	3.86	21.7	0.030	0.029
Grand Anicut	1.20	25.8	7.7	7.2	536	186	153	64	75.0	2.03	30.6	0.007	0.027
Kollidam	1.42	29.1	7.4	6.0	32701	163	3550	500	10699.7	2.41	13.5	0.009	0.019

Mettur Dam indicates the degree of pollution in the aquatic environment. Specific conductivity (EC) of river bottom sediment varied from 246 to 3840 µs/cm and 209 to 3750 µs/cm during post-monsoon and pre-monsoon period, respectively.

Spatiotemporal variability in phosphorus species in the sediment of Cauvery River

Phosphorus is both a nutrient and a key factor responsible for eutrophication of freshwater ecosystem. Knowledge on geochemical forms of phosphorous is one among the proxies to monitor the quality of an aquatic ecosystem. Sediment samples were collected from the Cauvery River and fractionated into five namely, exchangeable P (Ex-P), Fe-P, Al-P, Ca-P and Org-P for study. Total phosphorus (TP) content varied from 299.2-386.6 mg/kg and 372.6-484.6 mg/kg in post-monsoon and pre-monsoon, respectively. The mean values of P fractions indicate that Ca-P was dominated in all the station except Mettur where Fe-P was predominant. It implies P had a preferential association with Ca.



Spatio-temporal variation in percentage contribution of phosphorous fraction to Total P in the sediment of Cauvery river.

Pesticide residues in water, sediment and biota (fish)

A total of 34 compounds including pesticides and their metabolites belonging to three groups viz., organochlorines (OC), organo-phosphates (OP) and synthetic pyrethroids (SP) were targeted for residue analysis.

Water samples

The contamination of water in the selected stretch of the river with pesticide residues was at a very low extent and level. Among the OCs analysed, only pp DDT (0.025-7.65 µg/l) was recorded in water samples of Grand Anicut and Mayanur. Among the OPs, residues of chlorpyrifos (0.051 µg/l) in Mettur dam, malathion (0.069 µg/l) in Mayanur and me-parathion (0.063 µg/l) in Kollidam site were detected. In regard to SPs, cypermethrin (0.039-0.182 µg/l) in Mettur, Bhawani, Mayanur samples and fenpropathrin (0.155 µg/l) in Mayanur samples were detected. The concentrations of pesticides in water were mostly within the critical maximum concentration (CMC) but higher than criterion continuous concentration (CCC) as recommended by USEPA for aquatic life.

Sediment samples

In sediments accumulation of OC residue was negligible. Only traces of op DDD and pp DDE were recorded in Mayanur sediment samples. Among the OPs, only chlorpyrifos (0.004 mg/kg) was detected in one sampling site i.e. Mayanur. Among the SPs, cypermethrin (0.017 µg/g) in Mayanur, cyfluthrin (0.001 µg/g) and fenvalerate (0.002 µg/g) in Bhawani were recorded. So, pesticide residue load in sediments was very meagre.

Table: Spatial and temporal variations of different sediment parameters of Cauvery River

Parameters	pH		Sediment specific conductance (µScm^{-1})		Sediment OC (%)		Textural classification	
Stations	POM	PRM	POM	PRM	POM	PRM	POM	PRM
Mettur	8.1	8.38	3840	1207	2.89	3.04	Loam	Loam
Bhavani	8.48	8.2	300	365	0.27	0.36	Sand	Sand
Mayanur	8.47	8.17	246	209	0.15	0.21	Sand	Sand
Grand Anicut		8.44		219		0.22		Loamy Sand
Kollidam	8.71	8.75	190.3	3750	0.12	0.21	Sand	Sand

POM: Post-monsoon-2022; PRM: Pre- monsoon-2022

Biota (Fish)

About 12% of total fish samples collected from different sites were found to contain residues of OCs, particularly DDE isomers. In few instances, HCH isomer and endosulfan were also recorded. Total DDT residues in fishes varied from 0.002-1.69 µg/g which was much lower than the FSSAI (FSSR) tolerance limit of 7 µg/g. Total endosulfan residues varied from 0.002-0.018 µg/g which was also lower than 0.2 µg/g tolerance limit prescribed by FSSAI. HCH isomers were recorded at much lower concentration (0.001-0.007 µg/g). In regard to OP compounds, chlorpyrifos was detected in many fishes at concentrations varying from 0.003-0.641 µg/g. Other than this, malathion (0.089-0.358 µg/g) and quinalphos (0.167-0.698 µg/g) were also recorded in few fishes. Overall, 15% fishes were contaminated with OP residues. SP residues were also present in about 15% samples. Cypermethrin was mainly detected (0.005-0.447 µg/g), particularly in fishes from Grand Anicut. Cyfluthrin, fenvalerate, fluvalinate were the other SPs detected in fish.

Emerging contaminants

Phthalate esters

Phthalate esters (PE) are commonly used as plasticizers and in many personal care products. These are also known as endocrine disrupting chemicals and distributed in different environments including air, water, sediment and also bioaccumulate in fish. Fish samples collected from Cauvery river sites were processed for estimation of two important members of Phthalate esters viz. diethyl phthalate (DEP) and diethyl hexyl phthalate (DEHP) in GC-MS. DEP was recorded at concentrations 0.048-0.818 µg/g in different fish species viz., *Oreochromis nilotica, Mystus punctatus, Labeo bata, Puntius sarana* collected from Bhavani and Grand Anicut. DEHP (0.033-0.39 µg/g) was also detected in fishes like *Notopterus notopterus, Etroplus suratensis, P. sarana, O. nilotica* obtained from Bhavani and Grand Anicut sites.

Triclosan and Triclocarban

Triclosan (TCS) and Triclocarban (TCC) are two antimicrobial compounds used widely in different personal care, hygiene and domestically used products. Both of these chemicals are highly toxic to aquatic organisms, particularly algae, crustaceans and fish. Residues of TCS and TCC have been detected in 14% (n=37) of the fishes sampled across study sites. TCS was detected in muscle tissues of *Oreochromis niloticus* (0.148 µg/g) and TCC in *Mastacembelas armatus* (0.272 µg/g) from station Bhawani collected during post-monsoon season. Both the TCS and TCC with concentration of 0.721 µg/g and 0.366 µg/g, respectively were detected in *Mugil cephalas* from estuarine site of Kollidam. In addition, TCS was also detected in *Caranx* sp. (1.04 µg/g) and *Eleotheronema tetradactylum* (0.436 µg/g) from the same area. However, the compounds could not be traced in water matrices.

Pollution monitoring of Cauvery river in Tamil Nadu stretch of by sediment enzyme activities

Sediment microbial functional analysis in terms of sediment enzymes revealed distinctly higher activities in dam and barrage sites than normal river course for all four enzymes. Mettur dam sediments were characterized by higher alkaline phosphatase, acid phosphatises and glucosidase activities and lower general microbial activities than Grand Anicut Barrage site. Of the four river sites, Bhavani and Kollidam have higher enzyme activities except acid phosphatase. Preliminary findings revealed more phosphorous and carbon mineralization in dam than river sites which may be due to higher sediment organic matter and moisture. Among river sites, sites having more anthropogenic activities in form of city sewage, agricultural and industrial wastes showed higher mineralization potential.

Effect of Cypermethrin on wetland sediment enzymes

Experiment was conducted to understand effect of cypermethrin on wetland sediment enzymes playing role in phosphorous cycling (phosphatses), carbon cycling (glucosidase) and general microbial metabolism (dehydrogenase) by treating sediment of Khalsi wetlands for 7 and 14 days with 10 and 100 ppm cypermethrin. Data on 7 days incubation revealed marginally increased activities of both the phosphatase enzymes in 10 ppm

Table : Changes in soil enzyme activity of wetland due to treatment with cypermethrin

River Stretch		Dehydro-genase (µg TPF/g dry soil/h)	Acid Phosphatase (µg pNP/g dry soil/h)	Alkaline Phosphatase (µg pNP/g dry soil/h)	β- Glucosidase (µg pNP/g dry soil/h)
Dam	Mettur	26.47	402.86	499.91	99.90
	Grand Anikut above Barrage	34.42	97.06	139.76	41.43
River	Bhavani	1.09	33.80	71.03	20.28
	Kollidam	2.13	7.55	30.57	13.08
	Grand Anikut Below Barrage	0.27	13.86	40.89	9.14
	Mayanur	0.12	6.68	20.13	9.73

Table : Changes in soil enzyme activity of wetland due to treatment with cypermethrin

Treatment	Dehydro-genase (µg TPF/g dry soil/h)	Acid Phosphatase (µg pNP/g dry soil/h)	Alkaline Phosphatase (µg pNP/g dry soil/h)	B-Gluco-sidase (µg pNP/g dry soil/h)
		Incubation: 7 days		
Methanol (control)	15.28	78.87	180.20	40.52
Cypermethrin 10 ppm	15.91	89.12	187.88	40.09
Cypermethrin 100 ppm	20.24	199.07	295.02	58.90
		Incubation: 14 days		
Cypermethrin 10 ppm	82.86	200.02	298.89	97.68
Cypermethrin 100 ppm	25.89	144.28	266.31	59.78

concentration and significantly higher activities in 100 ppm in comparison to control. The dehydrogenase and β glucosidase activities increased in 100 ppm only. Acid phosphatase was the most impacted enzymes at 100 ppm concentration. In 14 days incubation, dehydrogenase activities increased in both the concentration with significantly higher in 10 than 100 ppm. In 14 days activities of both the phosphatase enzyme and β glucosidase increased significantly at 10 ppm while in 100 ppm phosphatase activities decreased, without any change for β glucosidase as compared to 7 days. The pesticides enriched enzyme producing population of microbes by providing the carbon source for microbial growth that increased their general metabolic activities and improved enzymes associated with maintaining sediment health in oligo- and mesotrophic wetland ecosystem.

Sub-project 2: Monitoring of heavy metals and arsenic in selected inland water bodies

Scientific Personnel : D. J. Sarkar (Sub-project Leader), S. K. Manna, Santhana Kumar V., P. R. Behera, T. Bera, S. Samanta, S. Das Sarkar (on leave 15.09.22-31.12.22), A. K. Bera (w.e.f. 01.04.2021)

Metal pollution status in River Cauvery

Water, sediment and fish samples collected from the river Cauvery were analyzed in ICPMS for finding the pollution of the river ecosystem with heavy metals like Fe, Mn, Zn, Cu, Cr, Cd and Pb. In water phase, the level of Pb and in few places Cd concentration exceeded the USEPA prescribed limit for aquatic community. In sediments, Cr level indicated moderate to heavy pollution. Deposition of metals like Cr, Cd and Pb were also found in fish tissue but their levels were very low, which apparently would not pose any health risk to the consumers.

Trophic level distribution of arsenic in Media beel, West Bengal, India

Arsenic (As) contamination in the wetlands of West Bengal is a serious problem and is a very critical issue in view of the human health risk. Due to bioconcentration and biomagnification carcinogenic As distributes in the various biotic compartments of the wetlands and ultimately bioaccumulate in the fishes. Hence in the present study As contamination level and its distribution mechanism was studied in a typical oxbow lake, Media Beel which is situated in a highly As contaminated belt of West Bengal. It was found that the wetland ecosystem is highly contaminated with As and in the wetland water it ranged from 20 to 45 ppb, whereas in the tube well water the contamination range was found higher (46-136 ppb). In the sediment As was found in the concentration range 70-352 ppb. Not only abiotic compartments As was also estimated in the various biotic compartments of the wetland (macrophytes, crustaceans, gastropods and finfish). In the aquatic weeds (*Ceratophyllum* spp., and *Eichhornia crassipes*) the As concentration ranged from 1.24 to 20.90 µg/g, and the value was found to be dependent on the accumulation behavior of As in the various plant parts. In the benthos (*Pila globosa* and *Bellamya bengalensis*) the contamination ranged from 0.19 to 0.99 µg/g. In the fin fishes (*Cirrhinus mrigala* and *Notopterus notopterus*), the concentration of As was ranged from 0.43 to 0.59 µg/g on dry weight basis.

Banana waste-based microalgae biofilm converts arsenic into non-toxic form

Banana pseudostem waste was used as a substrate for growing microalgae biofilm (BSB) and its arsenic (As) removal capacity was examined. BSB treatment removed 97.6% of added arsenite [As(III)] and converted into less toxic forms like arsenate and dimethyl arsenic acid within 5 days. The toxic mechanism might be the functional groups and EPS of the microalgae biofilm binds As (III) from the contaminated water and oxidized it into As (V). After oxidation, As (V) entered into algal cells through the phosphate transport pathway and transformed them into first MMA and then into DMAs. Finally, DMA was excreted by the microalgae biofilm into the treatment

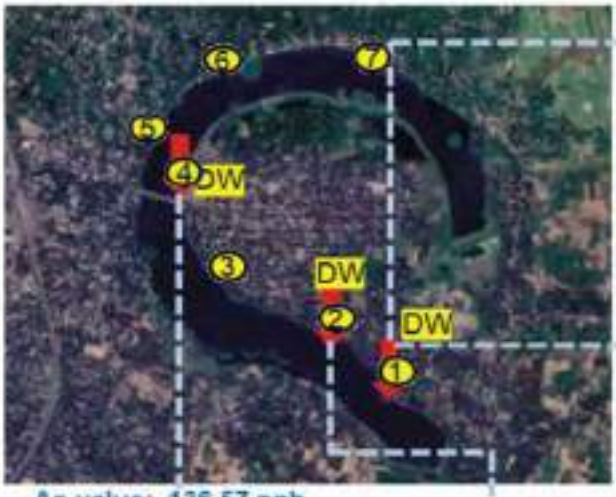
Table : Arsenic concentration in the abiotic and biotic compartment of the Media beel

	As in water (ppb)	As in sediment (ppb)
Station-1	38.85 ± 3.23	246.00 ± 23.54
Station-2	26.89 ± 5.12	73.54 ± 9.56
Station-3	20.69 ± 2.42	164.95 ± 14.96
Station-4	27.12 ± 6.24	70.73 ± 21.78
Station-5	21.95 ± 4.58	352.84 ± 78.36
Station-6	45.32 ± 6.35	137.51 ± 52.32
Station-7	20.01 ± 3.48	123.63 ± 57.36
Biotic compartment	**As content (ppm)**	
Fish		
Cirrhinus mrigala	0.59 ± 0.10 (Muscle)	
Notopterus notopterus	0.43 ± 0.09(Muscle)	
Benthos		
Pila globose	0.99 ± 0.02 (Flesh)	
	0.19 ± 0.04 (Shell)	
Bellamya bengalensis	0.58 ± 0.10 (Flesh)	
Aquatic Weed		
Ceratophyllum sp.	3.56 ± 0.65 (Leaf)	
Eichhornia crassipes	1.24 ± 0.96 (Leaf)	
	0.58 ± 0.21 (Shoot)	
	20.90 ± 3.45 (Root)	
Plant		
Solanum melongena	0.05 ± 0.02 (Fruit)	
	2.55 ± 0.97 (Leaf)	

water. Interestingly, banana pseudostem itself accumulates 70.4% of the total As (III) added, out of which 86% of As (V) and 14% of DMA. As exposure also led to a change in microalgae community composition towards more tolerant species (i.e. class Chlorophyceae and Bacillariophyceae) that produced more proteins and lipids facilitating the binding of As and amelioration of induced stress, respectively. The study also paves way for providing the concept of "waste into wealth" by utilizing the agri-wastes for a sustainable and more economical water treatment process.

Microalgae biofilm reduced arsenic accumulation in fish and human health risk

Microalgae biofilm was grown on mesh net to ameliorate the toxic properties of arsenite [As (III)] to a model fish i.e. *Labeo rohita* and also assesses the risk as food. Fishes are introduced to As (III) contaminated water (0.3 and 3 ppm) along with microalgae biofilm and fish health was assessed (growth, biochemical,



As value: 136.57 ppb
(present study)

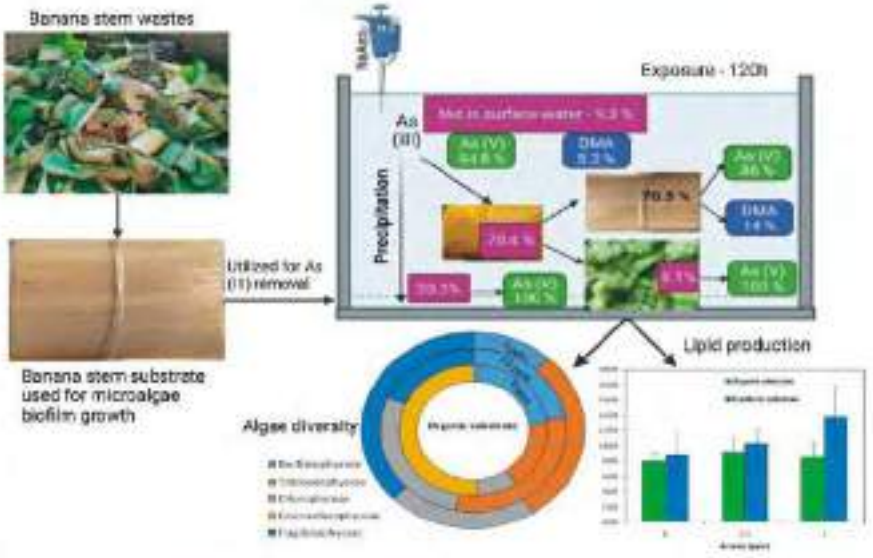
SWARUPNAGAR
Gram Panchayat: KAJURI G.P
Source Id: 8165-052
As value: 84 ppb
(46.08 ppb present study)
Depth: 1150 Ft
Category: India mark -II Type
Handpump Tube well

As value: 59 ppb (present study)

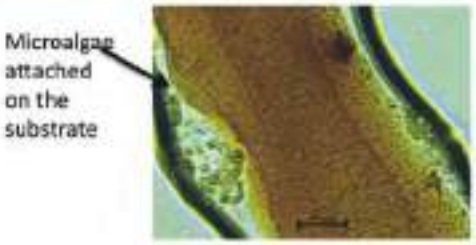
Station-1	Samity office
Station-2	Rabindranagar
Station-3	Duburighat
Station-4	Bridge
Station-5	Nikiripara beel
Station-6	Tepul beel
Station-7	Tepul beel

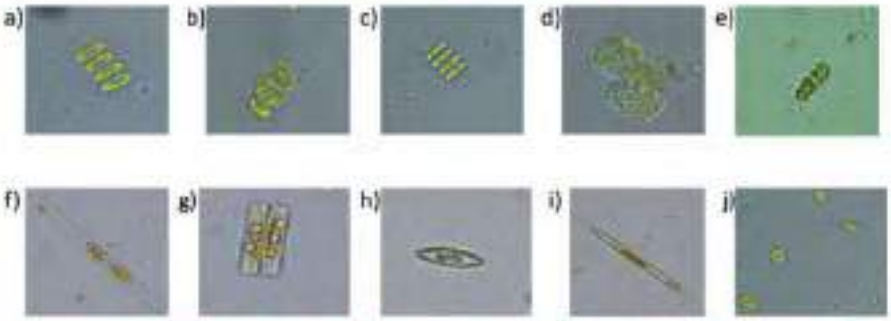
SWARUPNAGAR
Gram Panchayat: TEPUL MIRZAPUR
Source Id: 8169-195
As value: 62 ppb
(68.68 ppb present study)
Depth: 826 Ft
Category: India mark -II Type
Handpump Tubewell

Sampling sites at Media beel and arsenic concentration in the tube well water

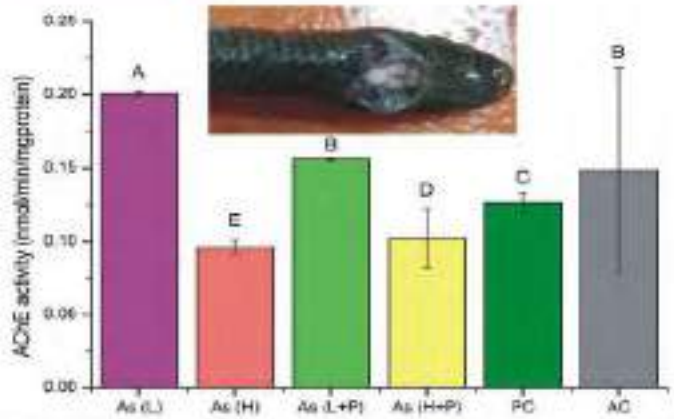


Banana pseudostem-based microalgae biofilm converts toxic arsenic into non-toxic forms





Microalgae community present in the biofilm grown on banana pseudostem. a) *Scenedesmus* sp., (b) *Scenedesmus* sp., (c) *Scenedesmus* sp., (d) *Scenedesmus* sp., (e) *Scenedesmus bijuga*, (f) *Nitzschia* sp., (g) *Fragellaria* sp., (h) *Navicula* sp., (i) *Synedra* sp., (j) *Chlorella* sp.



Changes in AChE enzyme activity of fish (*L. rohita*) brain exposed to different concentrations of arsenic with and without the presence of periphyton treatment. The bar that shares similar alphabets is not statistically significant from each other

haematological, neurological and physiological parameters) after 30 days of exposure. The human health risk was also evaluated via estimated daily intake, Target Hazard Quotient (THQ) and Target Cancer risk (TCR). Further, As bioaccumulation and their biotransformation in fish tissues and periphyton were analyzed through speciation studies using LC-ICP-MS. Microalgae biofilm incorporation greatly improved ($P<0.05$) the As (III) induced suppression in respiration, NH_3 excretion and brain AChE activity in fish via the reduction in oxidative stress and As bioaccumulation. It also improves the haematological parameters (RBC and WBC), serum and tissue biochemical parameters, specific growth rate (0.83-0.85 g day^{-1}) and feed conversion ratio (1.8-2.0) as compared to control. Speciation studies using LC-ICP-MS confirm high accumulation of As (V) by the periphytic system (5-31.9 g g^{-1}) and low accumulation in fish muscle. It was also observed their conversion to less toxic excretory forms [As (V) and DMA]. The present study signifies the usage of microalgae biofilm-based aquaculture system in As contaminated region for producing safe fish with improved fish yield.

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

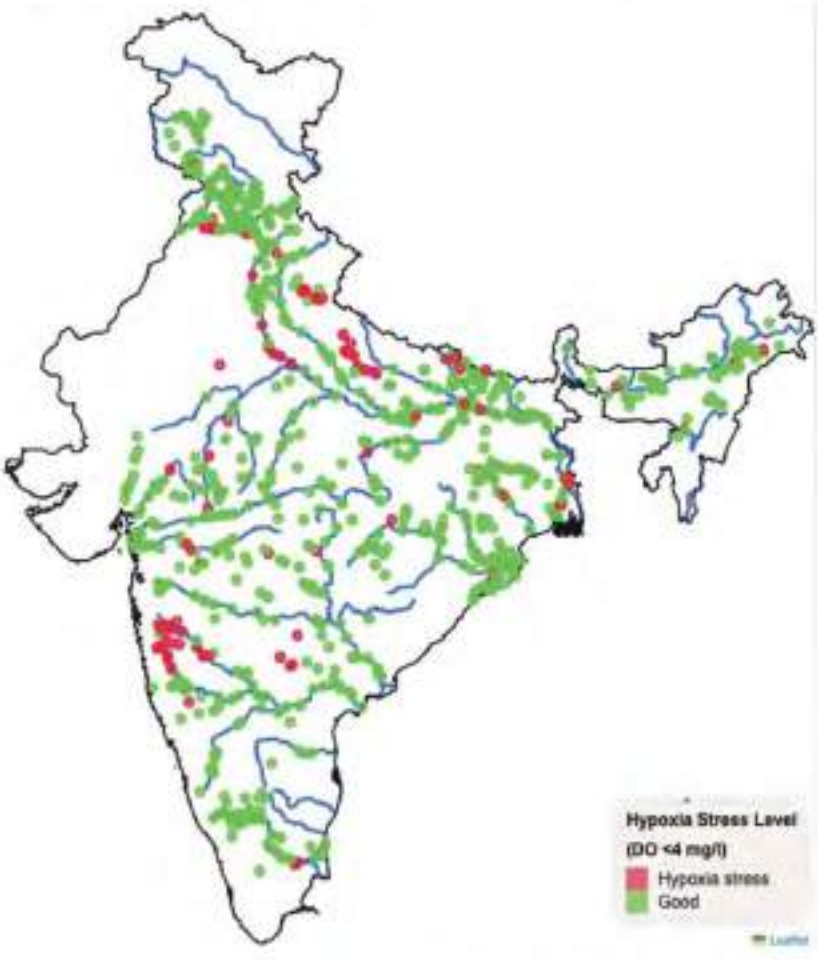
Project Code: FREM/20-23/18

Duration: April 2020 - March 2024

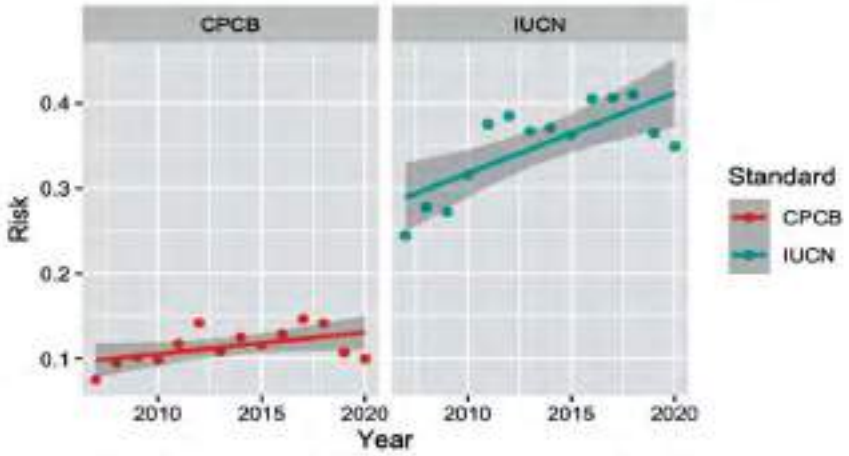
Scientific Personnel: M. Naskar (P.I.), B. K. Das, A. K. Das, S. K. Sahu, C. Jana, N. Chanu, Arun Pandit, S. N. Singh (upto 30.04.22) and D. Das

Data ingestion and munging: These two terms are the most important steps in the workflow of Bigdata analytics. The present data ingestion entails extensive web-search for relevant data to fulfill two objectives - creation of nationwide map of aquatic life suitability in Indian rivers and enlisting all inland fish species endemic and exotic to India. The data in Ministry of Jalshakti and CPCB websites are in different formats, especially in text and pdf files. A python program that converts tables in pdf was used to retrieve the data. The retrieved data were available for 14 years (2007 to 2020) asynchronous at 2667 location distributed over Indian rivers - including canals. The converted data were then saved into the cloud storage for application development using Big data tools. Again a python program has been developed for data munging that includes discarding outliers, filling missing values, synchronizing geo-location, parameter filtering, data concatenation, basic exploratory analysis. A python program has also been developed for web-scraping using 'Beautiful Soup' and 'selenium' modules. It automatically searches two main websites - FishBase and Catalogue of Fishes, and then downloads fish species list from both sites, matches two list and finally enlists all the freshwater fish species along with the alternative names. The programming error was assessed by setting the benchmark of the manual list. Finally, 1428 inland fish species (28 orders; 118 families; and 496 genera) were listed and saved in a cloud storage. It is somewhat higher than those listed by FishBase, as because we included all fish species that spend some period in inland waters during their life cycle. An extensive literature survey was carried out for exotic fish species; it entailed 21 research and popular articles, websites of ICAR-NBFGR, NFDB, MPEDA, aquarium Fish India (www.aquarimfishindia.com), resulting in 227 species belonging to 126 genera, 41 families and 15 orders. The future aim is to correlate species distribution with environment-specifically derived from remotely sensed images and on-field secondary data.

Feature add-ins to Web-GIS portal: Three very useful features are added in the existing Web-GIS portal, as follows. A feature add-in exploration of CPCB data through online GIS. A total of seven parameters-temperature, DO, pH, Conductivity, BOD, Nitrite and Fecal Coliform - were presented on the Web-GIS platform. It displays the maximum, minimum and mean values of each parameter. A timeline (year) slidebar is placed in the web pages that an interested user can visualize the spatial and temporal trend. The second feature is the online GIS mapping of hypoxic stress of the Indian river system, which is the first ever attempt in India. Hypoxia is an environmental phenomenon wherein Dissolve Oxygen (DO) concentration in an aquatic system falls below the minimum threshold necessary for the propagation of aquatic life. IUCN set the threshold DO of 5-6 mg/l, while CBCB conservatively set this threshold of 4 mg/l. The present exploratory analysis used the



GIS map of hypoxic stress in Indian rivers



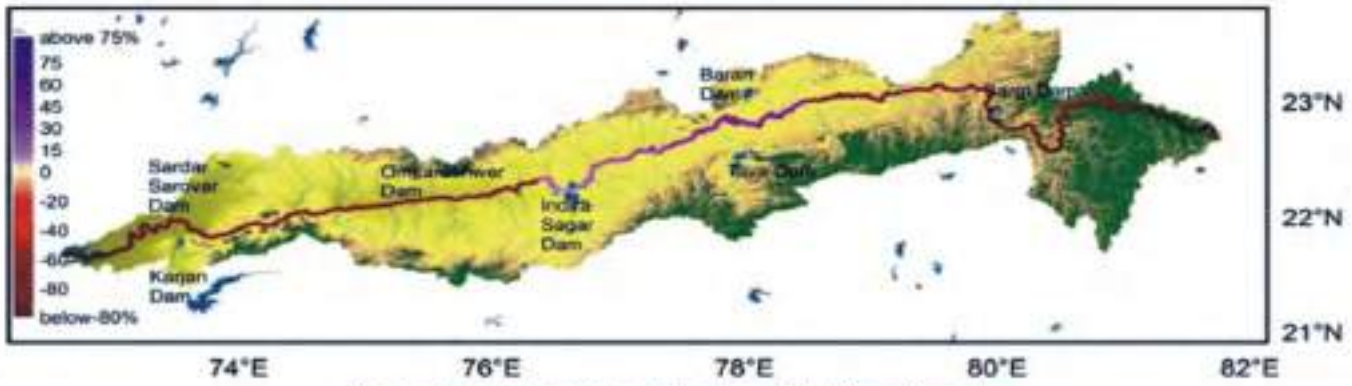
Trend in the risk of hypoxic stress in the Indian River system

minimum DO value as the indictor and defined the hypoxic stress of a site when the yearly minimum DO level falls below the threshold values mentioned above. The Web-GIS map produces hypoxic stress map for both the thresholds. It also has the timeline slide bar to see the spatio-temporal changes the risk of hypoxic stress in the Indian river system. The feature is very useful to the managers to location-specific decision-making for remedial measures and low enforcement. A Poisson-Gamma mixture model predicted increasing trend of hypoxic stress risk in Indian reiver system for both standards, IUCN and CPCB.

Species richness in different inland waters and in their interacting environment

The third feature allows a user to navigate aspatial species information. It readily displays a Venn diagram of the species richness of two interactive habitats: freshwater and brackish water. Besides, it offers other options of view, such as alphabetical list, habitat type, taxonomy type and their intersection. Indian fish taxonomic richness can be explored with a few mouse click, which is not available in India till date.

The zooplankton community is a widely used bioindicator for the biological assessment of riverine aquatic ecosystems. Phyto-zooplankton interaction and spatially varying river environment parameters perceivably govern their spatial distribution in a large river. This invites the challenge of predicting zooplankton abundance along the river channel. The present study has proposed a geostatistical framework to predict zooplankton abundance along the river course while decoupling phyto-zooplankton relationship from spatial dependency. The strength of secondary data on the river Narmada-a large tropical river in India-has been utilized to accomplish the goal. The nonlinear logistic regression kriging has been found to be the most effective framework. The phyto-zooplankton relationship captured 66% of zooplankton variability, having moderate (37%) residual spatial dependence. The results have shown longitudinally fluctuating spatial variability, which supports the river serial discontinuity concept. The proposed framework has generated smooth zooplankton abundance and sustainability predictive maps that have allowed detection of the change point locations of zooplankton abundance. The map has precisely identified the most productive zone of zooplankton sustainability. The study also has appraised obtaining approximate data in the areas where sampling is infeasible, which will be helpful for location-specific management strategies on a lower spatial scale. Although it does not replace actual sampling data, the approximate augmented data are helpful for better management-even on a low spatial scale. It is a significant step forward for better river management concerning potamoplankton.



Zooplankton Sustainability Index map of the River Narmada

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

Project code: RWF/17-20/09

Duration: April 2017 - March 2022

Scientific Personnel: B. K. Das (P.I.), A. K. Sahoo, M. H. Ramteke, U. K. Sarkar, S. Kumari, Mishal P., D. Das, M. A. Hassan, R. Das, G. Karnatak, H. S. Swain, T. Tayung (upto 05.10.21), S. P. Kamble, A. K. Das, V. R. Thakur, D. Debnath, S. Yengkokpam, P. Das

Evaluation of different substrates for periphyton based cage culture of *Systomus sarana*

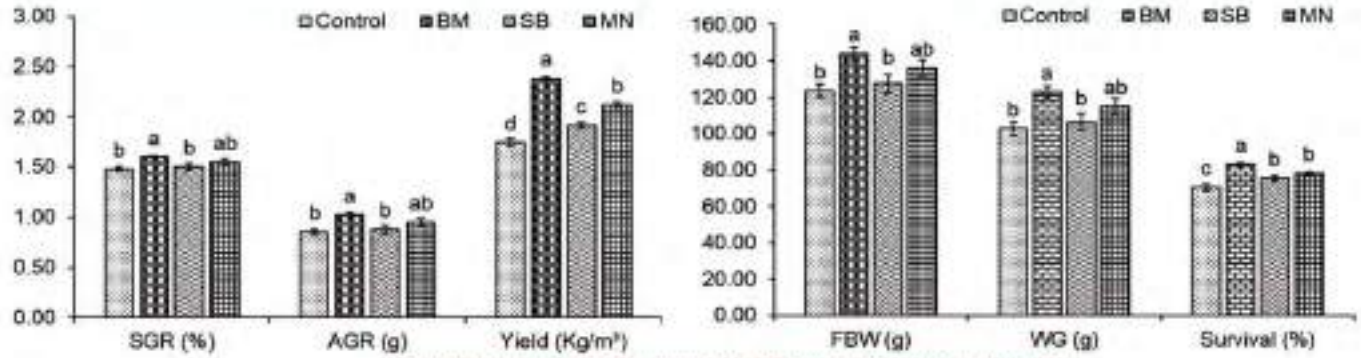
The study aimed at evaluating different periphyton substrates (quantitative and qualitative) and their impact on the growth and survivalof *S. sarana*. The study was conducted for a period of 120 days. The experiment was divided into four treatments based on the types of substrates used, namely C (control group – without substrate), BM (bamboo-based substrate), SB (sugarcane-based substrate), MN (mosquito net-based substrate). The fingerlings of *S. sarana* with avg. size 20.87±1.35g stocked @20 nos.m^{-3} in all the cages. The result showed that, the maximum Final Body Weight (FBW) was recorded in BM (143.80±3.35g), which was significantly ($P<0.05$) higher than control (123.50±3.49g) and SB (127.40±4.76g). Similarly, the highest Weight Gain (WG) was observed in BM (122.93±3.35g), which was significantly higher than control (102.63±3.49g) and SB (106.53±4.76g), but not significantly different from MN (114.93±4.55 g). Highest Specific Growth Rate(SGR) was recorded in BM (1.60±0.01%), which was 7.5% higher than the control (1.48±0.02%). The highest survival was recorded in BM (82.75±0.92%) followed by MN (78.06±1.06%), SB (75.25±1.30%) and control group (70.46±1.64%) respectively. The yield attribute analysis reflects that the highest yield per cage was obtained by BM (199.91±2.02 kg), which was significantly higher than other treatments. With the incorporation of periphyton in the treatments, the yield of SB (161.05±2.79kg) and MN (178.08±2.43kg) was increased by 10% and 21%, respectively, in comparison to control (146.19±3.41kg). The lowest FCR value obtained was 1.25±0.07 in BM which represents the best form of feed utilization by fishes in the present study. Though the FCR value of BM did not vary significantly from SB (1.57±0.09) and MN (1.40±0.08), it varied significantly from the control (1.74±0.08). The highest yield was recorded in BM than the other treatments.

Culture of *S. sarana* with periphyton substrate and different graded level of artificial feed

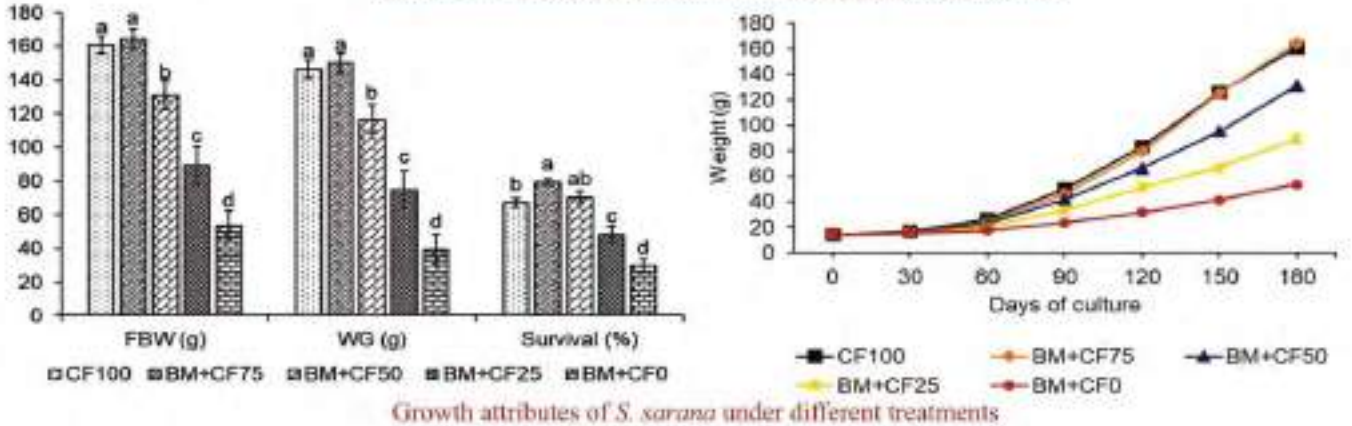
The study was conducted to evaluate the growth and survival of *S. sarana* under the bamboo substrate and different level of artificial feed. All the treatments were supplied with an equal surface area of bamboo based periphyton substrate and the commercial feed were reduced at a graded level and named CF100 (100% feed), BM+CF75 (75% feed), BM+CF50 (50% feed), BM+CF25 (25% feed), and BM+CF0 (0% feed). The third experiment was conducted for 180 days. All the treatments had three replicates, and the cages were assigned as per a complete randomized design (CRD). The fingerlings of *S. sarana* with avg. size 20.87 ± 1.35 g stocked @20 nos. m^{-3} in all the cages. The growth attributes of *S. sarana* reared for 180 day showed that, the FBW of BM+CF75 did not vary significantly, although it was higher (164.35 ± 6.06 g) than CF100. A gradual decrease in commercial feed supply resulted in a significant decrease in FBW in BM+CF50, BM+CF25 and BM+CF0. Lowest FBW (53.74 ± 8.92 g) was recorded in the treatment with no commercial feed along with bamboo periphyton substrates (BM+CF0). SGR was not significantly affected up to 50% commercial feed reduction i.e., BM+CF50; however, it was reduced in BM+CF50, BM+CF25 and BM+CF0. The FCR in the present study was in the range of 1.02±0.08 to

Bamboo substrate | Sugarcane based substrate | Mosquito net-based substrate

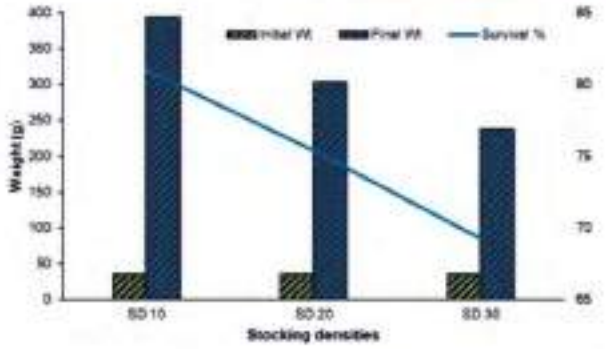
Different periphyton based substrates



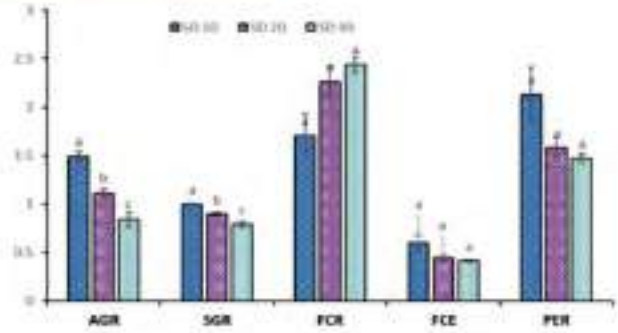
Growth attributes of *S. sarana* in different periphyton substrates



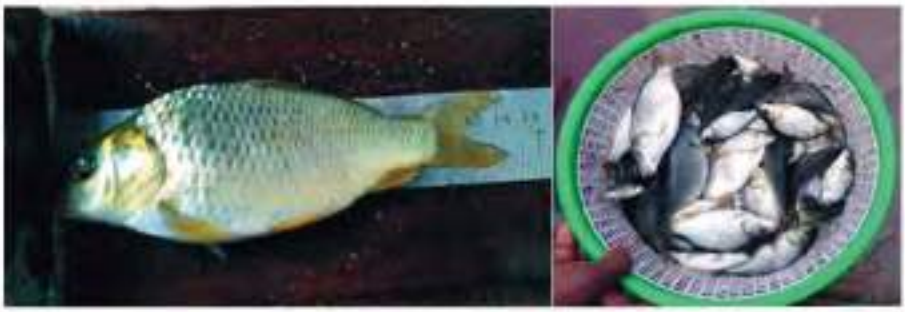
Growth attributes of *S. sarana* under different treatments



Growth and survival of Amur carp at different stocking densities



Growth indices and feed conversion efficiency of Amur carp at different stocking densities



Amur carp harvested from cages

2.63±0.14. The highest FCR was obtained in CF100, which was significantly different from other treatments. Highest yield was obtained in BM+CF75 (219.69 ± 13.27 kg) with no significance with CF100, the yield gradually declined with a decrease in the commercial feed supply from BM+CF50 onwards. The FCR in the present study was in the range of 1.02±0.08 to 2.63±0.14. The highest FCR was obtained in CF100, which was significantly different from the other treatments. The lowest FCR was obtained in BM+CF25 (1.02±0.08) followed by BM+CF50 (1.24±0.09) and BM+CF75 (1.58±0.08).

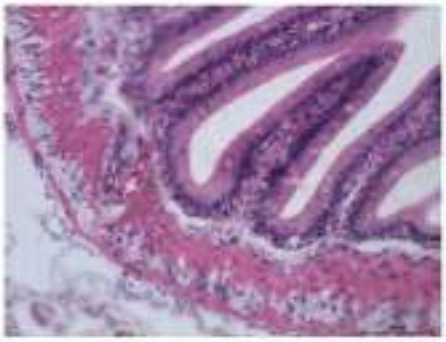
Grow-out culture of Amur carp in floating cages at different stocking densities

The present study was conducted in Maithon reservoir, Jharkhand India. The fingerlings of Amur carp (12.27±0.31cm, 35.6±3.16g) were stocked in CIFRI GI model cages (5m x 5m x 3.5m) in triplicate at three

Haul of *S. sarana* from inland cages in tropical reservoir

Vanya silkworm pupae meal-based fish feed

Vanya silkworm pupae



Intestinal histomorphology revealed inflammation when replacement level goes beyond 50% at protein level, with the incorporation of vanya silkworm pupae meal in the diet fed to *P. hypophthalmus* reared in net cages

different stocking densities viz. 10, 20 and 30 nos./m^3 designated as low, medium, and high stocking density. The fish were fed with CIFRI CAGEGROW feed at the rate of 3-6% of body weight twice a day. The study showed that stocking density significantly affects the growth performance, survival, and feed utilization of the fishes. After 240 days of culture, the higher growth in terms of weight gain (358.64 ± 10.05 g), absolute growth rate (1.50 ± 0.05) and specific growth rate (1.00 ± 0.01) and -feed utilization and feed efficiency (FCR: 1.71 ± 0.23) was achieved in lower stocking density of SD 10 followed by SD 20 and lowest value recorded in SD 30. Poor survival rate reported in highest stocking density. The B:C ratio was significantly higher in lowest density. The present study suggests that the optimum stocking density of Amur carp (10 nos./m^3) ensured the best growth performances in terms of weight gain, survival and feed and protein utilization.

Evaluation of silkworm pupae as protein source in diet of cage reared *P. hypophthalmus*

The present cage culture trial was carried out at Maithon reservoir for a period of 90 days. *P. hypophthalmus* (16.1±1.25g) were stocked in cages (75 m^3) at the rate of 33 numbers m^{-3} and fed with*vanya* silkworm pupae-based fish feed replacing fish protein (28% in feed) in feed with non-defatted pupae meal (0, 25, 50, 75 and 100%). Fish were fed @3-5% of body weight. The fish protein in diet was partially replaced by the incorporation of pupae meal protein, thus both the ingredients served as the main protein source holding a nearly equal amount of crude protein content individually. Final weight ranged from 36.2 - 43.62, SGR (%) ranged from 99.2- 99.8%, PER ranged from 2.0-2.82, and FCR ranged from 1.27 to 1.78. The study indicated non-defatted non-mulberry silkworm pupae protein can effectively replace the dry fish protein incorporating to the level of 50% in the diet of striped catfish in cages. However, as the replacement level increases from 75 – 100% the average body weight of fish declined significantly ($p<0.05$) in comparison to the rest of the diet treatment groups. Intestinal histomorphology revealed inflammation when replacement level goes beyond 50% at protein level, with the incorporation of vanya silkworm pupae meal in the diet fed to *P. hypophthalmus* reared in net cages.

Live metacercaria isolated from *O. bimaculatus*

Encysted metacercaria in muscle of *O.bimaculatus*

First report of *Isoparorchis hypselobagri* (Billet, 1898) infection in cage cultured *Ompok bimaculatus*

Occurrence of metacercariae of *Isoparorchis hypselobagri* was reported in *Ompok bimaculatus* cultured in cages at Maithon reservoir, India. The metacercarial parasite was initially identified morphologically. Molecular identification through partial amplification of 18S rRNA and cytochrome oxidase sub-unit 1 (COI) gene and sequencing further confirmed the parasite species. The prevalence of metacercaria ranged from 42.2% to 88.8% and intensity from 1 to 10. Host size influenced the intensity of infection. The occurrence of the first intermediate host snails indicated that they might be the possible source of cercaria in the cages. The presence of parasites not only affects growth and survival but also leads to reduced consumer acceptance. The control of snail vectors might play a significant role in prevention of parasitic diseases in cage culture system.

Project Title: Sustainable Production enhancement and livelihood improvement through technological intervention (pen culture) in selected reservoirs and wetlands of India

Project Code: RWF/21-24/14

Duration: April 2021 - March 2024

Scientific Personnel: M. A. Hassan (P.I.), S. K. Manna, D. K. Meena, R. Baitha, H. S. Swain (upto 31.08.22), S. Kamble, R. Das

Development of a new pen design for grow-out fish farming

A new pen has been designed and developed for installation in deep waters for grow out culture of fish by overcoming the problems of receding water levels and wave action in large water resources. The net pen was fabricated using polypropylene net of 3cm mesh, polypropylene rope, high density polyethylene drum float, sand-filled flexible polyvinylchloride pipe and metallic anchor and installed at Gogna, Maithon dam, Jharkhand. Polypropylene (PP) was selected as net material for its long durability, flexibility and high tensile strength that make it suitable for long duration pen culture in dynamic ecosystems of reservoirs and wetlands.

Considering greater physical stability and least amount of material needed for construction, the pen was constructed in a circular shape and installed in Maithon reservoir. The perimeter of the pen was 210m to cover an area of 0.3 ha. The pen site in the reservoir was selected based on seasonal fluctuation of water level below 10 m, road accessibility, gentle

Installation of pen in progress

Stocking of IMC fingerlings in pens at Katiganga beel

Table. Habitat parameters of water inside pens

Location	24° 07'24.33" N; 88 ° 17' 00.44" E
Air Temp (°C)	26.8
Water Temp (°C)	24.8
Depth (m)	1.0-1.5
Transparency (cm)	30-33
DO (mg/l)	6.6-6.9
pH	7.53-7.64
Conductivity (µs/cm)	622-627
TDS (mg/l)	442-447
Free CO_2 (mg/l)	Nil
Total Alkalinity (mg/l)	208-220
Total Hardness (mg/l)	306-314
BOD (mg/l)	2.8-3.6
GPP (mgC/m^3h)	78.13-80.35
Available PO_4(mg/l)	0.023-0.28
Total Chlorophyll (mg/m^3)	16.19-17.98

Input distribution cum awareness programme at the Katiganga wetland

slope, muddy and least undulating bottom free from boulders, and active fishers' group.

The pen wall was allowed to catch silt, get softened and develop periphytic community for a fortnight before seed stocking. Slaked lime @250kg/ha was applied in the entire pen area. Advanced fingerlings of 93±5.74g were stocked in the pen at stocking density of 12780/ha after acclimatization and prophylactic treatment in $KMnO_4$ solution. Fish were fed with supplementary feed @ 3% of body weight in feeding tray made up of PVC pipes and fine mess to restrict the floating feed to escape outside of pen area. The experiment is being continued and pros and cons of the new system are being recorded, with monitoring of fish growth and health.

Optimization of stocking density for composite culture of Indian major carps in pen

Wetlands are hotspots of aquatic biodiversity that supports livelihood and nutritional security to the riparian communities, despite sub-optimal levels of fish production. Fisheries enhancement is a recommended practice to bridge the fish yield gap in wetlands. To develop a standardized protocol of raising Indian Major Carps (IMC) fingerlings for stocking, a pen culture experiment of IMC in three different stocking densities have been initiated in Katiganga wetland located at Berhampore (Murshidabad) of West Bengal. The present experiment is of its first kind to evaluate the performance of composite culture of IMC in pens in wetland in Gangetic plains.

Six CIFRI-HDPE pen, each of 0.1 ha area, were installed at periphery of the wetland. Slaked lime (@ 250kg/ha) was applied in the entire pen area. The weed and unwanted fishes were removed by repeated netting. After 2 weeks, physico-chemical parameters of water and sediment of the pens were measured and Indian major carps fingerlings

(average body weight 4.31 ± 1.20 g) were stocked at stocking densities of 2 lakh, 3 lakh, and 4 lakh seeds per ha. Health of fish was assessed before stocking. Stocked fish were offered feed @ 3% live weight. Fish are being regularly monitored for health and growth.

The cage culture was conducted with active participation of the wetland fishers. An awareness program was organized for members of the Fishers Co-operative Society at the wetland site on pen culture.

Development of protocol for feeding and fish health management in winter

Fish being poikilothermic animals, winter imparts immense stress leading to low feed intake, poor growth and higher disease occurrences. An experiment is under way to examine efficacy of a plant preparation in maintaining feed intake and health of fish during winter. Stripped catfish *Pangasianodon hypophthalmus* is very sensitive to winter and was selected for the study. The plant extract, in different doses, is top-dressed on feed which is offered to the fish once a week; feed intake, behaviour, weight gain, overall health, haematological and blood biochemical parameters of fish are measured at regular intervals. Final results will be obtained at the end of the winter.

Project Title: Evaluation and management of environmental health through omics technologies

Project Code: FREM/20-23/17

Duration: April 2020 - March 2024

Principal Investigator: B. K. Behera

Sub-project 1: Metagenomic profiling of floodplain wetlands for ecosystem health for monitoring

Sub-project 2: Stock characterization of two bagrid species (*Mystus cavasius* and *M. gulio*) fisheries management

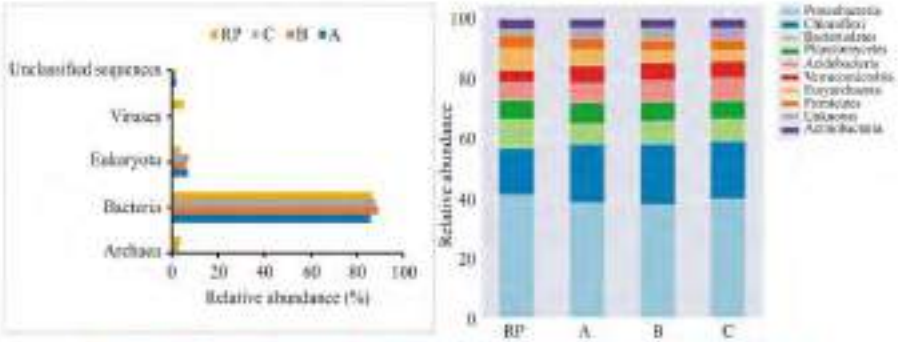
Sub-project 3: Efficacy of fish epidermal mucus as a biomarker for the environmental stress and potential antimicrobial agent against fish pathogens using 'omics' technologies

Sub-project 1: Metagenomic profiling of floodplain wetlands for ecosystem health monitoring

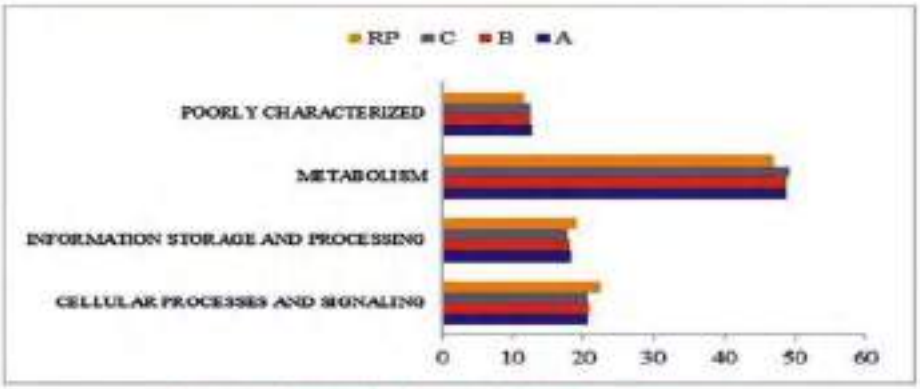
Scientific Personnel: B. K. Behera (Sub-project Leader) V. Kumar (w.e.f. 01. 04. 21), N. Sharma (w.e.f. 01. 04. 21), T. Bera, S. Roy (w.e.f. 01. 04. 22)

Metagenomic profiling of Sardar Bherry (East Kolkata floodplain wetland)

Since conventional culture-based approaches fall short of revealing the full extent of the taxonomic and functional diversity of the microbial community, the metagenomic approach has become the method of choice for analyzing in-depth taxonomic profiles, functional assessment, and interactions of microbial communities. Microbiome community structure studies in wastewater treatment constructed wetland sediments can provide new insights into the potential bio-indicator species and biomarker communities. To address this, we undertook the Sardar Bherry East Kolkata floodplain wetland as the model system for a metagenomic investigation. We collected samples from the Sardar Bherry Wetland at four different locations: RP (reference point, which is the intake site), A, B, and C (outlet site), respectively. Wetland sediment microbial community structure and diversity were examined using Illumina high-throughput sequencing technology and calculated using MEGAN6 software and the MG-RAST web server. The existence of large numbers of bacterial communities was confirmed by taxonomic classification, followed by minor abundances of archaea and eukaryotes in all of the sampling sites, although the occurrence of viruses was only noted at the RP (reference point) site. *Proteobacteria* was the most prevalent bacterial phylum in all sampling sites, followed by *Bacteroidetes*, *Firmicutes*, *Chloroflexi*, etc., as determined by the Sardar bherry wetland sediment metagenome analysis. The RP location had the highest concentration of microorganisms present. The major genera found in the metagenome of Sardar berry sediment include *Bacillus*, *Candidatus*, *Coptotermes*, *Burkholderia*, *Acidithiobacillus*, *Dehalococcoides*, *Methanolinea*, *Methanosaeta Aminobacterium*, and *Coxiella* etc. It is interesting to note that several bacteria and viruses have only been found at the RP sampling location, including *Arsenophonus*, *Bacteroides*, *Methanosaeta Aeromonas*, *Pseudomonas*, *Nitratiruptor*, *Desulfobulbus*, and *Flavobacterium*. The functional profiling of COG analysis revealed that nearly 50% of the genes were involved in metabolism (including carbohydrate, amino acid, lipid, nucleotide, and coenzyme transport & metabolism), followed by nearly 20% of the genes in charge of cellular processes & signalling (including cell division, cell cycle control, cell wall/membrane biogenesis, intracellular trafficking, and signal transduction mechanisms, etc.), and 18% of the genes in charge of information storage & processing (replication, transcription, translation, RNA processing, chromatin structure and dynamics etc.). Overall, these findings offer better understanding of the microbial diversity, dynamics of the community structure, and function of the Sardar bherry sediment from the east-Kolkata wetland, which is anticipated to open up opportunities for the investigation of novel functional genes and/or enzymes with potential applications in bioremediation and human health.



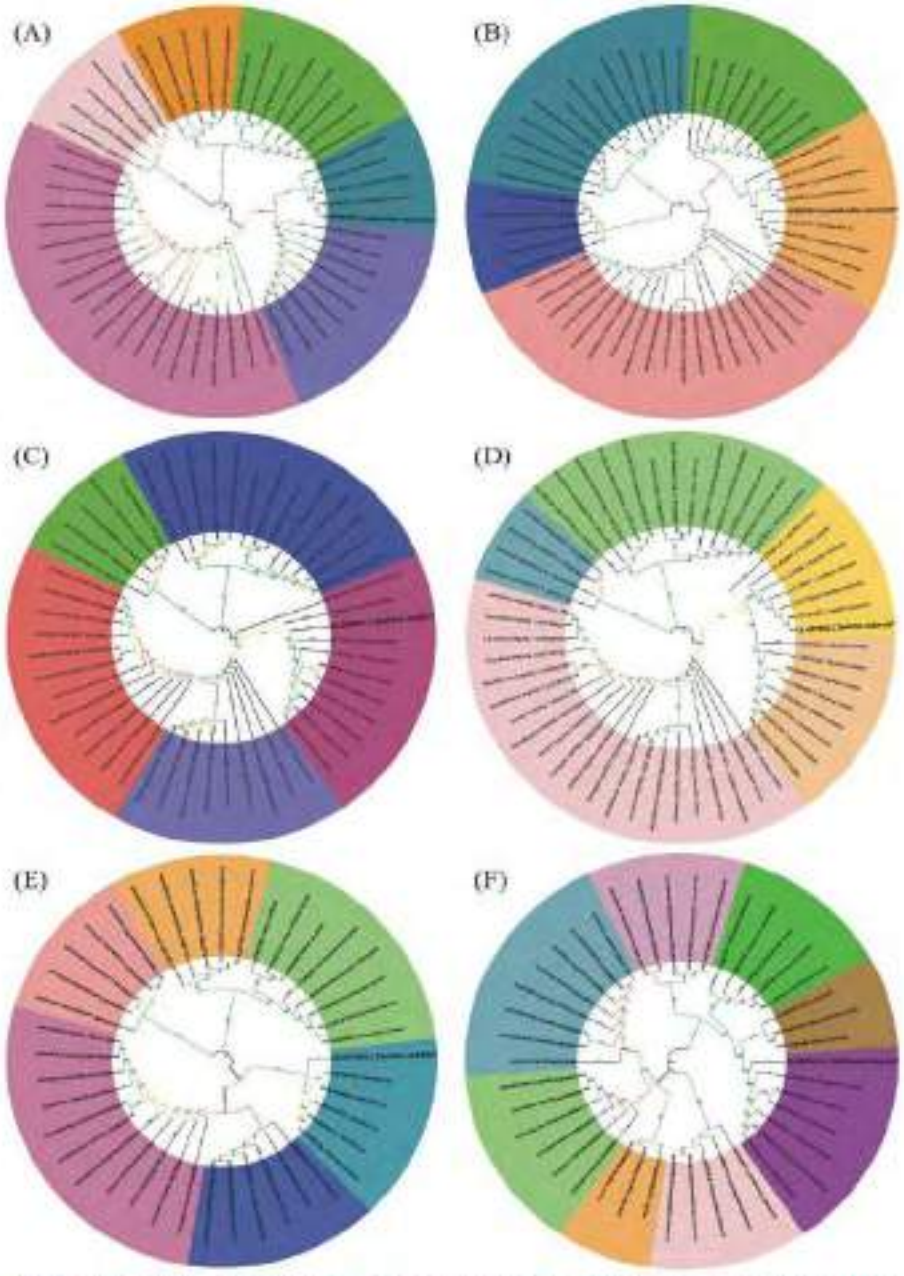
Taxonomic abundance of the microbial community of East-Kolkata wetland at different sampling sites (a) Domain and (b)Phylum level



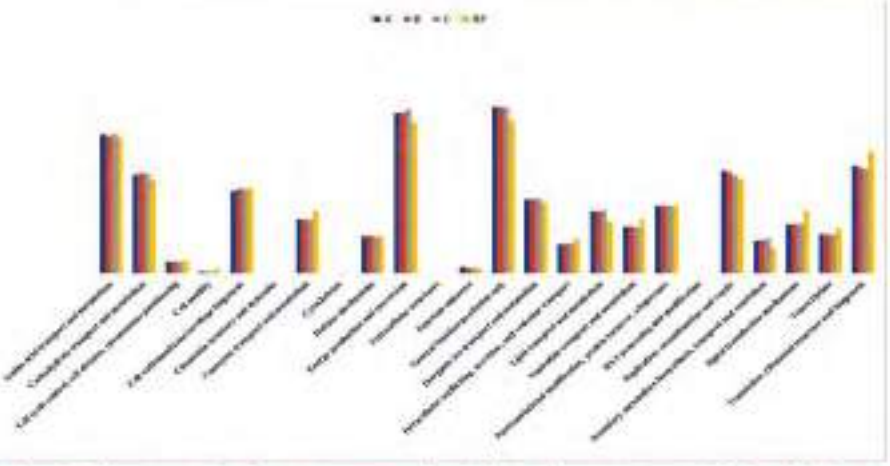
Functional annotation by (a) COG level 1 subcategory

Development of microbial consortium for the potential removal of ammonium from contaminated water bodies

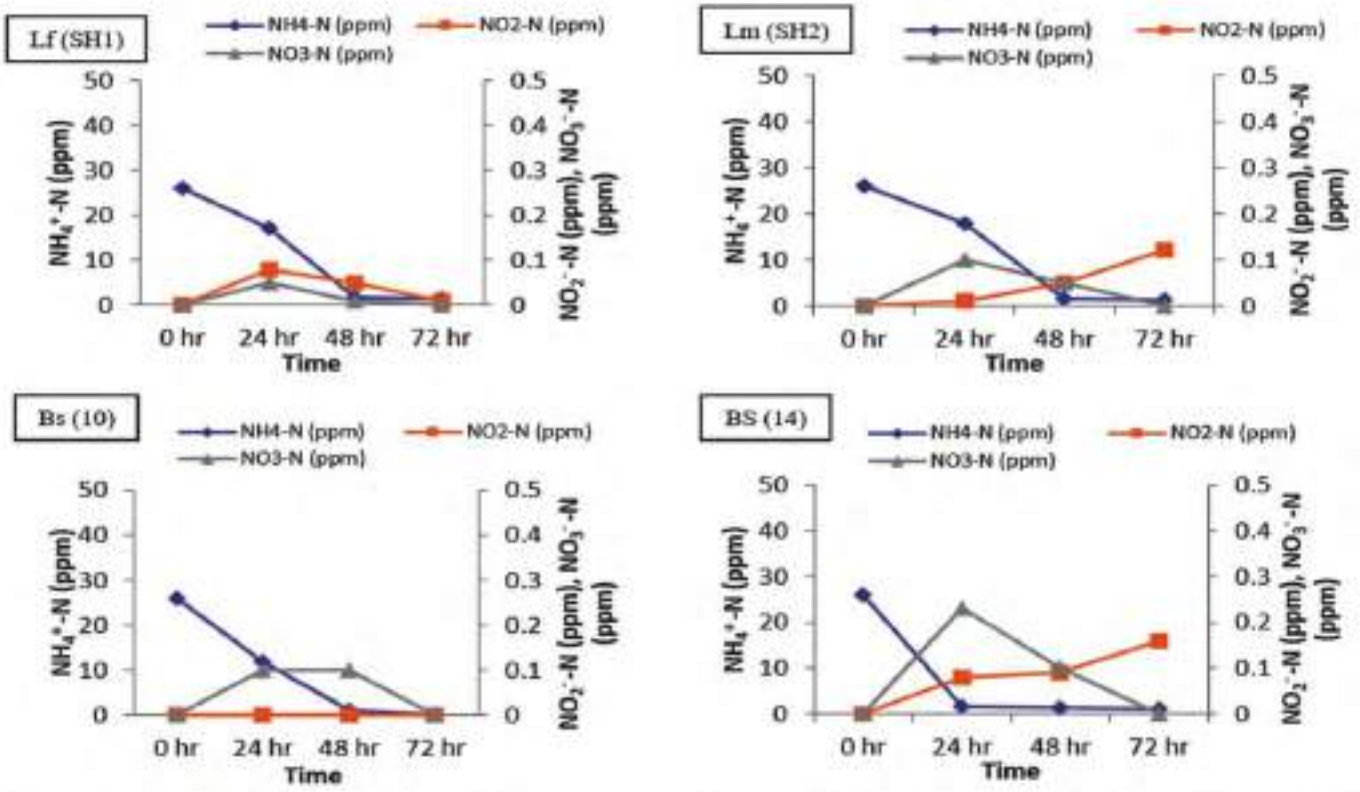
Chemical treatment includes directly injecting chemical oxidants into contaminated soil and groundwater, often associated with alteration in the native aquatic chemistry and biology. Biological treatment (Bioremediation) most commonly involves the breakdown of contamination into nontoxic forms using microbiological processes. The process utilizes living organisms to remove environmental pollutants from soil, water and gases. The advantages of employing mixed microbial cultures as opposed to pure cultures in bioremediation have been widely demonstrated. It could be a attributed to the effects of synergistic interactions among members of the association. It is possible that one species removes the toxic metabolites (that otherwise may hinder microbial activities) of the species preceding it. It is also possible that the second species are able to degrade compounds that the first is able to only partially. Our research was directed toward understanding the roles of individual members in influencing the effectiveness of a microbial consortium and removal of the nitrogenous compound from the aquatic ecosystem. Based on the survival and growth compatibility assays, a group of 4 bacterial strains which were able to effectively remove ammonia from the system.



Phylogenetic tree of *Lysinibacillus fusiformis* (SH1) (A), *L. macroides* (SH2) (B), *Bacillus subtilis* (10) (C), *B. safensis* (14) (D), *B. subtilis* (28) (E) and *Citrobacter freundii* (30) (F). Based on 16S rRNA nucleotide sequences following maximum composite likelihood method by the MEGA11 software



(b) COG level 2 subcategories of metagenome data of the urban constructed East-Kolkata wetland



Ammonia removal assay of bacterial isolates. The initial concentration of NH^{4+}-N is 26 ppm. The production of each intermediate nitrification product, NO_2-N and NO_3-N were shown for each non-pathogenic strain (*L. fusiformis* (SH1), *L. macroides* (SH2), B. *subtilis* (10) and *B. safensis* (14))

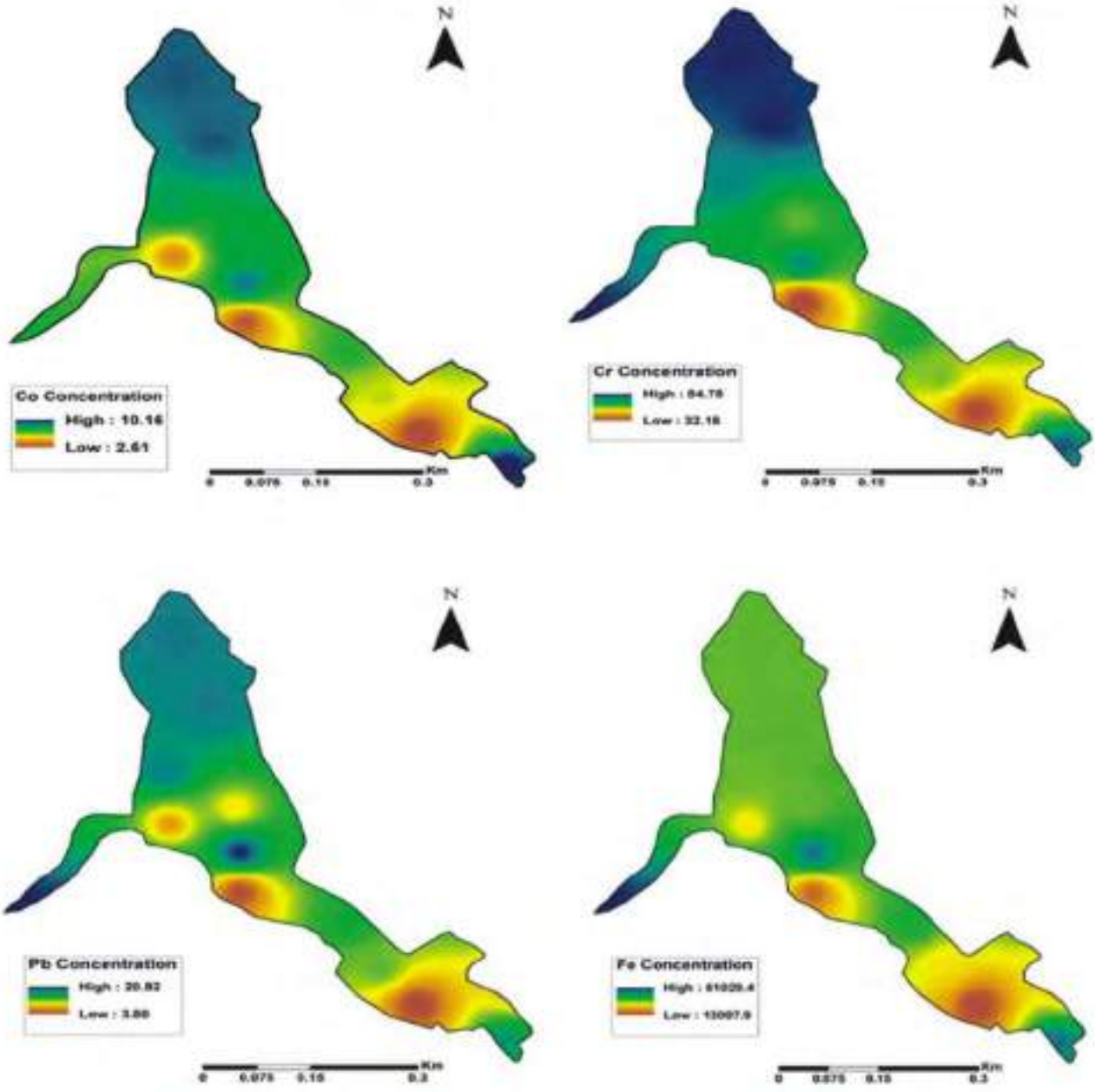
Microbial diversity and pollution status of Himalayan Lake (Mirik Lake)

The Sumendu Lake often referred to as Mirik Lake, is a body of water in the Lesser Himalayas that is 1.25 km long, 110 ha in size, and has a maximum depth of 8 m. The fish, water and sediment samples were collected from different sites to estimate the microbial diversity, physicochemical parameters and heavy metal concentration. The water and sediment chemistry of Mirik Lake exhibits distinctive variability. Inductively Coupled Plasma Mass Spectrometry was used to describe the concentration levels of the heavy metals (Fe, Mn, Zn, Cu, Cr, Co, Cd, Ni, Pb, and As) and to estimate the pollution quality indicators for the 33 no. of water and sediment samples that were taken from 11 sites during June 2022. The level of heavy metal contamination in the water was found to be within acceptable bounds. Sediment samples were found to be low to moderately polluted according to several pollution assessment indices (Degree of Contamination, Contamination Factor, Ecological Risk Index, etc.). *Pethia conchonius* and *Cyprinus carpio* were collected from mirik lake. The concentration of heavy metals was found to be within acceptable limits.

Spatial distribution pattern of heavy

Table : Heavy metals (µg/g wet wt.) concentration in fish muscle

	Cd	Co	Cr	Cu	Fe	Ni	Pb	Zn	Mn	As
Pethia conchonius	0.17	0.03	0.75	1.31	106.47	0.15	0.23	95.23	0.63	0.05
Cyprinus carpio	0.23	0.07	0.95	1.61	123.23	0.17	0.28	110.23	0.76	0.09
WHO (1989)	1		50	30	100	0.5-1	2	100	1	
FAO (1983)	0.05		-	30	-	-	0.5	30	-	



Geospatial distribution map of Cobalt, Chromium, Lead, Iron (µg/g) of Mirik lake, West Bengal, India

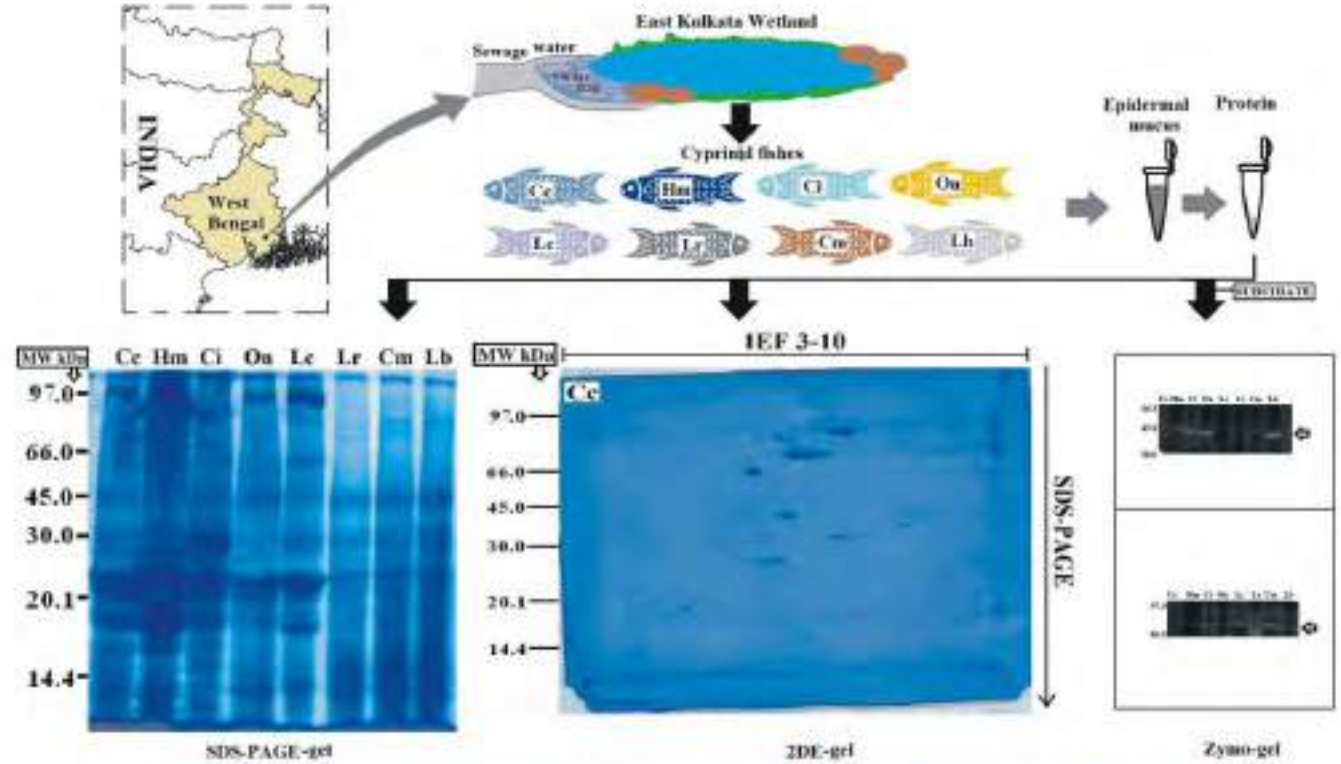
metals in sediment is depicted in figure. Cr concentration ranged between 32.1 µg/g - 84.7 µg/g with an average concentration of 64.4 µg/g. Co concentration ranged between 4.84 µg/g - 17.5 µg/g with an average concentration of 13.3 µg/g. Pb concentration ranged between 3.79 µg/g - 20.8 µg/g with an average concentration of 6.00 µg/g. The highest concentration of Pb was found in the station outlet point (20.8 µg/g). Fe concentration ranged between 12980 - 61032 µg/g with an overall average of 37823 µg/g.

Sub-project 2:
Efficacy of fish epidermal mucus as a biomarker for the environmental stress and potential antimicrobial agent against fish pathogens using 'omics' technologies

Scientific Personnel : P. Maurye (Sub-project Leader), M. S. Devi (On leave since 10.10.22), K. Kumari (On leave 22.08.22 to 31.12.22), Santhana Kumar

Fish epidermal mucus AMPs/proteases as specific biomarker for environmental stress

Biomolecules in fish epidermal mucus make a front-line defence barrier against pathogenic/non-pathogenic microbes residing in aquatic environment. Among various key constituent of innate immune system, the epidermal mucus of fishes comprises the AMPs for antimicrobial activity and proteases for activating immune mechanisms to efficiently degrade the potent pathogens. An indiscriminate use of antibiotics and increasing diverse pollutants in the fishponds leads to resistance in pathogens and affecting fish immunity, respectively which resulted in the down-/up-regulation of many mucus proteins/peptides /enzymes of innate immune defence system. Broadly classified mucus components exhibit broad-spectrum of antimicrobial/neutralizing activities against wide range of pathogens in stressed ecosystem. Local fishponds (East Kolkata Wetland or '*bhery*') were engrossed with wide range of stress factors due to incoming tanneries waste. Many commercially important Cyprinid fishes (family: *cyprinidae*) were extensively cultured in these nutrient rich fishponds by residential fish farmers after implementing mild waste/disease management strategies. Epidermal mucus of eight different fish species belonging to three groups of *Cyprinidae* (Indian major carp, Exotic carp, and Minor carp) inhabiting in the same fishpond was simultaneously analysed using substrate gel electrophoresis technique (SGET) in search for the potential biomarker of aquatic stress and for analysing significant actions of potent AMPs mainly cathepsin D; and serine/cysteine proteases. Fish mucus zymograms (1DZ) demonstrated the presence and activity of proteases expressed by each fish species which ranges from low to high molecular weight (30 to 66 kDa) with varying intensities and number. Presence or absence of some distinctive transparent bands in gelatin-zymo-gel (12.5% with 4% stacking) images showed higher level of Cathepsin D expression in some fishes as detected by degradation of specific substrate in gel. Heterogeneity in the expression pattern of bioactive molecules in the epidermal mucus has also revealed the adaptation differences among these fish species in same aquatic ecosystem. Total protein concentration (in mg/ml) and protein profile (no. of bands) of the epidermal mucus also showed variations within and among the group of fishes. Fish mucus protein content, mucus volume and mucus viscosity were varying at different level with highest in *Labeo rohita* (Lr) and lowest in *Oreochromis niloticus* (On), but this may be not an



Different fish species collected from EKW, West Bengal, India and proteomic (1DE & 2DE) for characterization of fish epidermal mucus and identification of proteases by zymographic (1DZ)

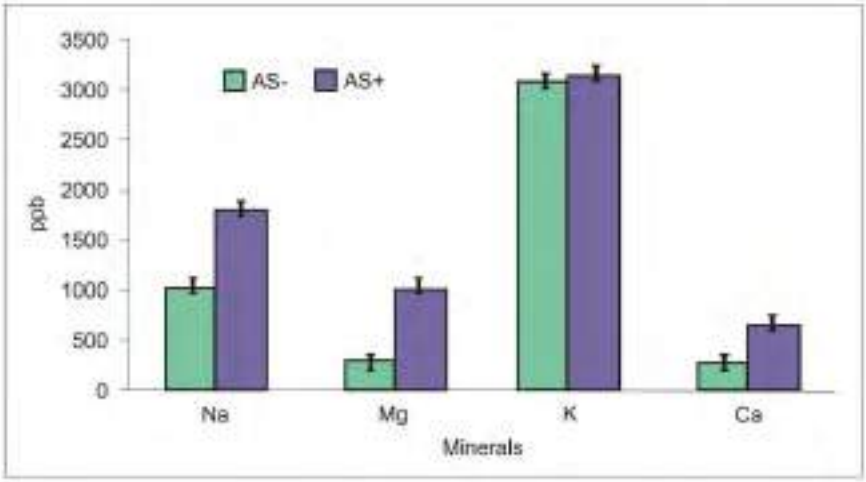
accurate depiction due to uncontrolled environment. In this regards, the lab experiments were done, and results were under process to provide concrete conclusions. Protein SDS-PAGE (12% and 15%) gels showed that exotic carp (*Cyprinus carpio* (Cc) expressed many proteins (42 no.) in epidermal mucus as compared to other fish species (Indian major carp and minor carp) which suggested that the expression of mucus proteins showed the interspecies variation. Comparisons were made between the gels that showed the apparent differences among the species in relation to protein band width and band intensities. According to the similarities in the gel position and neutralizing activities, two AMPs were classified in the *Labeo rohita* (Lr) and *Cyprinus carpio* (Cc). 2DE analysis was done only for *Cyprinus carpio* (Cc) to obtain the reference gel of mucus proteins. Few of these fish species have previous records of expressing proteins of mucosal immune response in different capacities. Our results showed that some fishes (*Cyprinus carpio* (Cc), *Hypophthalmichthys molitrix* (Hm), *Ctenopharyngodon idella* (Ci), and *Oreochromis niloticus* (On) have higher capacity to neutralized pathogens whereas other fishes (*Labeo catla* (Lc), *Labeo rohita* (Lr), *Cirrhinus mrigala* (Cm), and *Labeo bata* (Lb) were susceptible and does not provide much protection against pathogen invasion. With these results, it was concluded that the unsuitable environment triggers the infection and mortality in these fishes due to insufficient activity of the innate immune components of epidermal mucus. Other enzymes including metalloproteases are also the major mucus constituent of these fishes. As per the MW of the resolved proteins with transparent bands in substrate specific zymo-gels, some of the bands were embarked as metalloproteases (MMPs). Among these Cyprinid group of fishes, *Labeo rohita* (Lr), *Oreochromis niloticus* (On), and *Cyprinus carpio* (Cc) shows high expression of MMPs as compared to other fish species. So, the intra and inter species variations were observed in the expression of mucus enzymes of the studied fishes. So there were variations/similarities in the expression of major immune proteins/enzymes including major proteases and AMPs; elaborating their significant role in the fish primitive defence system. This study will be helpful in making strategic planning for eradication of important fish diseases that are making havoc in many aquatic ecosystems.

Molecular identification of fish epidermal mucus genes

A challenge experiment was performed to study the fish immune mechanism and to evaluate the expression of enzymes/AMPs for the possibilities of biomarker. A brief infection (infection$^{(positive)}$;1/10th and 1/100th of LD50) of the most opportunistic pathogen *A. hydrophilla* in the zebrafish was setup with control$^{(negative)}$ to establish the efficacy of the infection. The skin samples (avoiding muscles/scales) from the control$^{(negative)}$ and infected$^{(positive)}$ fishes were dissected out under lab conditions for transcriptomic study. Illumina SEQ (2 ×150 bp) pair-end sequence technology generated 25,489,828-26,860,806 raw reads in the control$^{(negative)}$ and infected$^{(positive)}$ fishes, respectively. After pre-processing and the removal of the adaptor sequences, low-quality sequences and reads with poly-N sequences, total 22,449,680 - 26,758,932 clean reads were obtained. Estimated 87% of the reads were successfully mapped to the reference genome of Zebrafish. In order to identify differentially expressed transcripts/genes (DEGs) among the skin transcriptomes of control$^{(negative)}$ and infected$^{(positive)}$ fishes, a comparative analyses revealed that the total 1,36,871 genes were differentially expressed in these two group of fishes.

Biochemical analysis and protein profiling of fish epidermal mucus

Arsenic (*As*) contaminations is reported from all parts of India including the Indo-Gangetic plain which affecting millions of people. The Cyprinid fishes showed remarkable adaptability after inhabiting in *As* contaminated environment but up to a certain extent. *As* in aquatic environment directly interact with the mucus layer of these fishes and it is foremost important to identify the known/unexplored biomarker (mainly protein/peptide) for revealing the adaptability strength of these fishes with novel enzymes/AMPs. Similarly, the changes in the biochemical profiles of epidermal mucus of the fishes from *As* affected sites provide information about the aquatic health status after comparing with the non-affected fishes of the same family. In this study, the fish epidermal mucus was collected from two prominent aquatic water bodies of West Bengal, India: (1) Media beel (MB; *As*+ level >10 ppb) and (2) Natun Chara Beel (NC; *As* - level <10ppb). After analysing the biochemical and protein profiling of all the fishes, the epidermal mucus samples of *Cirrhinus mrigala* (Cm) collected from NC*As*- showed differences in the total protein expression and decreased in the carbohydrate content as compared to the non-affected samples (MB*As*+). Partial shift/modifications were observed in the protein bands of 102, 48, 25 kDa in the MB*As*- samples out of observed 14 proteins bands which may be due to PTMs. A significant variations in the protein bands (15 to 250 kDa) with similar position in slab gel showed differences in the band width and intensities showing the high expression of some proteins. Therefore, the protein profile of *Cirrhinus mrigala* (Cm) from studied sites (NC*As*- and MB*As*+) showed the differential expression of some important protein bands (not yet identified) which are considered for characterization and



Fish collection sites, fish epidermal mucus protein profile and ionic composition of collected *Cirrhinus mrigala* (Cm) from arsenic-affected (MB*As+*) and non-affected (NC*As-*) area of West Bengal, India

identification of possible biomarker(s) specific for *As* contamination in aquatic water bodies. Activities of the MMPs (metalloprotease) are dependent on the presence/absence of few ions in the fish epidermal mucus. Therefore, ionic composition comprising sodium (Na), calcium (Ca), potassium (K), and magnesium (Mg) in epidermal mucus samples of MB*As+* and NC*As-* were estimated using ICP-MS. Nearly five-fold increase in the Mg; three-fold increase in the Ca; two-fold increase in the Na; and no significant change in the K were observed in the samples collected from the MB*As+* as compared to NC*As-* mucus samples. Normal level of few ionic components of the fish epidermal mucus were affected by the *As* contamination whereas others were unaffected. These results showed that the antibacterial properties of the epidermal fish mucus were compromised at certain extent in the NC*As-* fishes as compared to MB*As+* fishes which directly influences the immune mechanism.

Sub-project 3:
Stock characterization of two bagrid species (*Mystus cavasius* and *M. gulio*) for fisheries management

Scientific Personnel: P. K. Parida (Sub-project Leader), S. Roy (Sub-project Leader w.e.f. 21.12.22) (In the project w.e.f. 01.04.22), D. Bhakta, V. L. Ramya

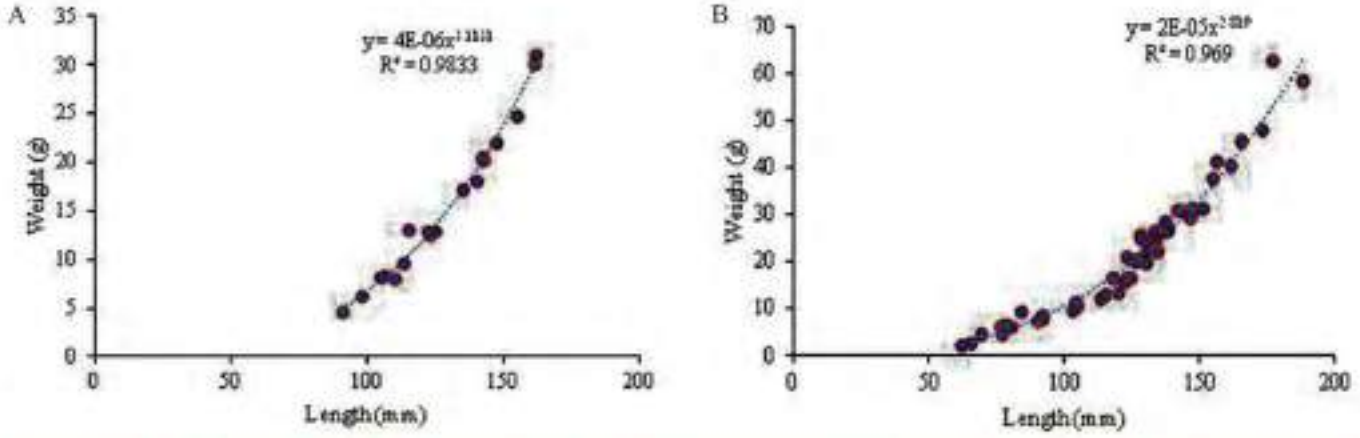
For fisheries management, the characterization of populations or stocks of a species is a crucial aspect. The management of fish wild genetic resources depends on an accurate assessment of genetic variability. Hence it is important to characterize the genetic stock of fish species with an emphasis on stock management. In the current study two small indigenous catfish species of the bagridae family, *Mystus gulio* (commonly known as long whiskers catfish/nona-tengra) and *Mystus cavasius* (commonly known as Gangetic mystus/golsha-tengra) were considered for the stock characterisation.

Length weight relationship (LWR) study

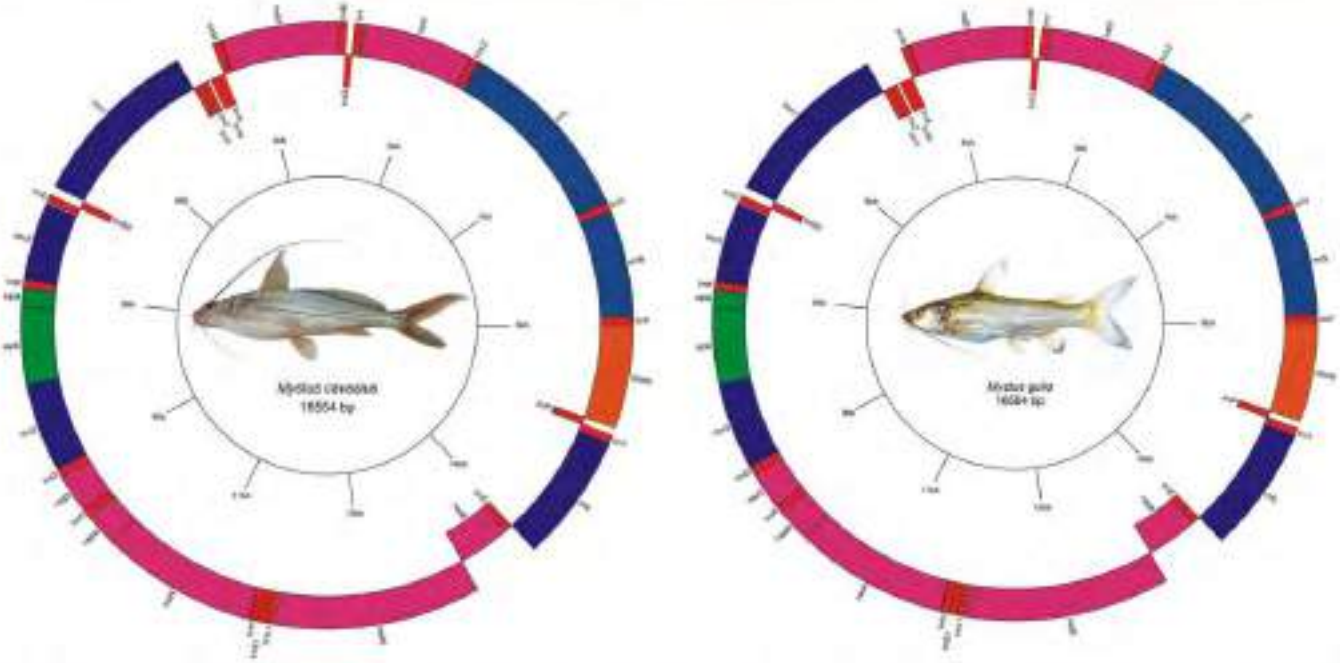
M. cavasius and *M. gulio* samples were collected from both freshwater and estuarine resources for the stock characterisation study. During the year 2022, a total of 19 *M. cavasius* were collected from lower stretch of the Ganga River (Nabadwip, Kuntighat). The size of the specimen ranged from 91-162 mm (128.00±20.79), and 4.70-31.10 g (16.05±7.58), respectively. The established length-weight relationship showed that exponent value 'b' was observed at 3.113 with a correlation of determination (R^2) as 0.987 showing a positive allometric growth pattern for the species in the collected environments. For the species *M. gulio* a total of 52 fresh samples was collected from Hooghly-Matlah estuarine zone (Sandeshkhali, Pathar Pratima, Bakkhali, etc.). The size of the specimen ranged from 62-188 mm (123.74±29.04), and 2.20-62.90 g (22.56±13.51), respectively. The established length-weight relationship showed that exponent value 'b' was observed at 2.819 with a correlation of determination (R^2) as 0.968 showing a negative allometric growth pattern for the species in the collected environments.

Genetic stock characterization

For the genetic stock characterisation of *Mystus* species, *M. cavasius* samples (dorsal fin) were collected from the rivers Ganga, Krishna, and Cauvery, while samples of *M. gulio* were taken from the river Ganga as well as hatcheries (Naihati). Total genomic DNA was extracted from all the samples following Asahida et al (1996) with minor modifications. The mitochondrial Cytb gene was amplified from each sample using PCR (forward primer L14841: 5'-AAAAGCTTCCATCCAACATCA GCATGATGAAA- 3' and reverse primer H15149: 5'-AAACTGCAGCCCCTCAGAATG ATATTTGTCCTCA-3'). PCR amplification was carried out in 50 µl reaction volume containing PCR reaction buffer (10mM Tris-HCl pH 9.0, 50 mM KCl, and 0.01% gelatine), 1.5 mM MgCl2, 0.2 mM of each dNTP, 10 pmol of each primer, 1.5U Taq polymerase and 100 ng of template DNA. PCR was performed using thermal cycler (Applied Biosystems) with following the procedure initial denaturation at 94°C for 5 min followed by 35 cycles of 94°C for 30 s and at 56°C annealing temperature for 1.5 min, elongation at 72°C for 2 min, with a final elongation at 72°C for 5 min. The amplified PCR products (1140 bp) were purified using GeneJET™ Gel extraction kit (Thermo fisher Scientific) following the manufacture's instructions and the purified PCR products were then sequenced using PCR primers in both directions for greater accuracy. Total 96 sequences mitochondrial Cytb gene of *M. cavasius* were submitted to NCBI with gene accession number MZ191061-MZ191062, MZ436919, MZ463197, MZ568802, MZ574438, MZ574438, MZ501209, MZ516518, MZ540027, MZ546614, ON715376-ON715380, ON310386-ON310398, OP573216-OP573218 from the river Ganga, OP503683- OP503689, OP535407- OP535419, OP546036-



Length-weight relationship of (a) *M. cavasius* from the freshwater habitat (Hooghly-Matlah estuary) and (b) *M. gulio* from the estuarine habitat (Hooghly-Matlah estuary)



The illustrated map of complete mitochondrial genome of (a) *M. cavasius* and (b) *M. gulio*. A total of 37 genes including proteins coding genes (PCGs), rRNAs, tRNAs and D-loop control region representing their location and features are displayed clockwise. Outer circle of circular map represents genes in heavy/positive strand and inner part represents genes in Light/negative strand.

OP546047 from the river Krishna, ON881331- ON881358, OP588455-OP588459 from the river Cauvery. Furthermore, a total of 42 sequences mitochondrial Cytb gene of *M. gulio* were submitted to NCBI, with gene accession number MZ229470-MZ229471, MZ998905- MZ998908, ON959477- ON959481, ON982217-ON982223 from the river Ganga and OP851491- OP851495, OP87102-OP87111, OP985171- OP985179 from the hatchery.

Complete mitochondrial genome of two Mystus species (Bagrid catfishes)

The mitochondrial genome is a potent molecular marker for ichthyological studies that can reveal phylogenetic links and molecular evolution. In the present study, for the first time we have used Next-generation Illumina sequencing technology to characterize the whole mitochondrial genome of *M. gulio* and *M. cavasius*. The mitochondrial genomes of *Mystus cavasius* and *Mystus gulio* are circular DNA molecules of 16,554 bp in length, well within the range of a typical vertebrate mitogenome size of 15–20Kb. The complete mitochondrial genome sequences *M. cavasius* and *M. gulio* have been submitted in GenBank with an accession number OR018997 and OQ984891 respectively. The total base composition for *M. cavasius* A 31.94%, T 25.7%, G 14.93% and C 27.43% and *M. gulio* was A 31.88%, T 26.91%, G 15.05% and C 26.16% respectively. According to our findings, *Mystus* species mitogenomic organization consisted of 37 genes in total, including 13 protein-coding genes (PGCs), two ribosomal RNA (rRNA), 22 transfer RNAs (tRNAs), and a D-loop regulatory region which is comparable to that of typical vertebrate or other fish mitogenomes, which indicates that mitogenomes may be highly conserved throughout the evolutionary process. In addition to providing unique genetic markers for the study of conservation genetics and species identification, the current work provides significant insights into the variability and evolution of fish mitochondrial genomes.

Project Title : Development of ammonium and phosphate remediation techniques using nanostructured materials for restoration of polluted water bodies

Project Code: FREM/21-24/19

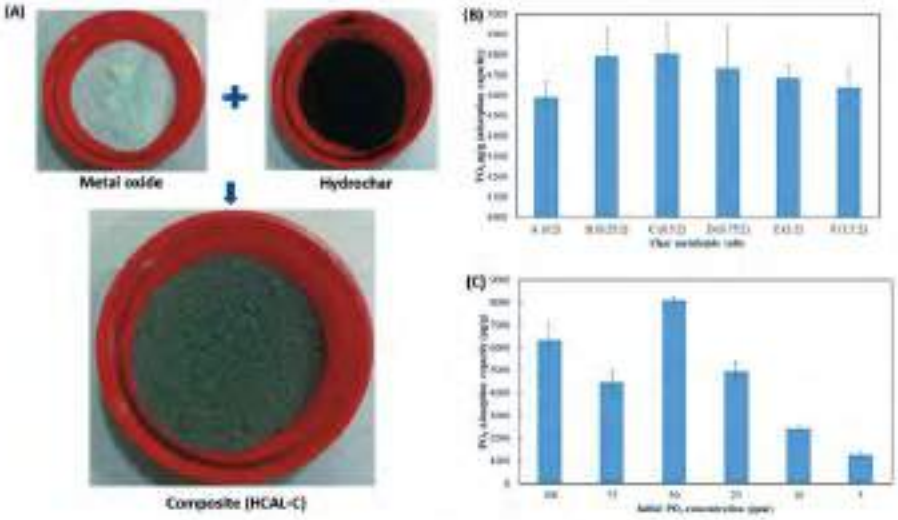
Duration : April 2021 - March 2024

Principal Investigator: D. J. Sarkar

Scientific Personnel: S. Roy (w.e.f. 01.04.22), T. Bera, Santhana Kumar V.

Metal oxide carbonaceous material composite for phosphate removal

Anthropogenic activities especially agriculture, urbanization, industry led to phosphate pollution to vital freshwater resources. Untreated domestic and industrial wastewater are main point sources of phosphate pollution. Though phosphate binds very strongly in soil through various hydrological processes like leaching, runoff etc. it gradually builds up into aquatic belts leading to algal blooms creating anoxic condition causing death of fish and other aquatic creatures. Hence, efforts are taken in the present project to develop a phosphate remediating material the application of which will lead to reduce the available phosphate concentration in these aquatic bodies. A simple method for synthesis of char-based material (HCAL) was developed leading to free-flowing powder with a capacity to adsorb free phosphate to non available form. A series of materials (HCAL A to F) were prepared by impregnating metal oxides in to char material with different weight ratios (0: 2; 0.25: 2; 0.5: 2; 0.75:2; 1: 2 and 1.5: 2). It was found that at 10 ppm PO_4 concentration the char metal oxide ratio of 0.5: 2 (HCAL-C) gave best performance with highest phosphate adsorption capacity (4805 µg/g) with incubation time of 20 hr. Hence HCAL-C was used further in subsequent studies. To study the effect of phosphate concentration on the adsorption capacity, different phosphate concentration (5 ppm to 100 ppm) was incubated with HCAL-C for 4 hr. It showed that the adsorption process is dependent on the initial phosphate concentration with gradual increase of adsorption with increase of initial phosphate concentration till 50 ppm. The study also showed that incubation time had effect on the phosphate adsorption capacity with gradual increase of the same with increase of incubation time. The efficacy of the developed material has been tested in the phosphate spiked distilled water, pond water and wastewater. In all the different water types, the material was found to remove phosphate with good efficacy.



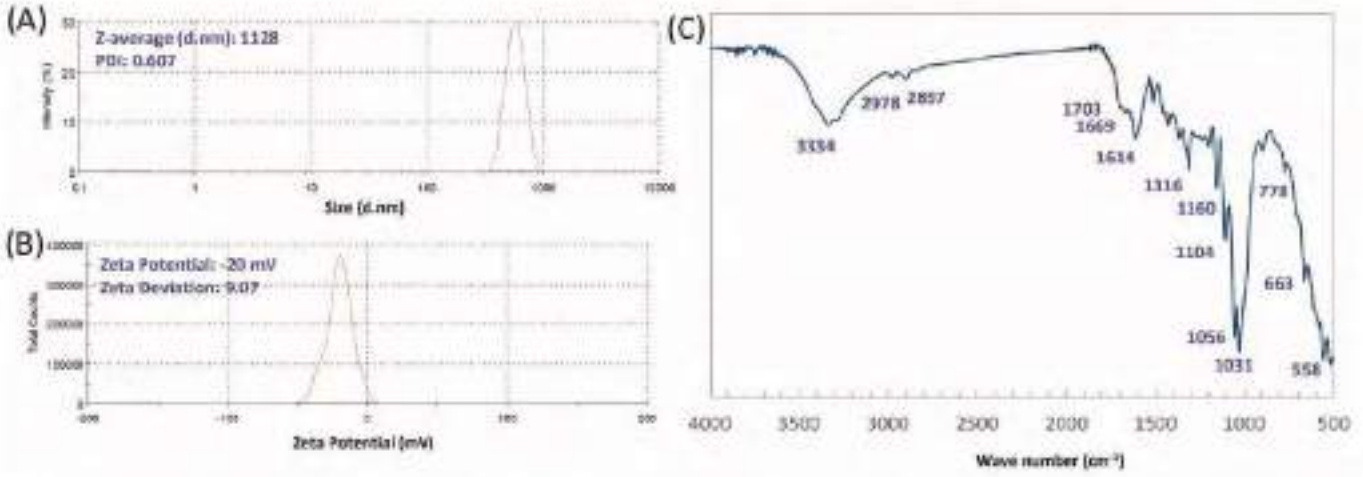
Composite material prepared from metal oxide and hydrochar for phosphate removal (A); Effect of hydrochar and metal oxide ratio on the phosphate removal capacity (B) and effect of initial phosphate concentration on the phosphate removal capacity (C)

Characterization of carbonaceous nanoscale material for ammonia removal

In the project carbonaceous nanoscale material was synthesised for ammonia removal through cationic adsorption. The synthesized material was characterized with Zetasizer instrument using the principle of dynamic light scattering. The average diameter was found to be 1128 nm and the zetapotential was found to be -20 mv. The negative sign of the zetapotential indicate the carbonaceous nanoscale material is highly negatively charged hence could effectively bind with the positively charged ammonium ion. Further the material was characterized with FT-IR spectroscopy which indicate presence various function groups viz. -OH (3334/cm), C-H (2978/cm, 2897/cm), >C=O (1703/cm), -COO⁻ (1614/cm) and -C-O-C- (1031/cm). This spectrum indicate that the synthesized material is rich in acidic moieties as compared to hydroxyl and ether moieties present in the parent material. The presence of more acidic moieties indicates the generation of pH dependent negative charge which helped in effective ammonium binding.

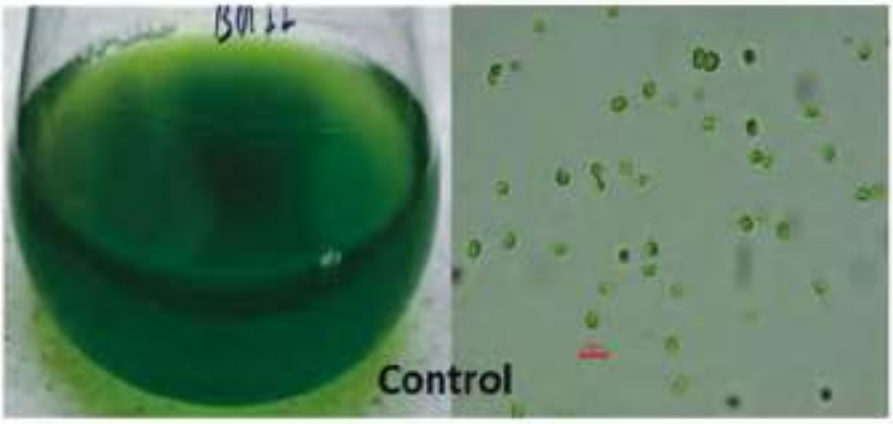
Cytotoxicity and acute toxicity assessment of carbonaceous nanoscale material

It is essential to assess the potential toxicity and negative impacts of nanoscale materials on the aquatic

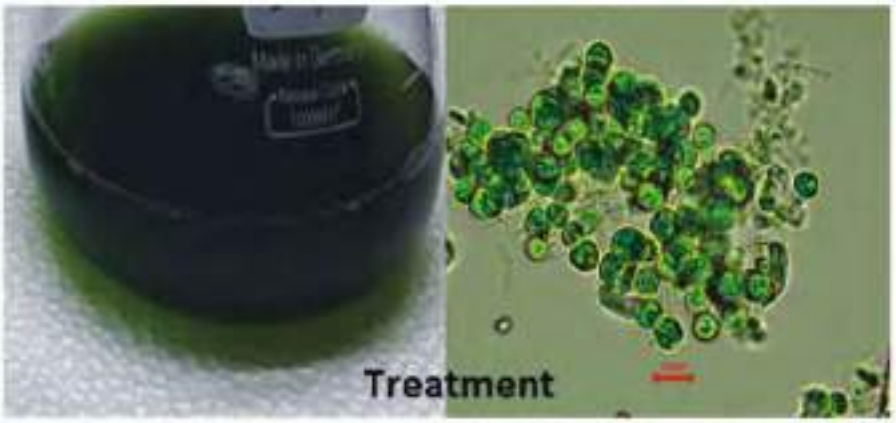


Hydrodynamic diameter (A), zetapotential (B) and FT-IR spectra (C) of the synthesised carbonaceous nanoscale material

organisms and ecosystems. Acute toxicity testing allows for the quick investigation of different chemical impacts on species and ecosystems. Taking this into consideration, *in vitro* fish cell lines and fish *in vivo* bioassays were used to evaluate the acute toxicity of developed carbonaceous nanomaterial compound. At first, the acute cytotoxicity of carbonaceous nanomaterials was assessed using a stable cell line derived from the gill of Zebrafish (*Danio rerio*). Zebrafish gill cell monolayers were exposed to the carbonaceous nanomaterial at various concentrations (20, 50, 100, 250, 500, and 1000 ppm) on 8-well plates. The cell viability is evaluated after 24 hours cells exposed to the nanomaterial product using fluorescent cell viability indicator dyes (0.4% Trypan blue). The findings are used to calculate the effective concentrations (EC50 value) result in a 50% decrease in cell viability. The examined carbonaceous nanomaterial product's EC50 value was determined to be 100 ppm. In the next experiment, fish fingerlings were used in an acute toxicity bioassay of nanomaterial at varied dosages. In accordance with OECD guidelines, the acute toxicity of carbonaceous nanomaterials was examined in IMC *Labeo rohita* (18.8±2.2g) for 96 hours at various nanomaterial exposure concentrations (20, 50, 100, 250, and 500 ppm). At the examined dose, no mortality or behavioural abnormalities was observed. It is important to note that though we observed acute cytotoxicity of carbonaceous nanomaterials in cell line (EC50 value at 100 ppm), fish did not exhibit any mortality or



Zebrafish gill cell line used in the study

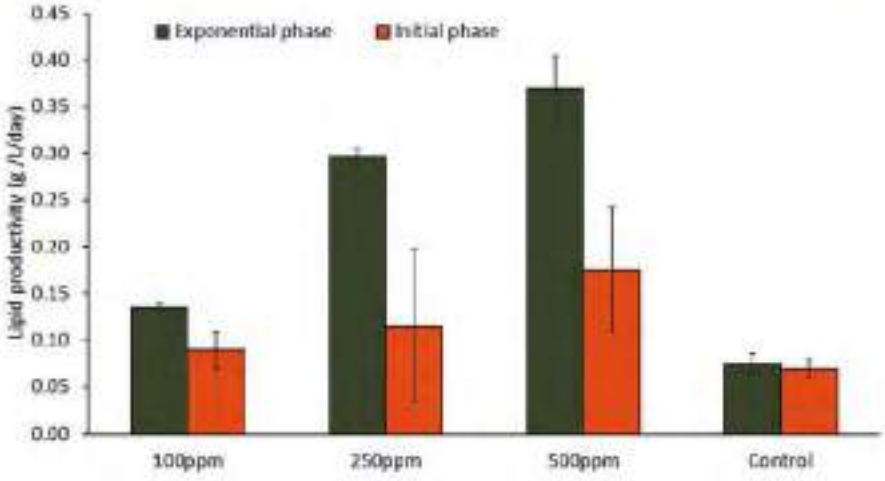


Microscopic images of carbonaceous nanoscale material treated microalgae

sublethal effects even at concentrations of 500 ppm, which is nearly 10-fold greater than the field application rate.

Carbonaceous nanoscale material enhanced the lipid productivity of microalgae

Huge availability of banana pseudostem waste leads us to utilize it for microalgae growth and lipid production. At first, banana pseudostem fiber was converted into carbonaceous nanoscale material by hydrothermal carbonification, and the same was used as a supplement for growing microalgae *Graesiella emersonii* for biodiesel production. The carbonaceous nanoscale material was added at concentrations of 100, 250, and 500 ppm at the initial stage and exponential phase of microalgae culture followed by an analysis of biomass productivity, lipid productivity, and fatty acid profiling, and compared with only BG-11 medium-grown microalgae. The study revealed that carbonaceous nanoscale material supplementation significantly ($P<0.05$) improved biomass productivity and it was 2-3 times higher than the control group. There was a 23% increase ($P<0.05$) in lipid content at 500 ppm supplementation. Similarly, lipid productivity was also improved, and the maximum lipid productivity of 0.4 g/l/day was achieved in 500 ppm supplementation during exponential phase. Further, the fatty acid profiling revealed the presence of more amount of desirable fatty acids such as methyl palmitate, methyl linolenate, and oleic acid in the treatments as compared to the control. The biodiesel obtained from the microalgae also complies with both national and international standards of biodiesel. Interestingly, it was also complying with the fuels of boat fishing at coastal seas. Hence the present study concludes that supplementation of the carbonaceous nanoscale material preferably at 500 ppm concentration stimulates more production of quality lipids in the test microalgae which could be further utilized for sustainable biodiesel production.



Lipid productivity of *G. emersonii* MN877773 grown in different treatments

Project Title: Sustainable Inland Fisheries Development Pathways to Ensure Sustainable Development Goals

Project Code: FSE/20-23/04

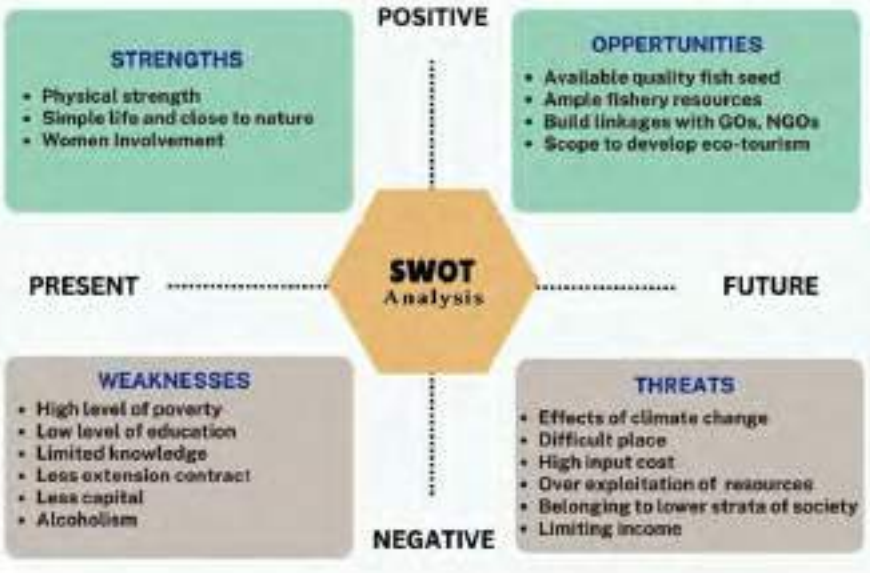
Duration: April 2020 - March 2024

Scientific Personnel: B. K. Das (P.I.), P. K. Parida (up to 20.12.22), A. Roy, P. Debroy, Lianthuamluaia, M. H. Ramteke, Satish Koushlesh, T. N. Chanu, M. A. Hassan, Arun Pandit, H. S. Swain (upto 31.08.22), R. Baitha, S. P. Kamble, A. K. Das, G. Chandra, P. R. Behera (w.e.f. 01.12.21), S. Kumari (w.e.f. 01.04.22)

The inland fisheries sector is important for achieving the Sustainable Development Goals around the world. This stems from the fact that this sector provides food and nutritional security to billions of people and caters to livelihood functions of millions of people in the world. The Project emphasizes on harnessing the relationships between inland fisheries, interventions of ICAR-CIFRI to address the SDGs through flagship programmes, sustainable fisheries resource management and the targets of SDGs. With this aim in view, we have worked on SDG 1 (No Poverty: Reduce Poverty by Involving PFCS, SHGs, NGOs etc.); SDG 2 (Zero Hunger: Ensure Household Nutritional Security through SIFs); SDG 5 (Gender Equality: Women Empowerment through Ornamental Fish Culture); SDG 8 (Decent Work and Economic Growth: Increase Farmers' Income through Production Enhancement Strategy); SDG 12 (Responsible Consumption and Production: Sustainable Fish Production); SDG 13 (Climate Action: Culture and Popularize Climate Resilient Fish Species); and SDG 14 (Life Below Water: Conserve Fish Diversity with Special Reference to SIFs). The following interventions are not only helping in achieving individual targets but also resulting in mutually beneficial synergies across the SDGs.

SWOT analysis of the fishers of Sagar Islands, Sundarbans

Sagar island is inhabited by more than two lakhs of indigenous people mostly associated with the fisheries and agriculture sector. 56 thousand people of Sagar Island belong to SC and ST communities, constituting 25% of the whole population, which belongs to the vulnerable, poor and marginalized part of the populace. A study was conducted to assess the socio-economic status, and SWOT analysis to know the baseline information towards socio-economic upliftment. The results of the SWOT analysis was given in Fig.. Training and capacity building for alternatives source of income would be an effective strategy for improving their livelihoods.



Enhancing household nutritional security of fishermen through SIFs

Data about role of SIFs in Duma wetland for the nutritional security was collected from 101 fishers. It has been found that the 15 types of SIFs, namely pool barb, mola carplet, glass fish, banded gourami, long-whiskered catfish, stinging catfish, zig-zag eel, gangetic mystus, bronze featherback, bullseye snakehead, spotted snakehead, rice eel, climbing perch, dwarf snakehead, tank goby were mainly consumed by the fishers and their families in Duma. Further it has been observed that 71.45% of their fish harvest comprised of SIFs. The price of SIFs is highest in the summer season during the months April through June. There is no catch or profit sharing mechanism with the Fishers' Co-operative Society for SIFs. The average monthly income of the fishers of Duma wetland is about ₹ 6,750 per month.

SIFs are a very crucial part of the diet of the fishers and their families of Duma wetland. 33% of the SIFs caught was consumed by the fishers in their families. The remaining 67% is sold in nearby the markets. SIFs consumption in fisher families have been also observed to vary according to the availability and supply of SIFs in the wetland.

Three types of marketing channels have been observed to be practiced by the fishers of Duma wetland. These are:

(I) Fisher Consumer (57%)

(ii) Fisher Wholesaler Retailer Consumer (31%)

Duma Wetland

(iii) Fisher Commission Agent / Wholesaler / Retailer representative / Retailer Consumer (12%)

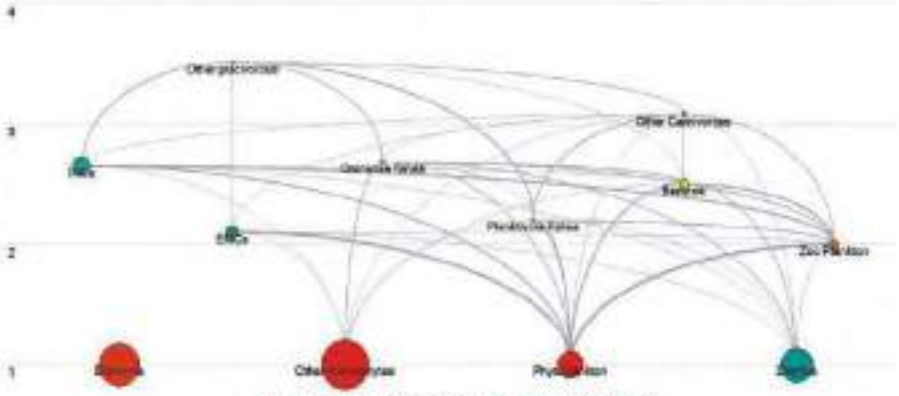
The markets where the Duma wetland SIFs are sold are Tau Bazar, New Market, Rail Bazaar, Chand Para Fish Market, Kali Tala and Angrail Fish Market in and around Duma wetland.

Fish production enhancement for improving the livelihood of the tribal fisheries in a small reservoir

The Kalo reservoir is a small tropical reservoir in Odisha with the submerged area of 535 ha. Around 130 fishers are depending on the reservoir fisheries for their livelihood. Because of poor reservoir fisheries management, fish production in the reservoir was only 25 tonnes in 2018-19. ICAR-CIFRI intervened by stocking large size and good quality fish seed produced through in-situ seed raising with the participation of the local fishers. FRP boat and six coracles were distributed to the local Primary Fishermen's Cooperative Society for fishing operation. Integrated reservoir fisheries development training programmes were conducted in addition to technical guidance and input support. Because of the intervention of ICAR-CIFRI, total fish production increased from 25 tonnes in 2018-19 to 50 tonnes in 2020-21. The increased fish production in the reservoir has increased the income of the fishers who rely on the reservoir fisheries for a living. This was targeted todoubled the fishers income in a community participation from the natural system as per the national goal of doubling farmer's income.

Developed food web of Beledanga wetland

A mass-balanced ecopath model for the Beledanga wetland has been developed. Considering the biodiversity and availability of fish catch data, the inhabitant community of this wetland has been categorized into 12 numbers of functional groups viz. "Other piscivorous", "IMCs", "EMCs", "Other carnivorous", "Omnivore fishes", "Planktivore fishes", "Benthos", "Zooplankton", "Eichhornia", "Other macrophytes", "Phytoplankton" and "Detritus". The mass-balanced ecopath models are well-known as one of the best available tools for Ecosystem-based fishery management strategy as it illustrates and also quantify the flows (both matter and energy) in between the functional groups. Moreover, its inbuilt ecological network analysis indices, indicate trophic status



The Food web of Beledanga Wetland

(The arches were denoting the flows and the circular nodes denote the ecological groups and the size of the circles indicates the magnitudes of the biomass of ecological groups. The IMCs and EMCs denote the Indian Major carps and the Exotic Major carps respectively)

integrity, system reserve and production cycling process within an ecosystem. In the developed Beledanga wetland groups like "Benthos" and "Zooplankton" were found as the most utilized groups with the higher ecotropic efficiencies (EE) value 0.7, whereas groups like other piscivorous fishes, Eichornia were the least utilized groups with EE value of 0. Also, a lesser utilization of plankton productivity is also observed as the calculated EE value was 0.2. All ecological groups of this wetland ecosystem are placed within trophic level 1 (the primary producers) to 3.516 (Other Piscivorous fish). This system showed a less transfer efficiencies (3.414%) and a low Finn's cycling index of 0.33%. Although, this system found as an immature system or developing towards maturity, but it has a good system of reserve to withstand the external perturbations.

Women empowerment through ornamental fish culture

The state of Jharkhand shares 38.29% of the country's SC & ST population (Census India 2011). Even though great strides have been made in the eradication of poverty, however, SC and ST peoples are still among the poorest of the poor. The ICAR-CIFRI encouraged small-scale backyard ornamental fish culture enterprise by woman to earn additional livelihood in the state of Jharkhand through distribution of ornamental fish culture kits, exposure visits, hands on training and demonstration. Under this program, 95 woman (30 from Simdega, 25 from East Singhbhum, 15 from Bokaro and 25 from Ranchi) of SC and ST community were benefitted. The ornamental beneficiaries in the other places like Bhubaneswar, Bhadrak, Kultali and Jamshedpur have started earning from this initiative. After 5-6 months of rearing, women started fish selling and their earnings started at Rs. 500-2000/month and are growing continuously. The women of Amtoli and Kultali of Sundarbans have also started marketing in local areas.

Increase in farmers income through production enhancement strategy in small reservoirs

Forest product, fishing, agriculture, animal husbandry and hunting are the important sources of livelihood among tribal communities of Jharkhand. But shrinking arable land, persistent failure or lower agricultural productivity, high population pressure, climate change, socio-political and economic circumstances are threatening factors for their sustainable livelihood sources. The institute extends support to the fishermen cooperative societies belonging to Scheduled Caste and Scheduled Tribe communities of 17 reservoirs situated of 5 districts. The livelihood improvement program was done through distribution of 34 pen culture units (CIFRI HDPE Pen), 2.540 tons of fish seeds (Indian Major Carps), 36 tons of fish feed (CIFRI-CAGEGROW) and 12 mechanized /motorized and 5 non-mechanized FRP boats (12 ft OAL) to fishers of the Schedule Caste and Schedule Tribes community. The beneficiaries were trained through demonstration of the pen culture activities with their participation. About 809 beneficiaries (SC-316, ST-493) with gender representation of Male-799 and Female-10 from 22 cooperative societies under 13 blocks of five districts. Sohagini Sakhi Mandal, Jarahiya, Hazaribag is exclusively female cooperative society benefitted through pen culture activity. The estimated cumulative volume of fish seeds raised through pen culture activities in 34 pen unit was 12.23 tons, considering 30% loss due to mortalities during culture period.

Pen culture demonstration in wetland and to culture and popularize the climate resilient species

Duma is one of the largest horseshoe-shaped wetland of Asia having an area of 257 ha with a water depth of 8 - 17 ft. The fisherfolk families of 9 villages surrounding Duma wetland are fully dependent on this wetland. For augmenting the fish production from this wetland through pen culture fisheries inputs like HDPE pen, fish feed, fish seeds of IMCs, *Systomus sarana* and grass carp were distributed previous year. With all this support, the co-operative society has raised the fishes in the pens and after attaining the size of 35 - 40 g, the

fishes have been released into the wetland for better production with less investment. In the year 2021 they have harvested about 79 ton of commercial fish of value around 82 lakhs apart from the small indigenous fish.

In continuation to previous year activity, this year also a "Penculture demonstration cum awareness programme" was conducted on 17th June 2022. About, 780 kgs of fish seeds were stocked in the six pens. Being a weed choked wetland, the 'Grass carp model' has also been adopted in this wetland. In the mass awareness programme fishers were sensitized about different aspects of integrated wetland development approaches including the in-situ raising of the fish seeds through penculture to reduce the cost of investment. Result demonstration of the penculture was done to motivate the fishers to adopt the pen culture for development of wetland fisheries.

The diversification, security and resilience of fishers' livelihood in floodplain wetlands of Lower Ganga Basin

Livelihood diversification is a process in which the households receive their means of livelihood from multiple income sources. In the present study, Simpson index measures will be used to study the diversification. The multiple linear regression analysis will be employed to identify the factors affecting the per capita income of the fisher households. Development of livelihood security index is one of the most important social indicators for assessing the quality of life, coupled with meeting the basic needs of human-beings. In the present study the scale to measure the livelihood security of the fishers developed by Binkadakatti (2013) and Pandit et al (2021) was used.Subcomponents of each livelihood capital were identified. Resilience of a system, in a broad sense, is the capacity of it to adapt to changes and how quickly the system bounces back to the normalcy. The Framework of Bene et al. (2009) and Pandit et al (2021) to assess the resilience of the fisher families against climate change will be used. The five pillars of resilience, namely natural capital, physical capital, financial capital, human capital, and infrastructural facilities were introduced. Altogether 12 variables under nine indicators and five pillars of resilience were developed following the literature. Three threshold criteria; crisis, stable and desirable have been developed. The present status of resilience of the fisher households was assessed against these thresholds.

Primary data are being collected by personally interviewing the fishermen using survey schedules. A total of 400 fishers from 4 floodplain wetlands in lower Ganga basin of West Bengal are being interviewed. Data are being collected on the different livelihood capitals viz., natural, physical, financial, human and social capital and sub-components under them.

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

Funding agency: ICAR

Scientific Personnel: S. Kumari (P.I. since October 2020-May 2021, 20.10.22 to till date), U. K. Sarkar (P.I. 01.06.21-19.10.22), A. Sinha (P.I. till 30.9.20), S. Yengkokpam, S. Kumari (w.e.f. 01.06.21), H.S. Swain (till 30.08.22), N. Sharma (w.e.f. 01.09.21)

Morphometric and meristic characteristics of *Danio dangila* (F. Hamilton, 1822)

Danio dangila which is also known as chain danio, moustached danio or dhani in Bengal. It is one of the popular indigenous ornamental fish in India. These are benthopelagic freshwater fishes found in Bangladesh, Nepal, Myanmar and India particularly in Ganga - Brahmaputra drainage system of Bihar, North Bengal and North East parts of India. Brooder fish were collected from different parts of wetlands of WB, acclimatize in cement tank and maintained in a glass aquarium of size 3ft. x 1.5ft. x 1.5ft. The aquarium was provided with all essential accessories including filter, air stones for continuous oxygen supply. The fishes were fed with live feed (tubifex) two times a day along with this regular monitoring of water quality to ensure good health of brooder fish under captivity.

Male and female brooders were identified based on colour pattern, presence of large cleithral spots and pattern of dark and light rings appears to be in a continuous chain. Morphometric and meristic characteristics of 10 samples were recorded as given in the table.

Induced breeding and larval rearing of *Danio dangila*

Male and female of *D. dangila* were separated based on sexual dimorphic characters such as females are larger than the male, belly is round in female, while slender in male and streamlined. Matured male and female were checked and separated by stripping method, in case of matured female oozing out eggs were found while in case of matured male milt oozes out on slight press of vent. The selected matured brooders were injected with hormone SPAWN PRO in the month of September. The mature brooders were selected for induced breeding @ 1:2 (female: male) ratio and kept in glass aquariums (2.0ft x 1.0ft x 1.0ft). Intra-peritoneal administration of synthetic hormone was done to the male and female @ 0.3ml and 0.4ml/Kg body weight of fish respectively. Spawning was observed 10 hours post hormonal injection in glass aquarium at a water temperature of 27-28°C. The spawning fecundity was around 250-280 eggs/female and a fertilization rate of 70% was achieved. Hatching of fertilized eggs were achieved in 36-40 hrs and yolk absorption was completed in 4th day after hatching with 40% survival. The larvae accepted the external food from 5th day onwards and two batches of larvae survived during the trial. % survival of larvae 5th day to 1 month was 21% of hatchlings and no mortality after reaching 1 month. At

Collected brooder maintained in a glass aquarium

Table: Morphometric and meristic characters of *Danio dangila* collected from North Bengal

Morphometric			Meristic	
Characteristics	N	Range	Characteristics	Range
Weight of fish (g)	10	9 -18.5	Dorsal finrays (DFR)	11-13
Total length (cm)	10	9.3-11.1	Caudal fin rays (CFR)	19-22
Standard length (cm)	10	7.6-9.5	Pectoral fin rays (PcFR)	10
Eye diameter(mm)	10	3-4	Anal fin rays (AFR)	16-18
Head length(cm)	10	1.5-2	Lateral line scale (LLS)	35-36
Body depth (cm)	10	1.9-2.6	Transverse scale (TS)	10-11

Larval development of *M. aral*: one day old larvae (10X compound microscope view), 15 days old larvae and five month old fingerling (from left to right)

Larval development of *D. dangila*: eggs laid in breeding tank, one week larvae and three month old fingerling (left-right)

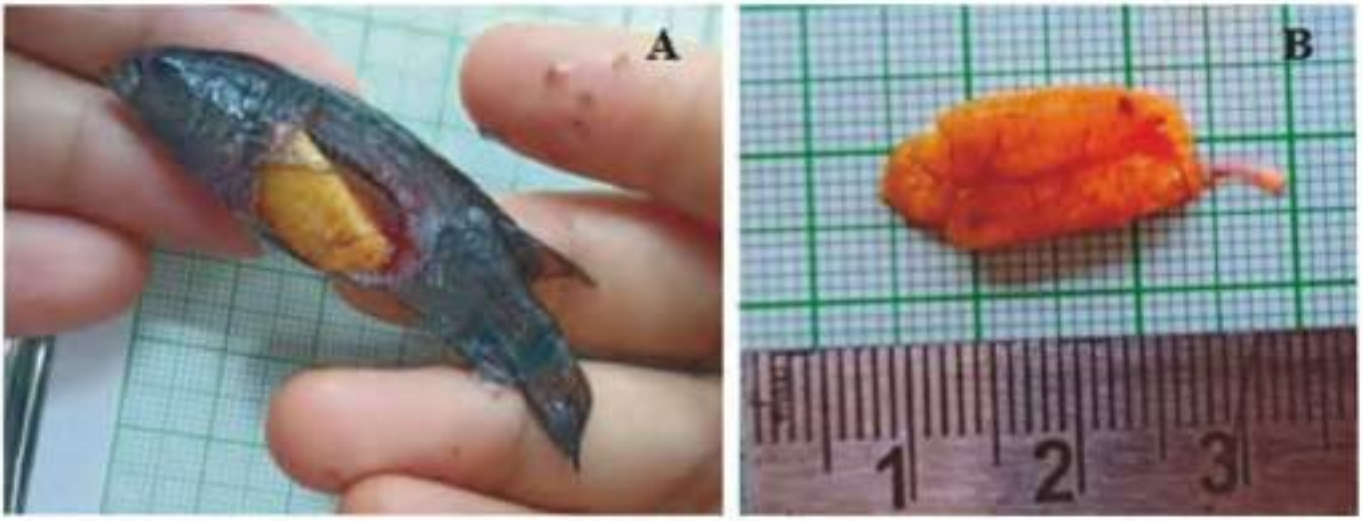
the end of 3 months length range of fish was observed 3.9-6cm in size.

Successful larval rearing of *Macrognathus aral* in captivity

Macrognathus aral also known as one spiny eel porthole or peacock eel, distributed in Pakistan, India, Bangladesh, Nepal, and Myanmar. This species live in fresh and brackish water bodies mostly in running and stagnant water. It could reach maximum length 63.5cm in length. Its body is long elongated and looks like eel having a fleshy snout and round caudal fin separated from the dorsal and anal fins. The colour of the fish is brown to yellow, ventrally marked with two long dark bands on both sides. The number of ocelli varies in count from 3-11(false eye spot) at the base of the dorsal fin. Apart from being the table food fish, they also have high ornamental value because of their beautiful body, different shape and colour. Brooders of *M. aral* were collected from the wetlands of Nadia district of west Bengal and induced breeding was performed in captivity but larval rearing is challenging. Successfully larval rearing in captivity was achieved for two batch of breeding of *M. aral*. Six Glass aquariums of size 12 x 8 x 8 inch^3 was set in series with different combination of water in replicates (2) Green water, Ganga water and filteres water. Highest survival was achieved in green water. At 4th day of hatching egg yolk was completely absorbed and first food was provided. Different types of food was fed to the *M. aral* larvae which includes; green water, infusorians and boiled egg yolk, the larvae were fed 3-4 times a day. It was observed that the most accepted food was infusoria among all, the acceptance of micro articulated shrimp powder increased after 15-18 days. Microparticulated shrimp powder was continued for next one and a half month. Later switch to large size food tubifex was fed to the larvae and continue with same food for further growth and survival. The larvae attain length of 10.4cm and weight 4gm in 5 month.

Reproductive biology Indigenous Ornamental Dwarf Chameleon fish, *Badis blosyrus* (Kullander & Britz, 2002) from Brahmaputra River System of Assam

Reproductive traits of indigenous ornamental dwarf Chameleon fish, *Badis blosyrus* was studied during this period. Altogether seventy five wild fish specimens were collected from the Brahmaputra River, streams and wetlands of Assam. Important parameters of reproductive biology including sex ratio, gonad weight, maturity status, gonadosomatic Index (GSI), absolute and relative fecundity, and egg diameter were estimated. Sexual dimorphism was well noticeable by their colour pattern, adult males display bright colour and larger in size than the females. Monthly sample was collected and found females were predominant over males in every month of sample size 30. The highest percentage (71.43%) of female fish was observed in the month of January and the lowest percentage (60%) was observed in the month of March and October. Male fish sample was recorded highest (40%) in March and October and lowest (28.57%) in January. The sex ratio of the fish ranged from 1:1.5 to 1:2.5 with an overall sex ratio of 1:1.77 (M: F) with no significant differences. The GSI for the females ranged from 1.01 to 17.89. The absolute fecundity varied from 892 to 940 eggs per fish while the relative fecundity ranged from 142 to 150 eggs per gm. of body weight. The fish due to its attractive and unique colour pattern have high demand in ornamental fish market.



B.blosyrus gravid fish with ovaries (A) and ripe ovary for the study (B)

Table 1: Details of species distribution, price and conservation status of three endemic snakehead of NE India

Sl No.	Name of the species	Food/ Ornamental	Price per piece	Source	Conservation status
1	*Channa aurantimaculata*	Ornamental	400 -1500	Brahmapatra River Basin of upper Assam and Arunachal Pradesh	DD
2	*C. stewartii*	Ornamental	150 -700		LC
3	*C. bleheri*	Ornamental	100 -600		NT

Market trend of high valued endemic snakeheads

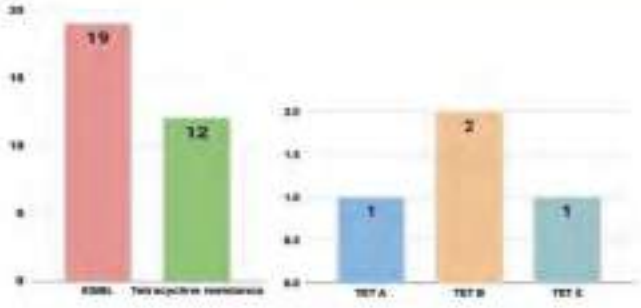
A study was carried out to study the market trend of three endemic snakeheads of Northeast India i.e., *Channa aurantimaculata*, *C. bleheri* and *C. stewartii*. These three snakeheads have high demand in international ornamental fish markets after the *Channa barca*. *C. aurantimaculata* is exported in large size and occupies majority of the trade, it is one of the highly demanding snakehead in export trade followed by *C. stewartii* and *C. bleheri*. All the three snakeheads have been recorded from upper stretches of Brahmaputra River basin in Assam and Arunachal Pradesh. The price of the fishes changed suddenly from price per kilograms to price per piece. The details of species distribution, price and conservation status is mentioned in table below. In recent years, as the people become acquainted about the demand for these fishes, few of the traders started catching these fishes illegally from the wild and as a part of conservation measure appropriate action against the poachers used to be taken by DOF, Assam. The price of fish varies greatly due to various factors such as demand, colour, size, marketing chain wholesale or retail, local or export etc.

Project Title: Network project on Antimicrobial Resistance (AMR) in Fisheries and Aquaculture

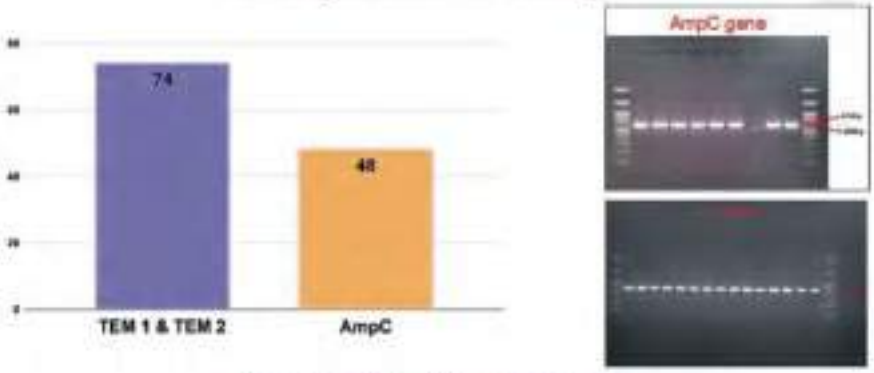
Funding Agency: ICAR

Scientific Personnel: A. K. Sahoo (P.I.) and A. K. Bera

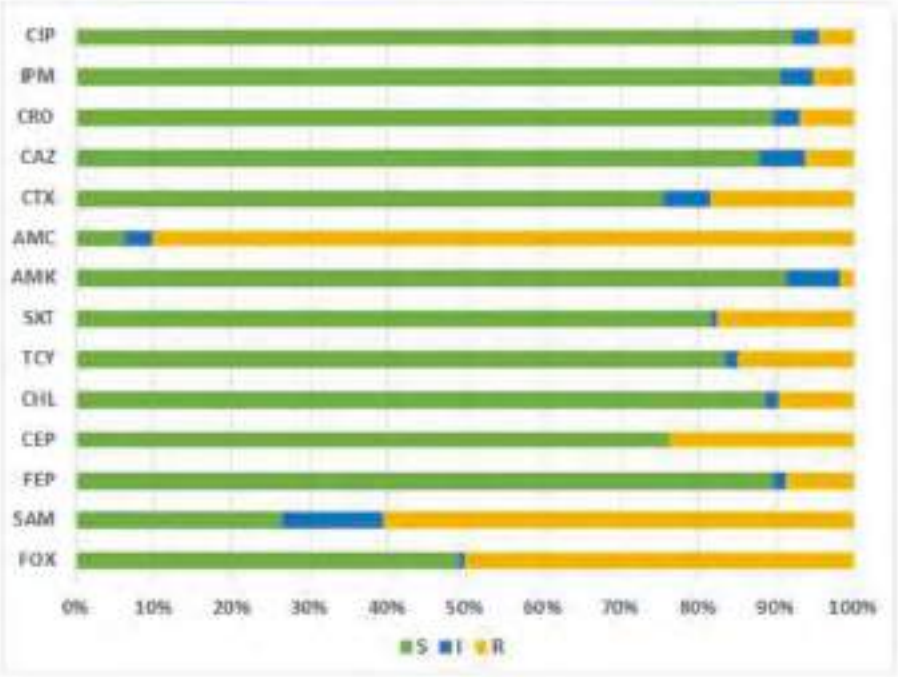
Antimicrobial Resistance (AMR) surveillance was carried out in 128 freshwater farms representing 128 fish of different species *Labeo rohita, Labeo catla, Cirrhinus mrigala* and *O. niloticus* from Burdwan, North 24 Parganas, Hooghly, East Midnapore and Howrah districts during January to December 2022. As per the Standard (SoP), *Aeromonas* spp., *Escherichia coli* and *Staphylococus aureus* were isolated and identified by both biochemical and molecular method. Of 128 isolates, 117 *E. coli*, 112 *Aeromonas* spp. and 92 *Staphylococcus* spp. Were identified. AmpC type β lactamase are commonly isolated from extended spectrum cephalosporin resistant gram-negative bacteria.Out of 117*E.coli* isolates, 74 isolates were carryAmpC type of β lactamase. 48 isolates were screened for TEM 1 & TEM 2 i.e. the resistance gene for Ampicillin and found to be positive



Screening of isolates for resistant genes



Screening of *E.coli* for resistant genes



AST for *Aeromonas* spp.

and amplified at 800 bp. While, of 112 *Aeromonas* spp. 19 isolates were phenotypically showed positive for ESBL production and 12 isolates were resistance to tetracycline group of antibiotics. Those isolates which were showed ESBL production phenotypically, further screened for different β-lactamase resistance genes like bla_{CTX-M} and bla_{TEM}. These genes indicate Class A type of broad spectrum β-lactamase production which is mediated by either plasmid or chromosome. 3 isolates were found positive for carrying bla_{TEM} gene and 8 isolates carrying bla_{CTX-M} gene. Among tetracycline resistant isolates, tet A (1), tet B (2) and tet E (1) genes have been standardized and showed positive. The resistance pattern of *Aeromonas* spp. indicated that, about 90% isolates were resistance to ampicillin-clavulanic acid, 61% isolates were resistance to ampicillin/sulbactam and 50% isolates were resistance to cefoxitin which revealed that most of the isolates were ESBL producer. Of 128 fish samples, 92 *Staphylococcus* spp. were isolated. Both biochemical and molecular showed that all isolates were Coagulase Negative Staphylococcus (CONS). Antimicrobial susceptibility testing of these isolates revealed that 100% isolateswere Penicillin resistant. 90 and 76% were Oxacillin and Cefoxitin resistant.

In addition to the surveillance of AMR, awareness among the fishermen, and general public have been found as an effective method against the misuse of antibiotics. A set of awareness programme was carried out at different places in West Bengal state. The World Antimicrobial Awareness Week (WAAW) was celebrated during 18-24 November, 2022 with a theme "Preventing Antimicrobial Resistance together". Along with the celebration of World Fisheries Day by ICAR-CIFRI, WAAW was celebrated amongst farmers, students and Subject matter specialist from different KVK saround the West Bengal on 21st Nov. 2022. An awareness programme was conducted in association with Nandigram Aquafarm Welfare Society at Gangrachar, Nandigram-1 (East Medinapore. During the period 2022, more than 10,000 people have been involved in AMR awareness programme.

An innovative concept towards AMR mitigation has been introduced by the

ICAR-CIFRI. The institute is involved in providing supports to SC and ST communities in terms of Fish seed, Feed and Fish medicine towards improving the livelihood under the SCSP and TSP programme. During the input distribution like medicine, fishermen were advised to provide medicine to fish with the technical guidance of Fish Microbiologists or Pathologists or Veterinary professional.

World antimicrobial awareness week celebrated at Chandannagore College, West Bengal

Project Title: Fish stock enhancement including hilsa and livelihood improvement for sustainable fisheries and conservation in river Ganga

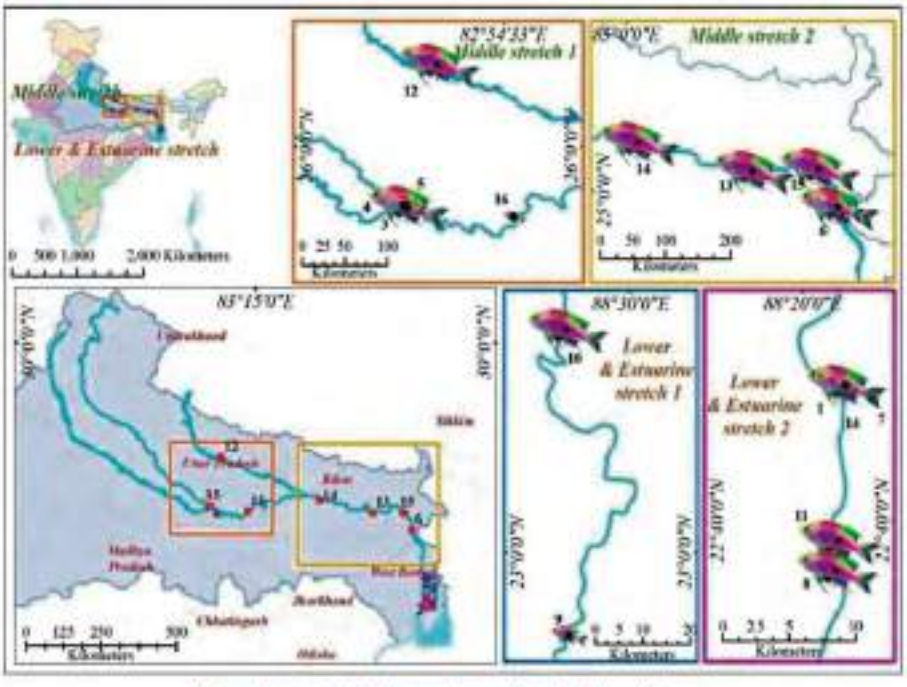
Funding Agency: National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Government of India

Scientific Personnel: B. K. Das (P. I.), A. K. Sahoo, D. N. Jha, D. K. Meena, S.C.S. Das, R. Baitha, J. Kumar, T. N. Chanu, H. S. Swain (upto 31.08.22), M. H. Ramteke, Canciyal J., Santhana K.V, A. Saha, D. Bhakta, and V. Kumar

Ichthyo-diversity of river Ganga

Holy river Ganga, the major lifeline of North and Eastern India, was once rich in fisheries but is fast depleting the food resource. The project aims to enhance fish stock of the river so that the riparian fishers community earn their livelihood and the river ecology also improves. In the year 2022, a total of 178 fish species (169 native and 9 exotics) belonging to 121 genera, 56 families, and 20 orders were recorded. Fish species richness was highest at Bijnor (97), followed by Narora (83), Prayagraj, (76), and Varanasi (75). Among the exotic fishes, Common carp dominated in the entire middle stretch of the river. Stock assessment study of five native fish species, viz. *Tor putitora*, *Gudusia chapra*, *Rita rita*, *Setipinna phasa*, and *Rhinomugil corsula* showed that the levels of exploitation were marginally higher than those recommended for sustainable fisheries in river Ganga.

The study, for the first time, recorded *Megarasbora elanga*, *Danio rerio* and *Nemacheilus corica* from Bijnor, *Salmo trutta fario* (Brown trout) from Harshil, and an albinoid *Clarias magur* from Bhagalpur. A specimen of *Schizothorax progastus* (McClelland, 1839), locally known as Snow trout, of 265 mm length and 170 gm weight, was recorded at Harshil, Uttarakhand. Four marine species (*Muraenesox bagio*, *Pisodonophis cancrivorus*, *Gymnothorax tile*, and *Chelonodon patoca*), reported earlier, were also recorded from Fraserganj, a brackishwater section of the river suggesting establishment of these marine species in the Hooghly estuary.



Map showing fish ranching sites in River Ganga

Ranching and awareness building

To achieve *ex-situ* conservation for restoration of the indigenous fish stocks, a total of 75 lakh Indian major carps (IMC) seeds were produced through induced breeding of riverine wild fish. Fish ranching programmes were carried out to increase fish catch and restore the native fish species (IMCs and Mahseer) in river Ganga. The Institute launched a massive "National Ranching Programme-2022" in Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal wherein 24.45 lakh fingerlings of IMCs and Mahseer were ranched in 18 occasions.

Beside ranching, a total of 58 awareness programmes were organized to raise awareness of sustainable fisheries among the stakeholders. The negative impact of operating zero-meshed nets and other destructive fishing techniques such as the use of toxic chemicals for fishing were also addressed and discussed with the local people, fisher folks, etc. A total of 3413 fishers were aware through different awareness campaigns in Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal.

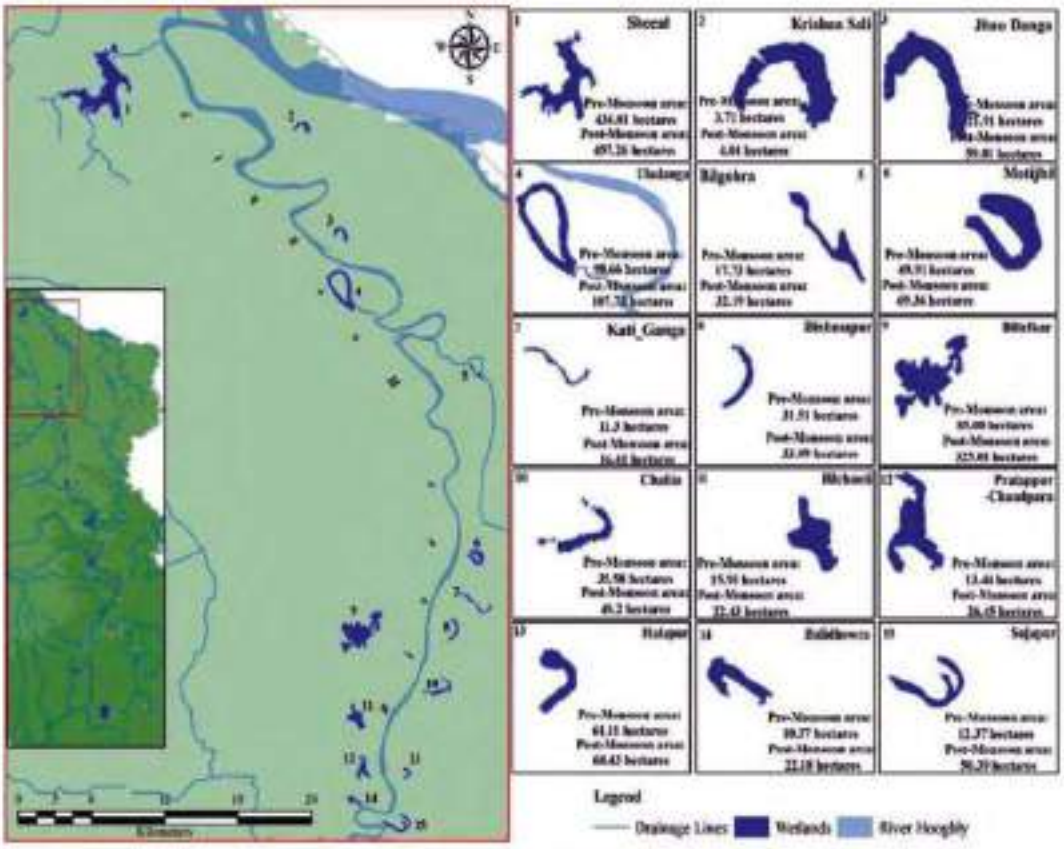
Mapping of wetlands associated with Ganga River in West Bengal

Mapping was done to identify how many wetlands associated with the Ganga River are still connected to the main river channel and how their connectivity is changing over time. The study would identify suitability of the wetlands as breeding and nursery grounds during monsoon. Mapping of the wetlands, done in pre-monsoon (February, March, April and May) and post-monsoon (October, November, December and January) seasons, identified 46 wetlands situated close to the main river channel.

Among these, the northernmost wetland is Sheal wetland near Farakka, and the southernmost

Ranching at different sites across river Ganga. A- Belur Math, Howrah, B- Chandannagore, Hooghly, West Bengal, C- Sangam Nose, Prayagraj, Uttar Pradesh, D- Dakshineswar, North 24 Parganas

wetland is Rabindra Sarovar in the city of Kolkata. The North-South span of all the wetlands together is more than 200 kilometers and all are within 5 km of the main river (River Hooghly). Out of 46 wetlands, only 4 have retained their connectivity with the main river. The largest among these is the East Kolkata Wetlands (EKW) (1011.36 ha) and the smallest is the Krishna Sali (3.88 ha) wetland. The highest seasonal change in water area was noted for Biltelkar (239.93 ha) and the lowest for Krishna Sali (33 ha) wetlands.



Mapping of some of the flood plain wetlands associated with Ganga River

Hilsa and Dolphin conservation awareness programme

Rescue and release of a Gangetic Dolphin at Farakka

Ranching of Hilsa for its re-establishment in middle stretch of river Ganga

Catch of high value fish Hilsa (*Tenualosa ilisha*) has been severely depleted above the Farakka barrage. This project has attempted to re-establish Hilsa in middle stretch of the river. Artificial fertilization of hilsa from the wild collected brooders was carried out at Farakka with 85-90% fertilization rate. Two innovative approaches were adopted: about 50% of the fertilized eggs were transported in oxygen-packs and transported and ranched at selected sites above Farakka barrage. Rest of the fertilized eggs were reared for more than 20 days and transported for the ranching. Habitat characteristics of the ranching sites were studied to ensure hatching of released eggs and larval development. A total of 5.8 lakh hilsa spawn were ranched in the river Ganga in the year 2022. Towards cage culture of the prized fish, circular cage of 16m diameter was installed and live Hilsa collected from downstream of the Farakka barrage were released into the cage for brooder development.

Atotal of 1,055 hilsa brood fish were also released in upstream of the Farakka barrage during the period, of which 1304 fish were tagged to study their migration behaviour. A total of 227 awareness programmes were held among the riparian communities. More than 8326 fishermen of Bihar, Jharkhand and West Bengal were provided scientific knowledge on the life cycle of Hilsa, its conservation, and the procedure to tag Hilsa. A total of 1921 number of juvenile Hilsa were recovered from several locations, including Murshidabad and Malda (West Bengal), Jharkhand and Bihar, based on interactions with fishermen and multiple awareness programmes.

Gangetic dolphin conservation awareness

Gangetic dolphin, endemic to the river, is threatened and need to be conserved. Fishers of river Ganga were made aware on Gangetic dolphin and need for their conservation. Due to the fishermen awareness, 2 river dolphins were rescued from the fishermen nets and released into the river Ganga.

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

Funding Agency: NICRA, ICAR

Scientific Personnel: B. K. Das (P.I.),U. K. Sarkar (P.I. till 19.10.2022), B. K. Bhattacharjya, S. K. Nag, M. Naskar, D. Debnath, S. Das Sarkar, T. T. Paul, S. Kumari, L. Lianthuamluaia, P. Mishal, G. Karnatak, K. Kumari, C. Johnson

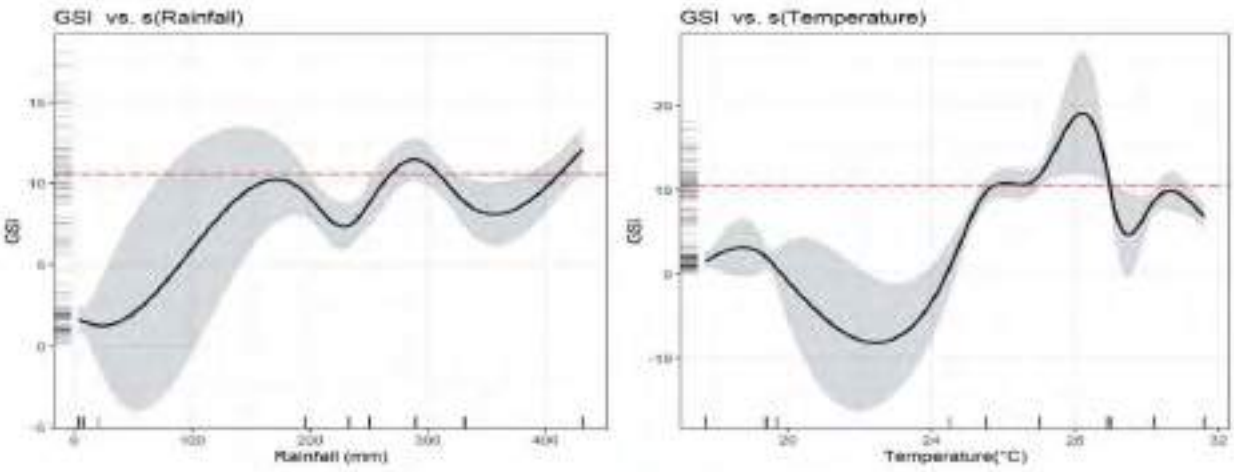
Climate change is an emerging threat to inland fisheries and ecology impacting livelihood of fishers across the globe. To reduce climate vulnerability in inland openwater fisheries sector, the institute is conducting research on assessment of ecological and stakeholder driven vulnerability, impact of climate on wetland fisheries, reproductive vulnerability, development and demonstration of climate smart adaptation strategies, assessment of carbon sequestration and greenhouse gas emission from in floodplain wetlands.

Vulnerability assessment of *Nandus nandus* in floodplain wetlands

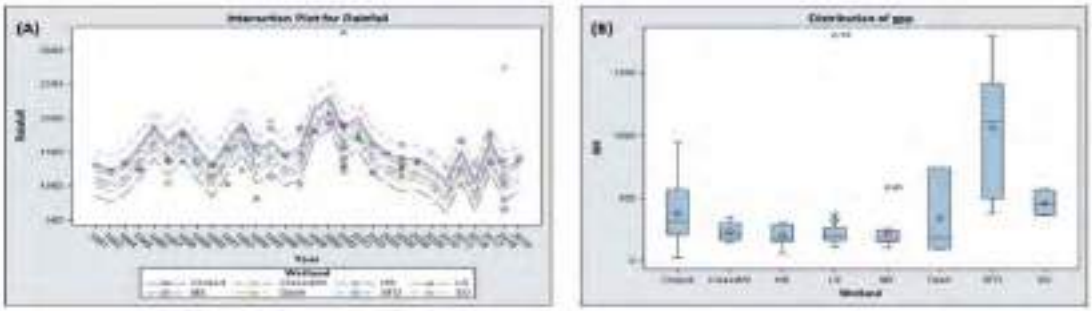
Asian leaf fish, *Nandus nandus*, is a small indigenous fish (SIF) with high food, and conservation importance. Impact of regional climate variability for on population attributes and breeding phenology of this fish from lower Gangetic floodplains and Brahmaputra floodplain wetlands was studied using GAM. Narrow $GSIspawn_{50}$ temperature window indicated that the species is more vulnerable to climate change in Assam compared to West Bengal. Temperature and rainfall were significantly correlated with gonadal maturity. Based on 14 designed attributes the population was found to be moderate to highly vulnerable to climate change. An innovative vulnerability framework was also developed for assessing resilience of the species.

Time series analysis of climate vulnerability of floodplain wetlands

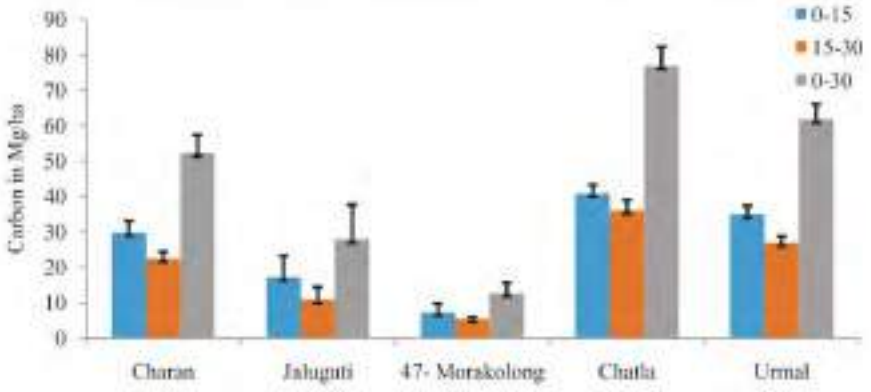
Time series analysis of climatic and environmental parameters was carried out in 67 wetlands in the Indo-Gangetic plain for the period 1985 to 2020. The study indicated temporal variability in rainfall pattern. Trend analysis of rainfall pattern showed a deceasing trend and temperature showed increasing trend in last two decades influencing different types of



Thermal and precipitation preferendum for attainment of breeding of *N. nandus* in wetlands of Assam



Spatio-temporal distribution of mean annual rainfall (mm) & GPP ($mgC/m^3/day$) in different types of wetlands



Carbon accumulation at different depths of soils in wetlands

wetlands differently. The sewage fed wetlands and macrophytes infested closed wetlands with reduced depth, low transparency, high nutrients and primary productivity were more vulnerable to climate change. The open wetlands showed better ecological status in the context of climate change.

Assessment of carbon sequestration potential and GHG emission from wetlands

Five wetlands of Assam were assessed for estimating carbon (C) capture and its accumulation in soil. The mean concentration of dissolved organic carbon (DOC) was highest in Chatla (17.77±4.12 mg/l) followed by Jaluguti (8.40±2.5 mg/l), Charan (7.59±2.22 mg/l), Urmal (7.4±1.2 mg/l) and lowest in 47-Morakolong (3.45±0.78 mg/l) wetlands. The C content of wetland soils at different depths varied widely. In 0-15cm layer the C content was 1.31-6.61% while in 15-30 cm layer it was 1-5.94%. It was estimated that 76.95 MgC/ha has accumulated at 30 cm sediment depth in Chatla, followed by Urmal (61.81 MgC/ha), Charan (52.22 MgC/ha), Jaluguti 27.91, and 47-Morakolong (12.65 MgC/ha).

The emission of Green House Gas (CH_4, CO_2, N_2O) was studied in Khalsi (open type) and Bhomra (closed type) floodplain wetlands of West Bengal. The average emission of CH_4 was 918±324 to 9534±6229g CH_4-C/ha/day in Khalsi and 1836±286 to 7117±4148g CH_4-C/ha/day in Bhomra wetland. The Bhomra wetland is estimated to emit 10248±2611 to 15725±8796g CO_2-C/ha/day while Khalsi wetland emitted 1211±1090 to 3858±2617g CO_2-C/ha/day. The overall emission of N_2O was 0.73-1.1g N_2O-N/ha/day in summer and 0.44-0.88g N_2O-N/ha/day in winter months with higher flux rate from wetlands as compared to upland reference sites. Emission of GHG was higher in summer months than that in winter months.

Stocking of climate smart fish seed at CRPS of various wetlands

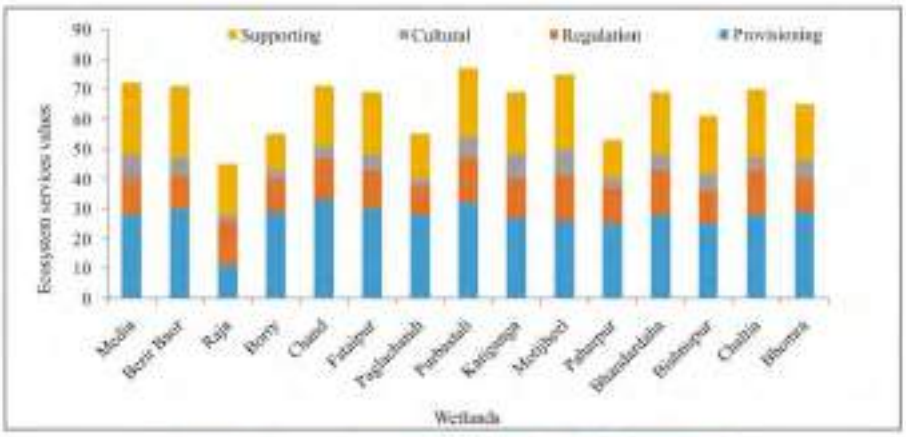
Climate smart adaptation technologies

Climate Resilient Pen Systems (CRPS: 11 nos., 0.1ha each), was demonstrated in 5 wetlands using climate smart species like *Systomus sarana* and *Labeo bata* along with IMCs. *S. sarana* and *L. bata* achieved a final weight of 124±38.82g and 65±18.29g respectively in 180 days with more than 75% survivality. These mature fish produced in CRPS were released in wetlands for stock enhancement and as an input for culture-based fisheries.

Climate Resilient Cage System, floating GI cages (6 nos., 87.5 m^3each) were implemented in Media wetland with resilient species like *S. sarana, L. bata* along with IMCs. Fish biomass of 2322 kg was harvested from cages and released in the wetland as input for culture-based fisheries.CRCS can be used in the wetlands to examine the growth and reproductive pattern of stocked fishes, production and conservation of indigenous species, and holding fish stocks in case of flood and storm.

Climate Resilient Culture Based Fisheries (CRCBF) was implemented in Media and Chand wetlandsof West Bengal and Vembanad wetland of Kerala. Climate smart fish species were stocked in wetlands of West Bengal i.e., *S. sarana, Mystus gulio, L. bata* along with IMCs and exotic carp *Ctenopharyngodon idella*. *C. idella* is a biological control agent to a variety of macrophytes and an efficient converter of carbon to blue carbon. A total of 6000 *Etroplus* seeds were stocked as an input for CBF in Vembanad lake.

CRCS activities in Media wetland



Ecosystem services provided by the studied wetlands

Vulnerability index of Vembanad lake

Assessment of ecosystem services and stakeholder driven vulnerability assessment

Stakeholders' perception on wetland fisheries vulnerability to climate change was surveyed in different states. Data was collected from 15 wetlands from 3 districts of West Bengal using structured questionnaire. The study documented 21 ecosystem services directly or indirectly influencing livelihood of the farmers. Climate change and anthropogenic activities have highly impacted the wetland ecological services.

A total of 24 different wetlands were selected within the coastal stretch of West Bengal. A coherent scenario-based approach combining physical assessment, perception of local people and field experts was used. Many coastal wetlands had buffering capacity to adapt the climate change but extreme climate events such as flood, storm, cyclone in combination with anthropogenic impact had significantly impact. The study shows climate change imposes 70-80% loss in fishery sector, 60-75% loss in agriculture sector, 45-55% loss in infrastructure and 40-45% loss in domestic animal sector.

Stakeholder survey conducted in Bor beel, an open beel connected with river Dihing in Assam, revealed that the wetland experienced a reduction in the deep pool area which provide shelter to brood fishes in summer months. It was also evident that depth and transparency of the wetland decreased in the past 20-30 years. Survey reported reduction in number of fish species with reduction in CPUE in present times. The majority of respondents said that reproductive behaviour is mostly influenced by macrophyte infestation (85%) followed by temperature (75%), rainfall/precipitation (70%), flood (43%), habitat modification (38%), siltation (25%) and wind intensity (13%).

Vulnerability index of inland fishery of Vembanad Lake was assessed for the first time identified relative fecundity as a major factor contributing to the vulnerability (11.03%), followed by temperature tolerance range (10.99%) and generation time (10.29%). The study indicated 7 species, namely, *Nandus nandus*, *Puntius melanostigma*, *Bunaka gyrinoides*, *Parambassis ranga*, *Channa orientalis*, *Mastacembelus armatus* and *Triacanthus biaculeatus* to be vulnerable in the lake.

Coastal wetlands of Ganjam district, Odisha were assessed for climate

Table: Public awareness building activities on climate change

Sl. No.	Name of the program	Date	No. of participants	Venue
1.	Awareness campaign on "Climate-Resilient Inland Fisheries"	29 April, 2022	35	Media wetland (North 24 Parganas, West Bengal)
2.	Awareness campaign on "Climate-Resilient Inland Fisheries"	30 April, 2022	35	Panchpota wetland (North 24 Parganas, West Bengal)
3.	On-field fisher's sensitization programme on "Adaptation Strategies for Wetland Fisheries in Changing Land Use and Enviro-climatic Condition"	4 May, 2022	50	Fataipur and Chand wetland (Nadia, West Bengal)
4.	On-field fisher's sensitization programme on "Adaptation Strategies for Wetland Fisheries in Changing Land Use and Enviro-climatic Condition"	5 May, 2022	50	Katiganga and Bhandardaha wetland (Murshidabad, West Bengal)
5.	Vulnerability assessment and sensitization programme on climate change impact on the coastal wetland	12 July, 2022	150	Astaranga (Puri, Odisha)
6.	Climate resilient technology Demonstration and Fish harvesting programme	19 August, 2022	30	Media wetland (North 24 Parganas, West Bengal)
7.	Harvesting of *Etroplus suratensis* from climate resilient culture-based fisheries associated with Vembanad lake	9 September, 2022	25	Vembanad lake, (Kerala)

Climate sensitization workshop at Astaranga, Odisha

change vulnerability. On an average, 1000 boats are operating in the Ganjam coast and estuary in the peak fishing season (March-June). After frequent extreme climatic events maximum number of river-estuary associated bheries, boats and gears were destroyed resulting in low fish catch/landings forcing migration of fishers to other states for livelihood. About 35% reduction in primary dependence on fisheries has been observed in Gopalpur coastal fishers' community in the last decade.

People's awareness building is a strong tool to survive climate change impacts. The Institute organized seven awareness and sensitization programmes in 2022 in this direction.

Project Title: National Surveillance Programme for Aquatic Animal Diseases: Phase II

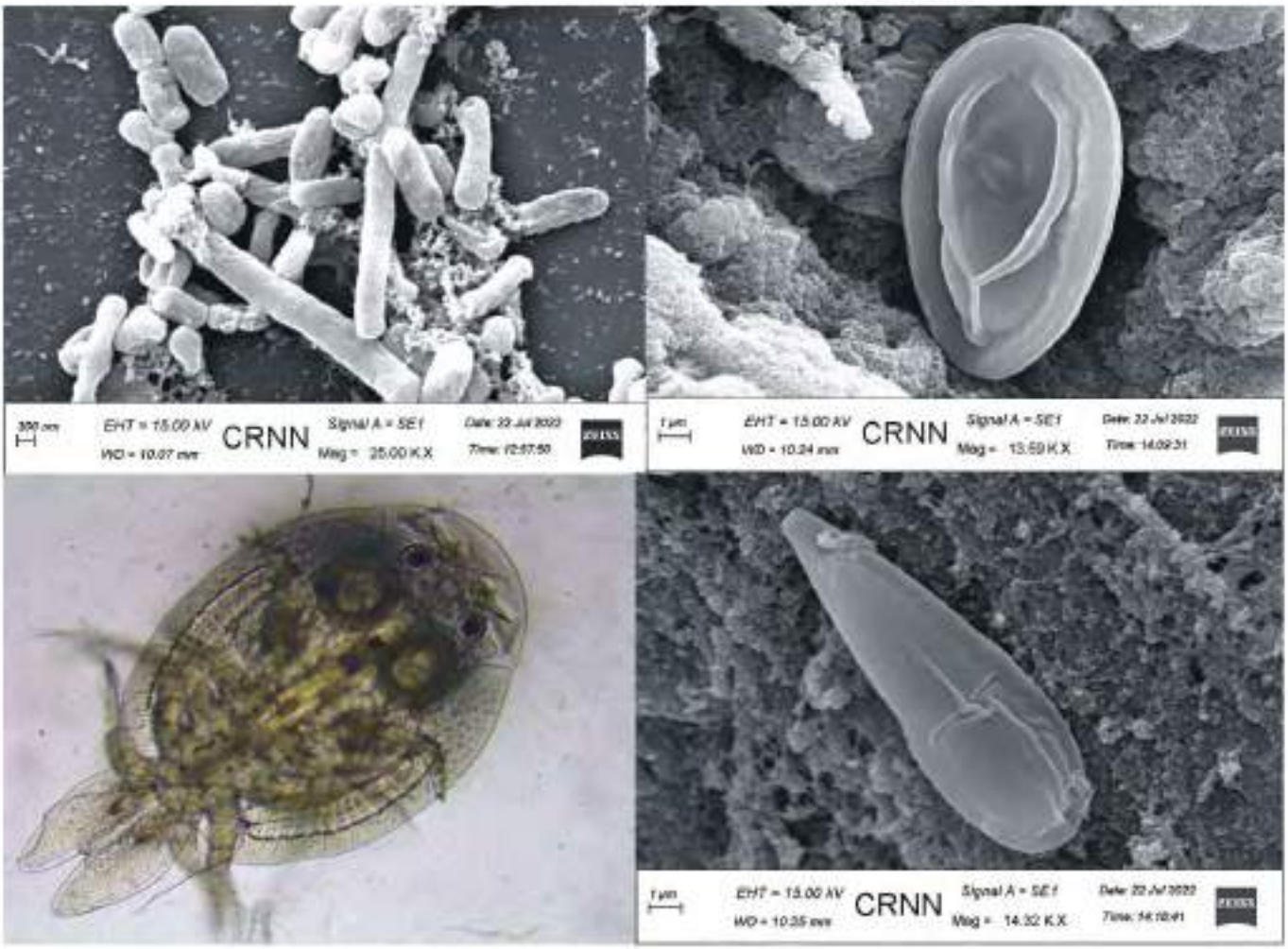
Funding Agency: Pradhan Mantri Matsya Sampada Yojana (PMMSY)

Scientific Personnel: B. K. Behera (P.I.), B.K. Das, P.K. Parida, Vikash Kumar

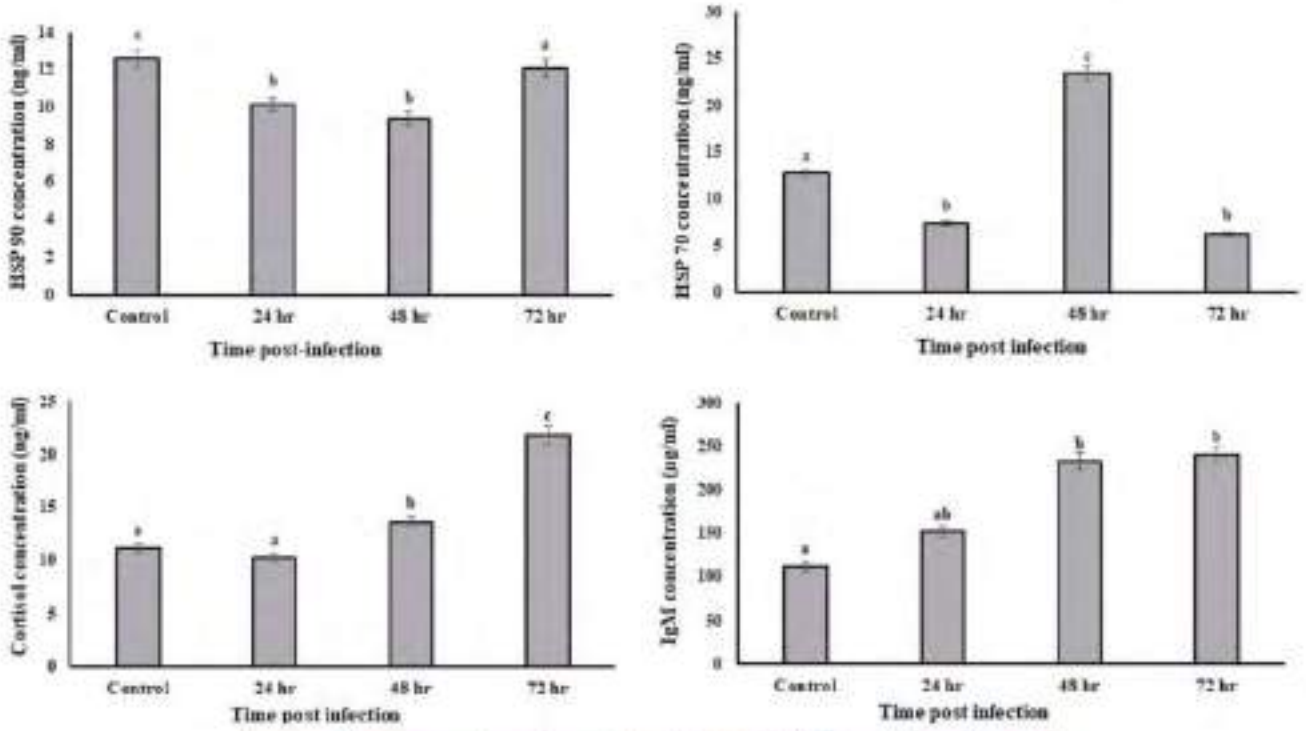
Active surveillance has been conducted in the farmers' field of East Medinipur, Howrah, South 24 Parganas districts of West Bengal for diseases of shrimp, Indian major carps, ornamental fish, etc. Fish pathogenic bacteria *viz. Aeromonas veronii, Aeromonas hydrophila, vibrio parahaemolyticus* and *Enterobacter cloacae* were identified from the diseased fish samples. The fish parasites *viz., Thelohanellus, Myxobolous, Argulus* spp., were also reported from diseased fishes in West Bengal and the details of the farm and farmerswere submitted in NSPAAD database. Furthermore, a total of 89 fin fish/ornamental fish samples received from the Animal Quarantine Office, Kolkata, Government of India were tested for pathogens such as TiLV, KHV SVCV, EUS and WSSV.

Aeromonas veronii isolated from *Labeo rohita* from an aquaculture farm in East Medinipurwas further characterized through biochemical assays, Scanning Electron Microscopy (SEM), 16S rRNA gene sequencing and phylogenetic analysis. Pathogenic potential of the isolate was studied through *in vivo* challenge in *L. rohita*, histological changes in challenged fish and virulence gene characterization. Fish physiological response such as HSP70, HSP90, IgM and cortisol levels were also studied to investigate the immune-stress response in *L. rohita*.

A field day was organized to sensitize the farmers and local entrepreneurs about the importance of early disease diagnosis and surveillance in health management and control of production loss. The fish and shrimp farmers of East Medinipur and South-24 Parganas districts actively participated in the program and pamphlets both in English and Bengali were distributed to sensitize them about emerging fish pathogens and the need for proper management of ponds.



The SEM images of *Aeromonas veronii, Thelohanellus, Myxobolous, Argulus* spp. isolated from different fish



Immune-stress parameters of control and bacterial challenged fingerlings of *L. rohita*. Control denotes the average data of 24 h, 48 h and 72 h

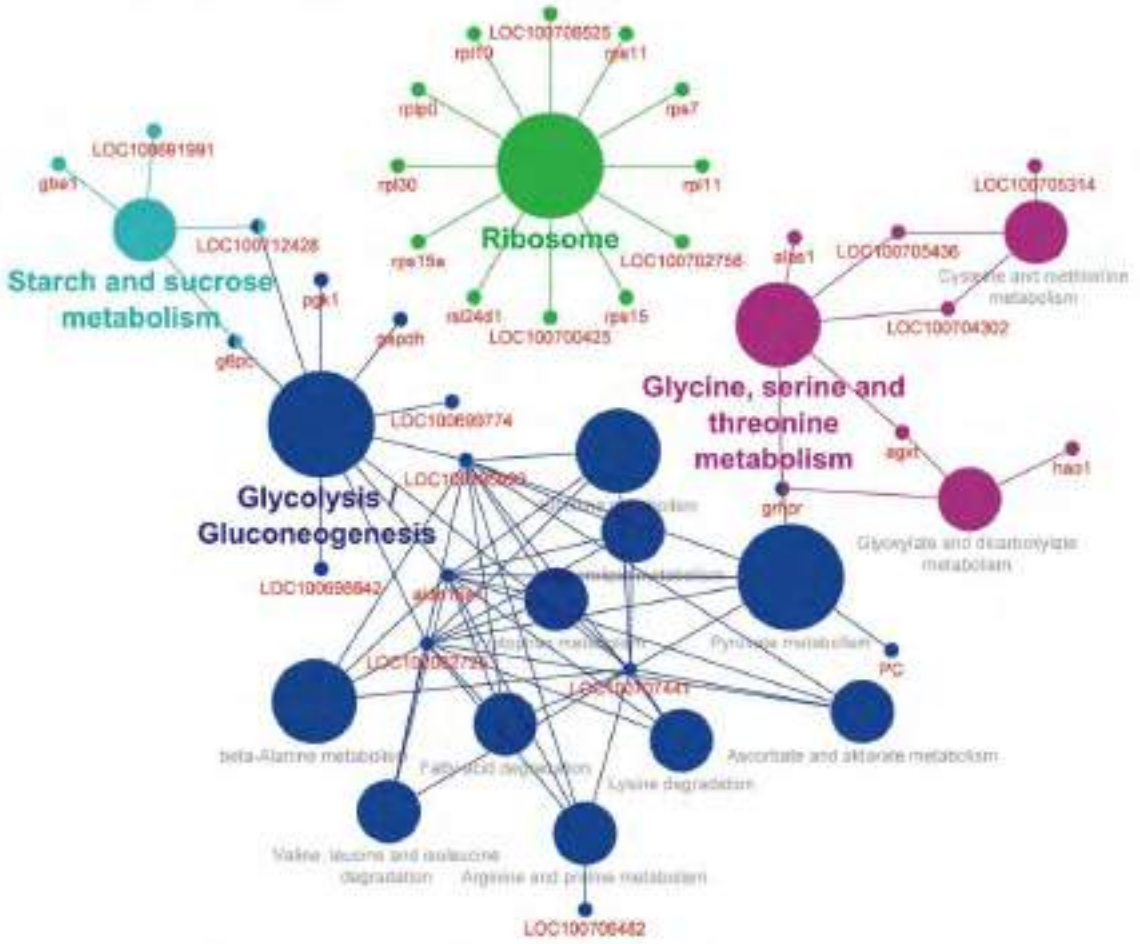
Interaction with farmer on efficient pond management to limit the emergence of pathogen

Project Title: Microbiome meta-transcriptomics assessment of Indian river basins for ecosystem health monitoring

Funding Agency: CABin, ICAR, New Delhi

Scientific Personnel: B. K. Behera (P. I.), P. K. Parida (upto 20.12.22), D. J. Sarkar, B. K. Das

Oreochromis niloticus (Tilapia) is the second most important farmed fish species and cultured in over 100 countries. It is an excellent candidate for the aquaculture due to its high tolerance to environmental changes and survival against pathogens. Despite all, pollution in riverine ecosystem affects the growth and production of Tilapia. Hence, liver transcriptome of Tilapia fishes sourced from river Ganga was investigated to identify different candidate genes to expand our understanding on the response mechanisms to different pollution levels. A total of 51392582 and 32800883 RNA-Seq raw reads were obtained from liver transcriptome of Tilapia collected from non-polluted (Barrackpore) and polluted (Kanpur) sites of river Ganga, respectively. About 36866749 and 62542146 reads



The enriched KEGG pathways displaying the functional nodes and edges shared between DEGs

were found aligned to the reference genome of Tilapia. Out of 363 differential expressed genes, 236 genes were found to be upregulated in polluted site and enriched with 20 Gene Ontology. The pathway enrichment analysis disclosed that mostly up-regulated genes were significantly enriched with 16 pathways ($p\ value < 0.05$) out of which metabolic pathways were the most frequently affected. Furthermore, it was found that upregulated four candidate genes were participated in several pathways like glycerolipid metabolism, beta-alanine metabolism, histidine metabolism, etc. Overall, this transcriptome investigation provided a comprehensive overview of pollution induced transcriptional patterns in Tilapia liver and would enhance understanding molecular responses to pollution.

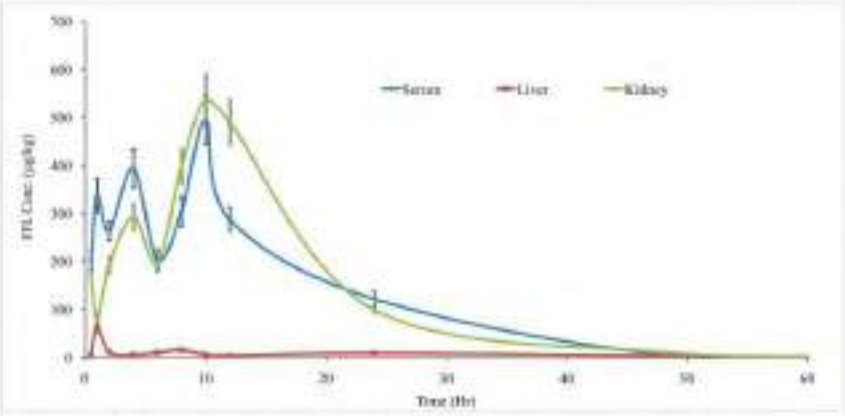
Project Title : All India Network Project on Fish Health

Funding Agency: ICAR (Network Project)

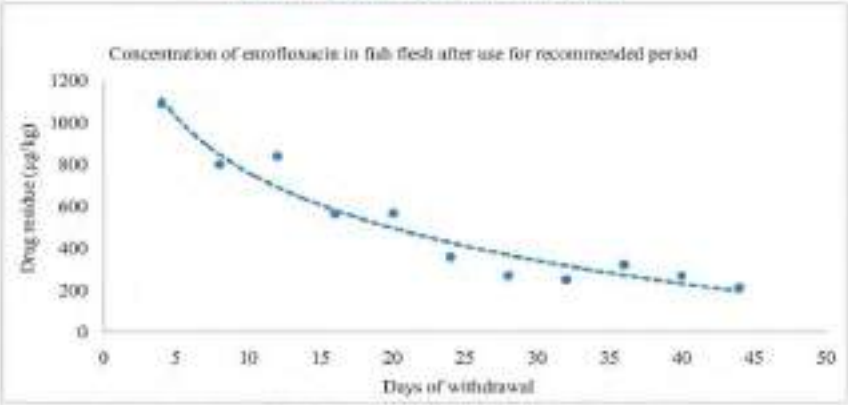
Scientific Personnel: S. K. Manna (P.I.), S. K. Nag, P. Panikkar, A. K. Bera, D. Debnath, R. Baitha

Pharmacokinetics of Florfenicol

A good number of antibiotics are used globally for fish health management, sometimes even in absence of pharmacological data. Florfenicol, a wide-spectrum antibacterial agent, is approved by FDA and EMA for use in both fresh and saline water aquaculture for treatment of bacterial diseases of fish. Pharmacokinetics of the drug was studied in *Pangasianodon hypophthalmus*, a catfish of huge aquaculture significance. The drug was administered once in-feed @10 mg/kg body weight and blood and tissue samples were collected for up to 5 days.In a separate experiment, the antibiotic was administered by injection @10 mg/kg body weight for comparison. The drug concentrations were measured in different tissues at different time intervals using LC-MS/MS. Upon oral administration, the antibiotic attained the highest concentration in blood in 4 h showing fast absorption from the gut; there was a second and lesser peak at 8h, followed by a higher peak at 10 h indicating enterohepatic recirculation. A similar drug behaviour was observed in kidneysand to lesser extents in liver. Following in-feed administration, about 27% of the drug is bioavailable, which is satisfactory.



Florfenicol concentration in different tissues of *P. hypophthalmus* following one-time oral administration



Enrofloxacinresidue in muscle of *P. hypophthalmus* for prolonged period after 5-days in-feed administration

Withdrawal period of antibiotic enrofloxacin

Use of antibiotics and other antimicrobials, pesticides etc. are fast increasing globally in the aquaculture sector, sometimes ignoring national and international regulations, posing risk to the health of environment and fish consumers. We determined withdrawal period of enrofloxacin, a commonly used antibiotic in veterinary and aquaculture sectors, in widely cultured catfish *Pangasianodon hypophthalmus* for human health safety. Following in-feed administration of the drug at the recommended dose of @10mg/kg body weight for five days the drug residue levels in fish flesh were monitored by Liquid Chromatography coupled to Mass Spectrometry (LC-MS/MS) for another 44 days. Results showed that the concentrations of enrofloxacin and its derivative ciprofloxacin declined gradually with the days of withdrawal; however, even after 44 days of withdrawal fish flesh had a residual drug concentration of 212.97 ±3.8 µg/kg, which is over the Maximum Residue Limit (100 µg/kg) in fish for human consumption. Thus, the antibioticis retained in fish flesh for long period, and considering consumer safety, cannot be recommended for use in *Pangasius* spp.. Longer duration study is needed to establish withdrawal period of the drug in *Pangasius* spp.

Winter fish health camps at Tripura

Diseases are major constraints in fisheries and aquaculture causing massive loss to the sector. Fish health and Disease Management Camps were organized under the under the project in West Tripura, South Tripura, Gomati, Khowai, Sipahijila districts of Tripura for awareness generation cum training on fish disease management during 21 – 25 February 2022. Dr. Raju Baitha, Scientist led the team in the fish health camps. The meetings were used as a bidirectional knowledge sharing platform among the scientists, State fishery officials and farmers. About 250 fish farmers and fishery officials participated. Shri. A. Debbarma, Joint Director of Fisheries, Deputy Directors of Fisheries and District Magistrate of Belonia, Tripura extended their facilities to organize the programme.

Glimpses of fish health camps cum training in Tripura

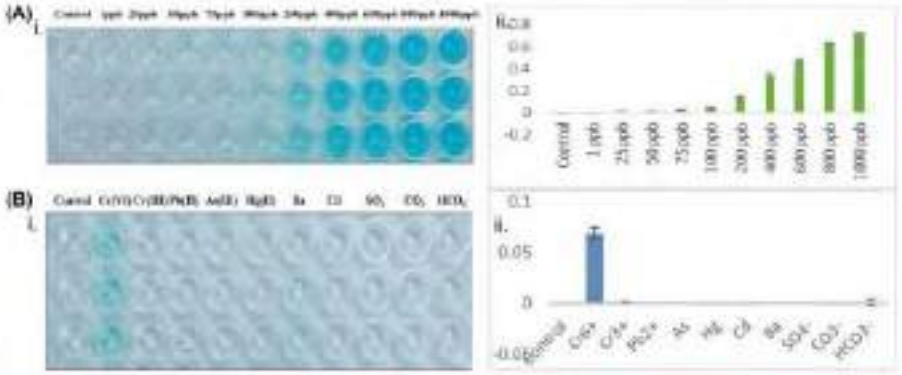
Project Title: Development of biosensors for detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies

Funding Agency: NASF, ICAR

Scientific Personnel: B. K. Behera (P.I.), D. J. Sarkar, P. K. Parida (upto 20.12.22), B. K. Das

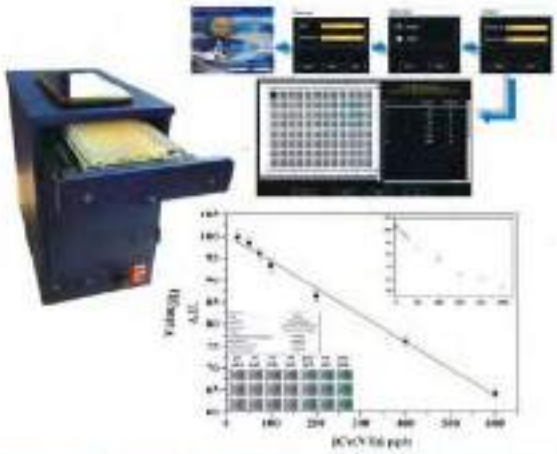
Partner Institutes: CDAC-Kolkata, IIT Kharagpur

Nanoparticles including gold and silver were synthesized and examined for their suitability to enhance the signaling efficiency of the developed Molecular Recognition Element (MRE). A sensor has been developed for the efficient detection of Cr (VI) in water with a linearity range 100 ppb to 1 ppm. The UV-Vis absorbance intensities gradually increased with increasing concentration of Cr (VI). The sensor can detect Cr (VI) up to 100 ppb which is the permissible limit notified by US EPA. It does not show any cross-reactivity when checked with other heavy metals like Cr (III), Pb, As, Hg, Ba, Cd and ions (SO_4^{2-}, CO_3^{2-}, HCO_3^-). The sensor has been incorporated into a hand-held prototype device.



UV-Vis absorbance intensities of the developed sensor with increasing concentration of Cr (VI) (A, i and ii) and selectivity towards Cr (VI) in presence of other heavy metals and ions (B, I and ii)

Further, a raspberry pi based colorimetric prototype GEN 2.0 has been developed with the incorporation of an image analysis software named "Cr-Detector" with RGB calculation-based precision algorithm towards data collection and analysis.



A raspberry pi based colorimetric prototype for Cr (VI) detection

An aptamer-based Nano-biosensor has been developed for the detection of fish pathogenic bacteria *Aeromonas veronii*. The sensor can specifically detect *Aeromonas veronii* and shows no cross-reactivity with other bacteria such as *A. hydrophila*(AH), *Pseudomonas aeruginosa* (PA) and *Klebsiella pneumoniae* (KP). The sensor can detect the bacterial cell upto a concentration of 10^0CFU/ml.

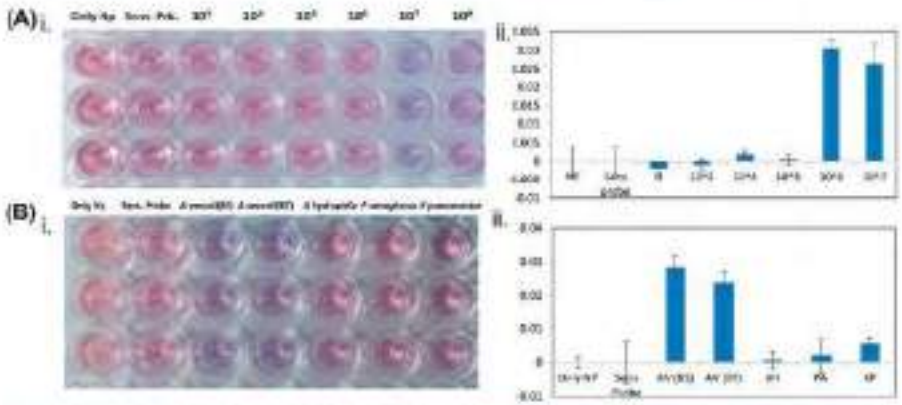


Fig.UV-Vis absorbance intensities of aptamer based nano-biosensor with increasing concentration of *Aeromonas veronii* (A, i and ii) and selectivity towards *Aeromonas veronii* (B, i and ii)

Project Title: Captive breeding of Hilsa, *Tenualosa ilisha*: Phase II

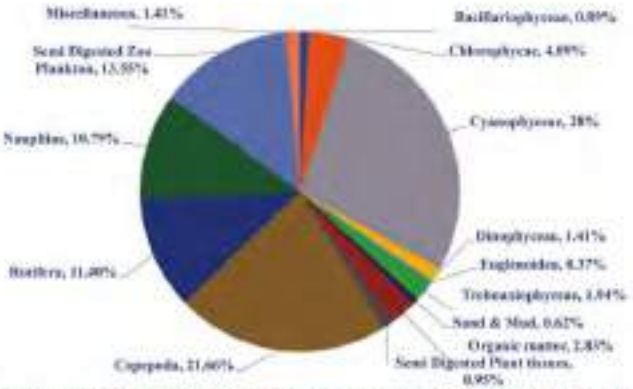
Funded by: National Agricultural Science Fund (NASF), ICAR

Scientific Personnel: S. Samanta (Consortium P.I.)., B. K. Behera, R. K. Manna, A. K. Sahoo

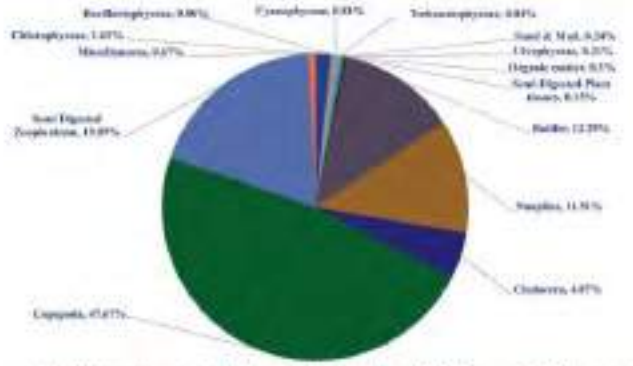
Lead Institute: ICAR-CIFRI

Partner Institutes: ICAR–CIBA, ICAR–CIFA and ICAR–CIFE

Captive breeding and rearing of highly prized Indian Shad *Tenualosa ilisha* are major objectives of the project. Ponds of river-water fed intermediate systems were set up at Kolaghat, West Bengal where experimental ponds of 0.17 ha and 0.40 ha size are used for rearing of Hilsa brooders under captivity. The ponds were stocked @ 2000 fingerlings/ha (10.0±2.7 g) and (5.6±1.0 g) respectively in two ponds. Culture for 7 months and 20 months resulted in 95.4±15.0 g and 277.4±18.9 g body weight gain, respectively. Gut content analysis of pond-reared juvenile and adult hilsa was performed: zooplankton constituted the major share (Copepoda 47.67%, Rotifera 12.29%, Cladocera 4.87%) of gut content of adult Hilsa; whereas, phytoplankton also contributed significantly (Cynophyceae 28%, Chlorophyceae 4%) besides zooplankton in juveniles.



Stomach content (% volume) of Hilsa fingerling (6.7 cm, 5.9 g) at Kolaghat



Stomach content (% volume) of Pre-Adult Hilsa (23.7 cm, 177.0 g) at Kolaghat

To maintain sufficient zooplankton density (about 1000 nos./l) in ponds, mass culture facilities for *Chlorella* and mixed zooplankton have been developed at pond site and need-based supplementation of zooplankton was done in the pond. The water quality parameters of hilsa ponds are monitored to maintain a uniform environmental condition for the stocked hilsa. Fertilization of ponds on fortnight basis were performed using NPK fertilizer. In addition, organic juice (mixture of mustard oil cake and groundnut oil cake along with yeast and molasses) is also used fortnightly as plankton booster. Proliferation of *Microcystis* sp. in the culture ponds was controlled with the use of microbial consortium. In addition to plankton, daily feeding of artificial feed was practised.

Project Title: Environmental & aquatic animal health monitoring in Hirakud reservoir under cage culture program

Funding Agency: Directorate of Fisheries, Government of Odisha

Scientific Personnel: B. K. Das (P.I.), S. K. Kouslesh , C. Johnson

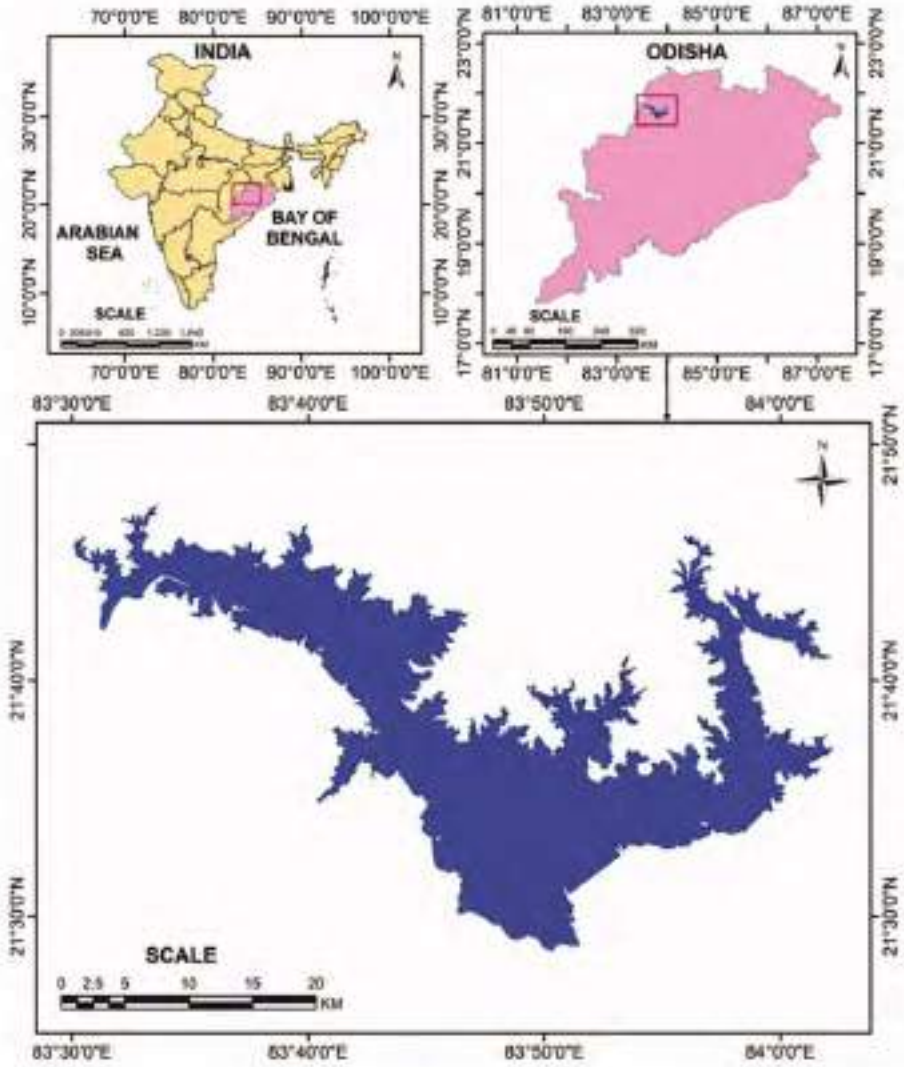
Hirakud reservoir plays a strategic role in the economic and social structure in Eastern India and may offer opportunities to mitigate food, nutritional and livelihood security threats faced by the dependent communities. Odisha has 138 reservoirs with a water spread area of nearly 1.4 lakh hectares, which are underutilized from a fish production perspective. The Directorate of Fisheries, Odisha is leasing out reservoir sub-zones to private entrepreneurs in Hirakud reservoir for cage culture. Hirakud reservoir can accommodate 1875 circular cages or 15000 Rectangular cages with production potential of 45,000 tonnes. As per the existing governmental guidelines, it is necessary to take environmental precautions and perform assessments for overall sustainability of the cage aquaculture. Presently there are lack of scientific data on the impact of

cage culture operations on the Hirakud reservoir ecosystem. The project aims:

- To monitor the water and sediment quality parameters in the reservoir keeping in view the need for long-term environmental health of the reservoir
- To take up the aquatic animal health surveillance in the cage culture and in the wild population of the reservoir
- To conduct Environmental impact assessment (EIA) with an aim of protecting aquaculture operations from detriment of excessive nutrient load in water and sediments and also to protect the environment from the harmful effects of cage culture (Eutrophication and chemical/pharmaceutical inputs).

Environmental attributes of Hirakud reservoir

Regular samplings were carried out in five different sites of the reservoir, namely, Mahamadpur including cage culture as well as reference sites, Kurla, Tamdei, Birenbandh, and Zeropoint. The sediment was acidic to slightly alkaline pH (pH 5.45-7.4) with moderate specific conductivity (0.235-0.568 mS/cm), predominantly sandy in texture (49-82%), moderate available nitrogen contents (9.8-19.6 mg/100g) andwith low to moderate available phosphorus contents (0.4 – 7.53 mg/100g). The reservoir water has neutral to alkaline pH (7.2-8.3), moderate dissolved oxygen content (6.0-8.6 mg/l), moderate total alkalinity (52-98 mg/l), available nitrogen (0.010-0.053 mg/l), phosphate-P (0.008-0.0385 mg/l) and total phosphorus (0.0125 - 0.0971 mg/l) which indicated medium productive nature of the reservoir. The mean annual values of GPP, NPP, and CR revealed medium productivity of Hirakud reservoir with values of 125.85 mgC/m^3/h, 66.14 mgC/m^3/h and 59.71 mgC/m^3/h, respectively. Spatial and seasonal studies in the reservoir revealed Chlorophyll*a* content in the reservoir water in the range between 1.562 and 7.884 mg/m^3.

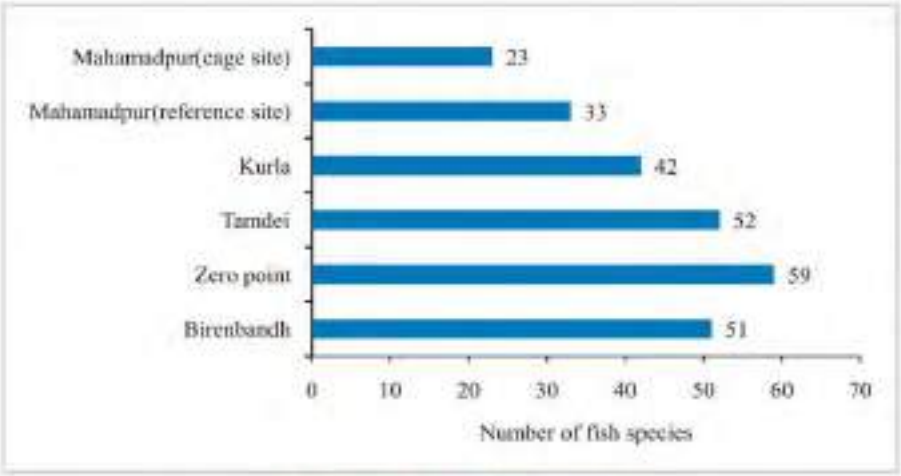


Hirakud reservoir

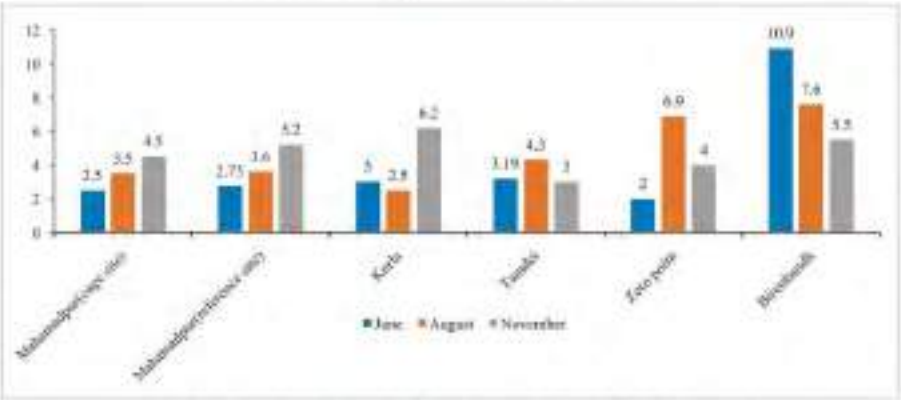
Fish and fisheries

The fish species richness in the reservoir was represented by 68 species under 25 families and 9 orders. This higher species richness was attributable to family Cyprinidae (22 species), Bagridae (6 species), Danionidae (5 species), Ailiidae (4 species), Channidae (3 species) and Ambassidae (3 species). The remaining families were found to be represented by either one or two species. Among different sites studied highest species richness was observed at Zeropoint (59 species) while lowest at cage sites (23 species). Slightly higher species richness was recorded at Mahamadpur reference site (33 species). Exotic fish species like *Oreochromis niloticus, Clarias gariepinus, Pangasianodon hypophthalmus, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis, Cyprinus carpio* and *Pterygoplichthys disjunctivus* were recorded from reservoir.

Bulk of the fish catch from the reservoir was contributed by carps (35 %) and catfishes (33%), followed by perches (8%), clupeids (6%), barbs and minnows (6%), freshwater eels (5%) and featherbacks (4%).



Fish diversity in Hirakud reservoir



Catch per unit effort of gillnet fishers in Hirakud reservoir

There were spatio-temporal variations in catch per unit efforts (CPUE). In case of gillnet fishing the CPUE varied from 2-10.9 kg/day/fisher with highest values at Birenbandh (10.9 kg/day/fisher) and lowest at Zeropoint (2 kg/day/fisher). The CPUE ranged from 2.5-4.5 kg/day/fisher at cage site while it was 2.75-5.2 kg/day/fisher at reference site.

Establishment of health monitoring laboratory

The "Environmental and aquatic animal health monitoring laboratory" for regular monitoring of fish health and ecosystem health of the reservoir has been established at DDF office in Sambalpur District of Odisha. Most of the equipment have been installed at the laboratory.

Project Title: ICAR-WorldFish Collaborative project under Window-3 programme on 'Small scale fisheries in wetlands for livelihood and nutritional security'

Funding Agency: ICAR-WorldFish

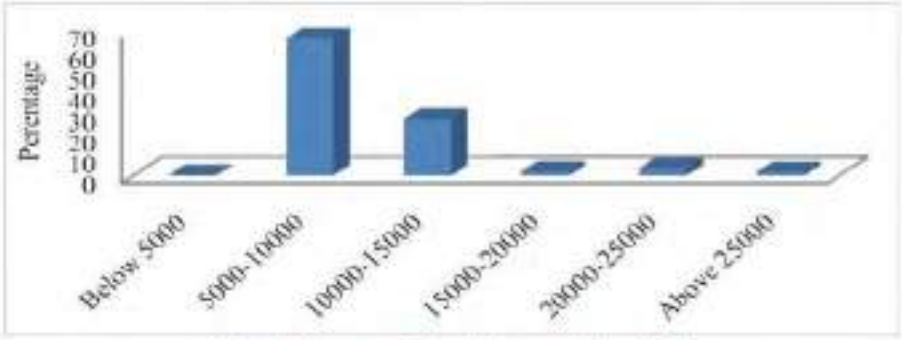
Scientific Personnel: B. K. Das (P.I.), B. K. Bhattacharjya, A. K. Das, Arun Pandit, B. K. Behera, A. K. Sahoo, A. Roy, P. K. Parida (upto 20.12.22), G. Karnatak, S. Borah

Fish consumption pattern and Socio-economic status of fishers of Thekera beel

A survey was carried out on beel dependent communities of Thekeraguri beel, Morigaon, Assam. All the beel fishers belong to Scheduled Caste category. Majority of households preferred fresh fish: 8.5% consume fish once a week, 52.5% twice a week, 37.2% 3-6 times a week and 1.69% once every 2 weeks. About 88% of the total respondents consume fish products (e.g., fish pickle, dried fish etc.) once a month, 5% once in every 2 weeks and the remaining 6.7% does not have any specific routine of consumption. About 57.6% of the people agreed that they buy fish as it is affordable and fits in their budget, 23.7% like the taste, 11.8% for freshness and good quality, 5% for health reasons. About 66 % of households have TV and 34% have other gadgets like mobile phone and radio. About education, 61% have primary, 13% secondary, 17% higher secondary and 9% graduate level of education. The survey revealed that 66% of total surveyed households has total monthly income in the range of ₹5000-10000. The high-income group households have members engaged in other activities in addition to fisheries. 62.7% of surveyed households had family size of less than 5 members and 37.2% had 5-10 members. Among fishers the male:female ratio was skewed towards males comprising 64% and rest 36% were females indicating that females were less represented in the sector. Age group analysis of full-time fishers showed that 6.8% are in age group 18-25 years, 22% in 26-35 years, 56% in 36-45 years and 15.2% are greater than 55 years.

Contribution of wetlands to agriculture and livelihood of the riparian communities

Wetland ecosystems provide numerous ecosystem benefits. However, many of the ecosystem services such as groundwater recharge, flood control, nutrient cycling, storm protection, pollution



Monthly income of studied population (in ₹)

Socio-economic survey

abetment, evaporation, etc. which are not traded in the markets and consumers don't pay for it, thereby the traditional cost benefit analysis fails to adequately value the ecosystem services in economic terms. In present study, valuation was attempted for some of the provisioning services, crops grown, fisheries and aquaculture, livelihood, employment generation and nutritional security of the fishers.In this regard an attempt was made to evaluate the contribution made by the wetlands (ox bow lakes) to agriculture and livelihood of the riparian communities. Four wetlands from Nadia and North 24 Parganas districts of West Bengal (Beledanga, Chamta, Sindrani and Kholsi) were selected. Fisher families are members of fishermen cooperative societies and are directly dependent on these waterbodies.

Contribution of beel fisheries on livelihood of fishers

In the Chamta, Beledanga and Kholsi beels fishing contributed 100% livelihood to more than 4% households and below 30% livelihood to 4-6% fishers. In Beledanga around 64% of the households drew 60-90% livelihood from the waterbodies. Hence, fisheries constituted an important contributor to livelihood of fishers in all the beels.

Consumption of animal protein

The study shows that the fisher households ate 20-28 kg fish per capita per year; amount of chicken and mutton consumed were 2-4 kg, and 0.9-1.7 kg, respectively. per capita egg consumption was 70-144 per year. The consumption of milk was 24-41 ml in all the households. Every household consumed fishes that mostly came from their own catch.

Further, about 90% of the fishers don't purchase fishes from market, they rather collect them from beel. Hence, the beel fishes were extremely important for providing nutritional security to the fishers in both the states.

Employment generation

Through fishing

Four beels generated around 12850 man days of labour in a year only

Table: Contribution of *beel* fisheries to livelihood of the fishers

Contribution to livelihood (%)	Beledanga	Chamta	Sindrani	Kholsi
90% & above	4	6	2	4
60 to 90%	64	58	14	24
30 to 60%	28	32	80	66
<30%	4	4	4	6

Table: Consumption of high value food items per capita

Food item	Beledanga	Chamta	Sindrani	Kholsi
Fish (kg /year)	22.93	26.73	28.46	20.66
Chicken (kg /year)	2.92	4.34	4.23	1.82
Mutton/Chevon (kg /year)	0.91	0.81	1.69	0.91
Eggs (number /year)	144.37	137.16	78.34	70.50
Milk (ml/day)	40.89	30.45	25.48	24.14

Table: Generation of employment through fishing (mandays/year)

	Beledanga	Chamta	Sindrani	Kholsi
Fishing of stocked fishes	2100	800	1925	2800
Fishing of un-stocked fishes	1750	625	1750	1100
Total	3850	1425	3675	3900

Table: Employment generation through crop farming (mandays per year)

Name of the beel	Hired labour	Family labour	Total
Beledanga	2625	2610	5235
Chamta	3284	3297	6581
Sindrani	3020	3175	6195
Kholsi	2710	6690	9400
Total	11639	15772	27411

through fishing. It was highest in Kholsi beel, followed by Beledanga and Sindrani. The average number of fishing days (for stocked fishes) in a year ranged from 40 in Chamta to 70 in Kholsi. On an average 20-40 numbers of fishers fish on those days. The contribution of unstocked fishes on employment was also significant, being 5225 man days in a year. In the latter case women participation is significant.

Through crop farming

In the agriculture sector, the total mandays was 27411 per year where contribution of family labour was more (around 58%). Hence, the beels under study generated substantial employment opportunities for the riparian communities.

Contribution of wetlands in agricultural economy

Crops cultivated in vicinity of the beels use beel water in varying degrees. The area under rice was around 118 acre while the jute and oilseeds were grown on 57 and 83 acres, respectively. The water of the beels could also be used in growing vegetables and other miscellaneous crops in the area of 57 and 45 acres, respectively. The beel-wise area analysis showed that the total area under crops in the vicinity of Beledanga beel was 80 acres, producing around 2590 quintal of crops. In the Chamta beel the figures were 101 acres and 3690 quintals, respectively. The Sindrani and Kholsi beels support production of 2580 and 2365 quintal of crops from 97 and 83 acres, respectively.

Crops differed on quantity of water consumption from the beel. Rice crops used 50-70% of the irrigation water from the beel. During rabi season many farmers depend upon the beel water for their full irrigation. The jute was grown only in kharif season, hence, the beel water requirement was less. Similar to the rice crops, water consumption of oilseeds, vegetables and miscellaneous crops were around 50-70%.

The gross values of the agricultural crops were also estimated considering market price at which the farmers sold their produce, i.e. the farm gate prices. It was found that ₹289 lakh worth crops per year was produced in the vicinity of the beels which use beel waters for their

Table: Area (acres) and production (quintal) of crops

Name of	Rice		Jute		Oilseed		Vegetables		Misc. crops	
the beel	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Beledanga	25.0	600.0	13.3	180.0	18.3	285.0	13.3	1125.0	10.0	400.0
Chamta	36.7	875.0	10.7	165.0	21.7	350.0	20.0	1700.0	11.7	600.0
Sindrani	26.7	505.0	20.0	225.0	23.3	450.0	13.3	900.0	13.3	500.0
Kholsi	30.0	700.0	13.3	175.0	20.0	290.0	10.0	750.0	10.0	450.0
Total	118.3	2680.0	57.3	745.0	83.3	1375.0	56.7	4475.0	45.0	1950.0

Table: Extent of irrigation water drawn from the beels (as % of the total irrigation required)

Name of the beel	Rice	Jute	Oilseed	Vegetables	Misc.
Beledanga	65	30	65	65	65
Chamta	70	40	70	70	70
Sindrani	60	45	45	65	72.5
Kholsi	50	35	47.5	52.5	52.5

Table: Value of the crops grown (₹ in lakh/year)

Name of the beel	Rice	Jute	Oilseed	Vegetables	Misc. crops	Total
Beledanga	12.00	9.00	12.83	21.38	10.00	65.20
Chamta	17.50	8.25	15.75	34.00	15.00	90.50
Sindrani	10.10	11.25	20.25	18.00	12.50	72.10
Kholsi	14.00	8.75	13.05	15.00	11.25	62.05
Total	53.60	37.25	61.88	88.38	48.75	289.85

culture. Among the 4 beels, Chamta produces crops worth ₹91 lakh, followed by Sindrani (₹72 lakh), Beledanga (₹65 lakh) and Kholsi (₹62 lakh). Thus, crops worth ₹171 lakh was produced using water from these four wetlands.

Project title: Assessment of endocrine disruption in fish reproduction

Funding Agency: DBT, Govt. of India

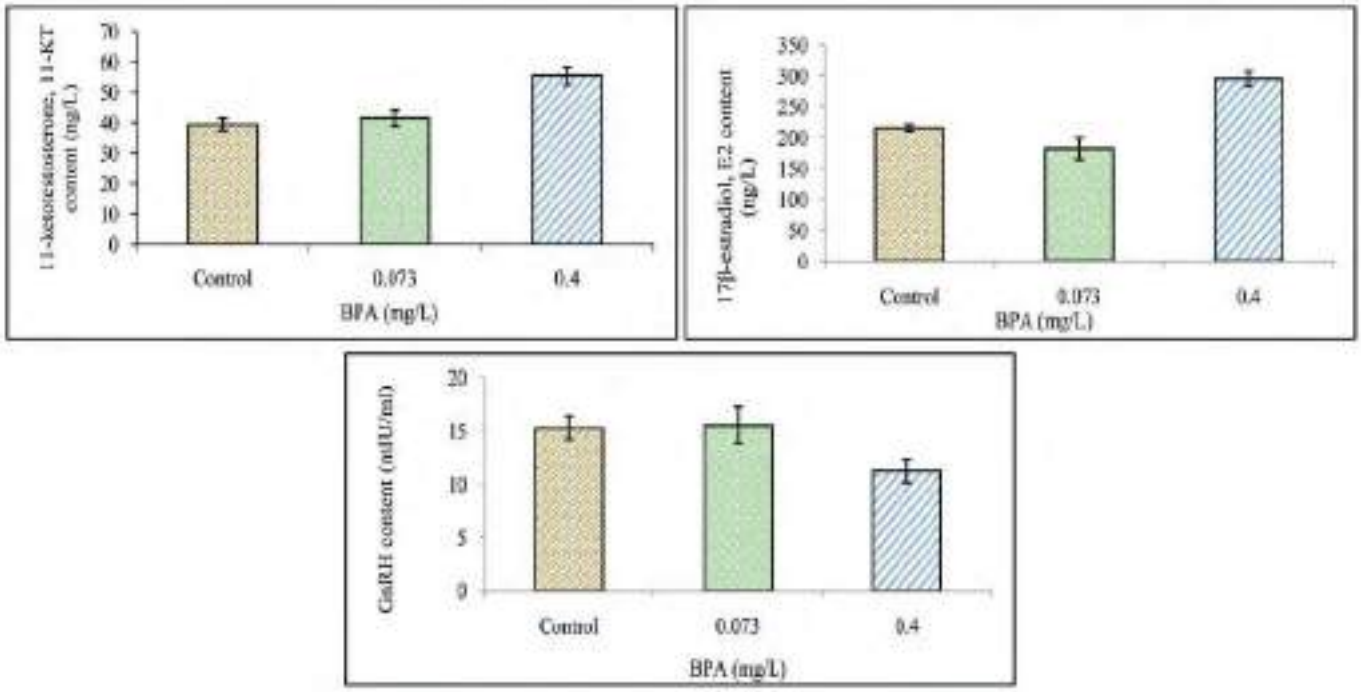
Scientific Personnel: B. K. Das, S. K. Nag, K. Kumari

Biochemical alterations induced by bisphenol A

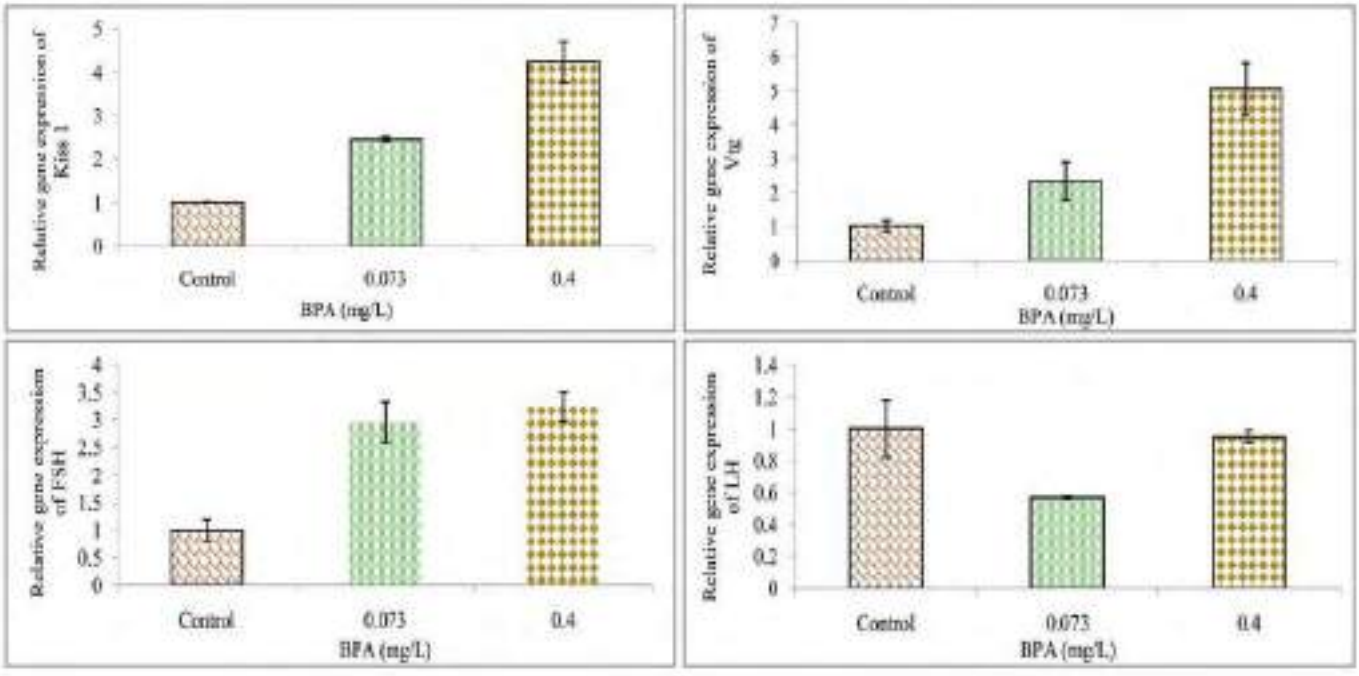
Under experimental conditions exposure to bisphenol A (BPA) at sub-lethal concentrations [$1/10^{th}$ (0.4 mg/l) and $1/50^{th}$ (0.073 µg/l) of LC_{50} dose] for a period of 30 days to *Labeo catla* there was a decrease in antioxidant enzyme SOD and CAT activities in serum, liver and kidney. An increase in concentration of reproductive hormones, *viz.*, 17β estradiol and 11 ketotestosterone and decrease in GnRH content were also observed in serum and brain samples of BPA exposed Catla. Comparative gene expression analysis by qPCR showed a significant up-regulation of genes associated with the HPG axis (*Kiss1*, *Vtg*, *FSH*, *LH*).

Biochemical alterations induced by diethyl phthalate

Experimental exposure ofdiethyl phthalate (DP)at sub-lethal concentrations [1/10th (1.62 mg/l) and 1/50th (0.32 mg/l) of LC50 dose] for a period of 30 days to *Labeo catla* caused a decrease in antioxidant enzyme SOD and CAT activities in serum, liver and kidney tissues. An



Variations in levels of (A)11-ketotestosterone (11-KT), (B) 17β estradiol (E2), (C) GnRH in serum and brain samples *Labeo catla* exposed to sub-lethal doses of BPA

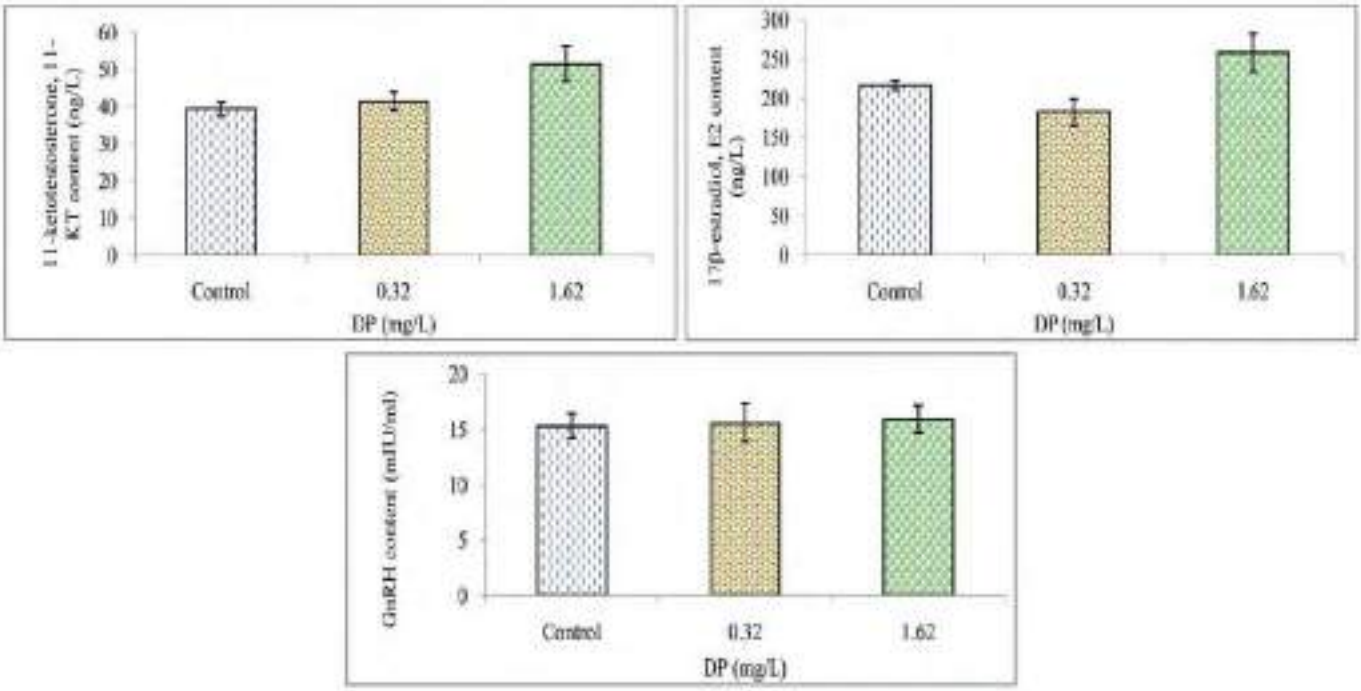


Relative expression analysis of genes related to HPG axis (*Kiss 1, Vtg, FSH, LH*) in *Labeo catla* exposed to sub-lethal doses of BPA

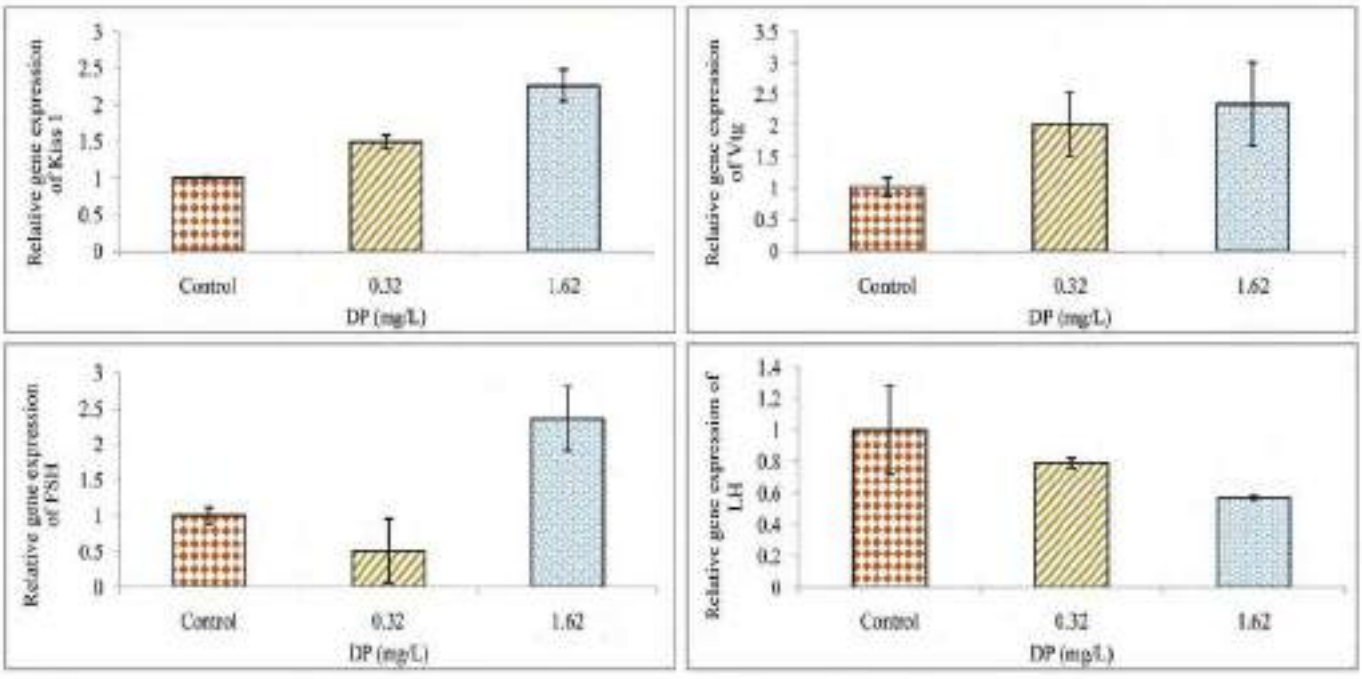
increase inconcentrations of reproductive hormones, *viz.* 17β estradiol, 11 keto testosterone and GnRH,were observed in a dose dependent manner in serum and brain samples. Comparative gene expression analysis by qPCR showed a significant up-regulation of selected genes associated with the HPG axis (*Kiss1, Vtg, FSH*).

Molecular docking studies of selected EDCs on Vtg and other proteins of HPG axis

Molecular docking studies were

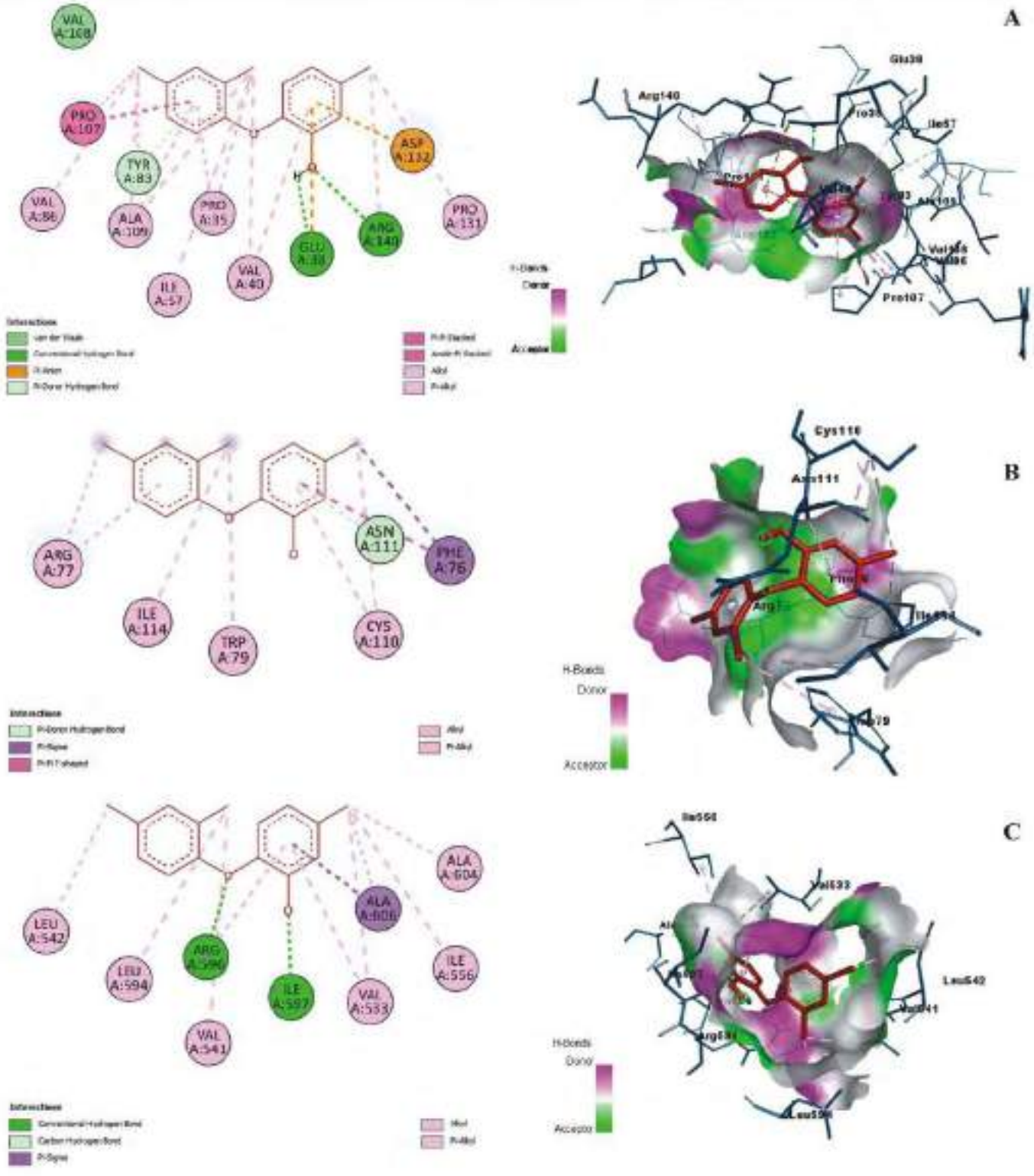


Variations in levels of (A)11-ketotestosterone (11-KT), (B) 17β estradiol (E_2), (C) GnRH, in serum and brain of *Labeo catla* exposed to sub-lethal doses of DP



Relative expression of genes related to HPG axis (*Kiss 1, Vtg, FSH, LH*) in *Labeo catla* on exposure to DP

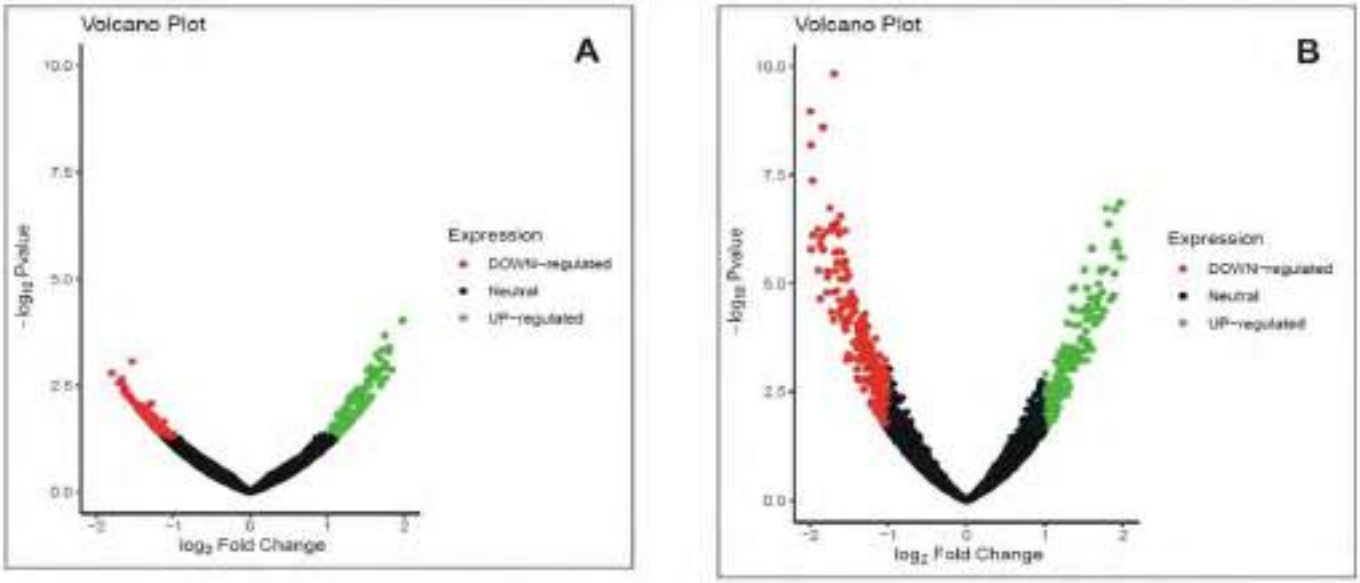
carried out to understand the inhibition process of EDCs such as triclosan ($C_{12}H_7Cl_3O_2$), cypermethrin ($C_{22}H_{19}Cl_2NO_3$), bisphenol A ($C_{15}H_{16}O_2$), diethyl phthalate ($C_{12}H_{14}O_4$) on target receptors of vitellogenin and essential proteins of the HPG axis i.e., FSH and LH. The target protein-ligand interaction study revealed that these ligands bind with the amino acid residues of the target proteins, the compounds exhibited significant inhibition on the target proteins recording binding energy ranging from -4.72 to -7.99



Two-dimensional and 3-dimensional interaction map of Cypermethrin (CYP) with interacting residues of proteins associated with HPG axis (A) CYP-LH (B) CYP-FSH (C) CYP-VTG

Kcal/mol and also compounds registered hydrogen bond, hydrophobic interaction, electrostatic interaction, van der Waals interaction, total polar and non-polar bonding interaction with protein amino acid residues, many of which formed strong hydrogen bond(s) with the target protein thus inhibiting it. Some non-oxygenated molecules because of strong hydrophobicity also strongly inhibited the protein.

Among the four EDCs, cypermethrin



Volcano plot showing DEGs, up-regulated and down-regulated genes in Brain (A) and Liver (B)

showed the best binding affinity with target proteins FSH, LH, Vtg and bind with the proteins perfectly. The docking results indicate that cypermethrin showed lower scores of docker energy, good active hydrogen bond interaction as compared to other EDCs studied. Therefore, molecular docking studies showed among the EDCs studied, cypermethrin as a potent EDCs that can easily bind to the ligand-binding sites of these important proteins of the HPG axis and thereby causing endocrine disruption by further blocking the downstream pathways.

Brain and liver transcriptomics study following exposure to cypermethrin

Cypermethrin, a pesticide belonging to synthetic pyrethroids, is extensively used in agriculture, aquaculture and fisheries, and public health. As a result of unrestricted usage, it has become an environmental stressor posing toxicity to non-target organisms including human beings. To understand the overall molecular mechanism involved in cypermethrin toxicity, next-generation sequencing (NGS) of the brain and liver tissue of *Labeo catla* was carried out by Illumina HiSeq after chronic exposure at sub-lethal dose ($1/10^{th}$ of LC_{50}) for 30 days which generated 125918244 and 138489964 number of total reads in brain of control and treated fish respectively, and 145347058 and 192563686 number of total reads in liver of control and treated fish. Comparative brain transcriptomics analysis revealed that 531 genes were differentially expressed (DEGs), with 302 upregulated and 229 down regulated genes. Similarly, liver transcriptome analysis revealed 1242 DEGs with 323 up-regulated and 374 down-regulated genes. Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway analysis revealed significant enrichment of steroid biosynthesis pathway, butanoate metabolism, fatty acid degradation, fatty acid metabolism etc. The DEGs identified will further help in identifying potential biomarkers for assessing the effect of EDCs in fish reproduction.

Project Title: Empowering women of wetland-dependent fisherfolk community of lower Gangetic plain through cost-effective technologies

Funding agency: Department of Biotechnology, Govt. of India

Scientific Personnel: A. Roy (P.I.), A. K. Bera, Arun Pandit, P. K. Parida (upto 20.12.22)

Khalsi beel is a closed ox-bow lake spread across 62 ha area in Haringhata block of Nadia District, West Bengal. Fisheries of the wetland is operated by Khalsi Udbastu Samabay Samiti with 226 members and almost 85% of the members belong to SC/ST. The beel is surrounded by eight villages, out of which five were selected, namely Khalsi, Mathpara, Uttar Brahmapur, Kanapukurdanga and Satshimulia. The project is multi-component collaborative project aimed to empower the women of the fisherfolk community by introducing cost effective technologies.

To promote the ecosystem-based Integrated Wetland Management, the project initiated a Fishers' Field School, based on the principle of Farmers' Field School Approach of

Table: Training and capacity building activities organized

Capacity building programme	Number of beneficiary	Number of women beneficiary	Number of SC/ST beneficiary	Number of self employed persons	Increase in income/well being of beneficiaries
Fishers' Field School	77	77	42 SC 22 ST General 3	-	-
Sensitization programme on Empowering Women of Wetland dependent Community through Cost-effective Technologies	346	196	SC 178 ST 121 General 19 OBC 28	-	-
Workshop on Penculture in wetland	48	28	SC 27 ST 19 General 2	-	₹4000 additional income i.e. 33.3% increase in income in a year
Hands on training on Backyard poultry farming	81	81	SC 63 ST 18	17	₹9242 additional income i.e 100% increase in income in a year
Training on Mushroom cultivation	35	35	SC 26 ST 9	6	₹ 2600 additional income from a single unit (3 months)

FAO, at Khalsi beel. The Fishers' Field School received recognition from ICAR and was acknowledged and appreciated by Ministry of Agriculture and Farmer's welfare, Govt. of India; Press Information Bureau, Govt. of India; MyGovIndia; DD Kisan; and Dept. of Fisheries, Animal Husbandry and Dairying. About 77 women beneficiaries are being trained through Fisher's Field School.

During the year, 346 farmers were trained or sensitized on various agricultural components *viz.* fish seed raising in pens, backyard poultry farming, kitchen gardening and mushroom cultivation. The 80 selected farm families generated employment of 62 mandays/ family/annum. About 42.5% of the beneficiaries have produced marketable surplus that will help them to upscale their socio-economic status. Further, fish health was regularly monitored in pen culture and in wetland, and 11 bacteria were isolated as etiological agentsof fish diseases. The bacteria have been identified by 16S rRNA sequencing method and the sequences have been submitted to NCBI GenBank.

Project Title: MEAN: Measuring EDCs and aquatic diagnostics through biosensor networks with special reference to North East India

Funding Agency: Ministry of Electronics and Information Technology, Govt. of India

Scientific Personnel: B. K. Behera (P. I.), D. J. Sarkar, P. K. Parida (upto 20.12.22), B. K. Das, S.C.S. Das (P. I., NE Component),

Partner Institutes: CDAC, Kolkata; IIT, Hyderabad

Prototype bio-sensing device for detection of OP pesticides in inland open waters

Inland aquatic ecosystems such as rivers and lakes of North-East India are considered to be recipients of industrial, urban and domestic effluents and agricultural runoffs containing Endocrine Disrupting Chemicals (EDCs), thus polluting aquatic ecosystems significantly. ICAR-CIFRI in collaboration with CDAC, Kolkata and IIT, Hyderabad developed a prototype Bio-sensing colorimetric device for detection of EDCs, like OP pesticides in inland open waters. The biosensor was deployed in five wetlands (Borsolabeel, Bharalu river, Samaguri beel, Charan beel and Damal beel) of Assam and field

Biosensing prototype device for OPs pesticide detection (A) and Deployment of prototype device at wetlands of Assam (B)

validated. The outcomes of the project would be useful to different stakeholders like fishermen community, export and quality control agencies, Government agencies etc. for formulation and implementation of effective fisheries and aquaculture in the region.

FAO-CIFRI Collaborative Effort: A review of the inland fisheries of India and the creation of capacity in the collection and analysis of inland fisheries statistics

Funding Agency: FAO, Rome

India has rich and diverse Inland fisheries resources in the form of rivers, canals, ponds, lakes, reservoirs, upland lakes, and floodplain wetlands that support livelihoods, income, and nutrition of people from time immemorial. Inland fish production systems in the country comprise the capture fisheries of the rivers, estuaries, lagoons and lakes; aquaculture in ponds; and various forms of enhancements (mainly culture-based fisheries and stock enhancement) being practiced in reservoirs, lakes and floodplain wetlands. However, like many other developing countries, there are several gaps in the data and information on inland water resources in India. The highly dispersed and unorganized catch disposal and marketing system impede the attempts to collect reliable data on fish yield. As a result, an updated database on resource size and fish production trends of inland fisheries is still elusive. Improved documentation on different aspects of these resources is essential not only to bring under the fold of development packages, but also for mainstreaming the principles of sustainable and equitable utilization of inland open water resources into the policy and legislative instruments in the country. This FAO-CIFRI collaborative report is an attempt to fill this obvious gap and document the magnitude, richness and potential value of these resources primarily aimed at informing the national attempts to achieve utilization of these resources in a sustainable manner.

The document attempted to collate the exhaustive information on inland fisheries in one place. The national data on resource size of rivers, canals, reservoirs, floodplain wetlands, estuaries, lagoons, lakes, and mangroves are estimated based on the data collected from federal agencies including the Ministry of Water Resources (Jal Shakti), National Remote Sensing Agency, Fisheries Ministry and the surveys conducted by the Central Inland Fisheries Research Institute and various state departments. Collection and reporting of resource data have been standardized across the states under the guidance of the Institute. In the document the area under rivers, estuaries, reservoirs, floodplain wetlands have been estimated to be 1,64,118 km, 4,85,185 ha, 34,60,301 ha, 5,64,286 ha, respectively and the inland capture production has been estimated at 21,44,428 tonnes.

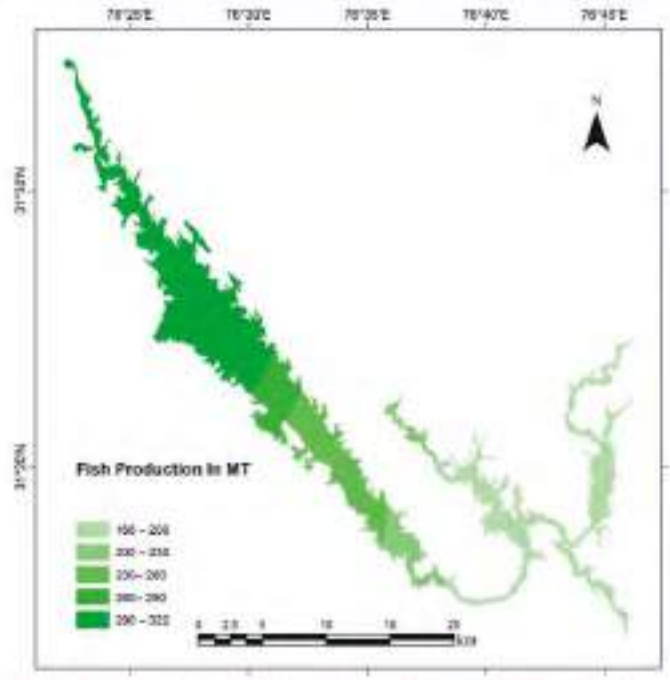
Project Title: Investigation on fisheries and ecological status, threats, and remedial measures for enhancement of fish productivity of Gobind Sagar reservoir, Himachal Pradesh

Funding Agency: Department of Fishery, Govt. of Himachal Pradesh

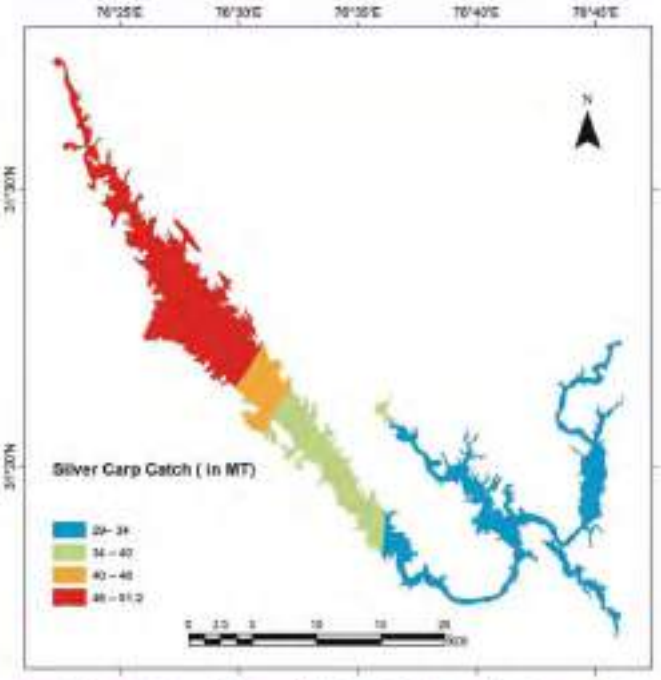
Scientific Personnel: B. K. Das (P.I.), U. K. Sarkar (till 19.10.22), A. K. Das, Lianthuamluaia, Mishal P.

Gobindsagar reservoir is a large category reservoir located in Sutlej river in Himachal Pradesh. A year-long detailed study was conducted to investigate present fisheries status, explore the factors influencing fish productivity and to come out with suitable measures and recommendations for fisheries enhancement in Gobindsagar Reservoir in the context of declining fish production.

The water and sediment quality parameters indicated that the reservoir is medium productive. The highly fluctuating water-spread area in recent years is one of the most probable reasons for declining fish production. The water level fluctuations can have a big impact on fish breeding grounds/ habitats which influence the natural recruitment of the auto-breeding populations and also the natural food availability. The fish production was positively influenced by the water spread area as shown by regression analysis and sufficient water is needed for sustainable fish production. The fish species richness was 17 based on the experimental fishing and 21 based on the stakeholders' perception which indicated that the species richness has reduced as compared to previous records. Habitat disturbance due to the wide fluctuation of the water spread area and climate change impact could be the possible reasons for the loss of fish diversity in the reservoir. The fish catch data analysis for the last decade (2010-20) indicated that the exotic fish *Hypophthalmichthys molitrix* and *Cyprinus carpio* led the fish catch followed by *Labeo catla*. The time series data also indicated that *H. molitrix* was the most dominant fish. However, the catch of *H. molitrix*



Map showing the spatial variation of annual fish production in Gobind Sagar reservoir during 2010-20



Spatial variation of *Hypophthalmichthys molitrix* production during 2018-19 to 2021-22

decreased drastically after 2013 onwards and kept on decreasing which greatly impacted overall fish production.

Canonical corresponding analysis (CCA) indicated that nutrient nitrate-N and phosphate-P were the most influencing parameters for silver carp, the most dominant fish caught in the reservoir. Alkalinity, conductivity, dissolved oxygen were the most important parameters influencing the abundance of common carp and minor carp. Transparency and pH were the most important parameters influencing the productivity of mahseer, rohu, mrigal, catla, grass carp, calbasu and seenghala. The study clearly indicated that stocking has an impact on the fish production but other interventions like identification of and protecting the breeding ground can enhance the fish production in a sustainable manner. The potential fish yield was estimated in the range of 136-153 kg/ha/yr (average 145 kg/ha/yr) on the basis of the algal biomass model. The fish yield ranged from 23-149 kg/ha/yr with an average of 72 kg/ha/yr during the last decade indicating that the actual fish yield in the reservoir is quite less than the potential yield.

The Schaefer's model estimated the MSY for the reservoir to be 101.42 kg/ha/yr and the fishing effort to attain the maximum sustainable fishing effort (fMSY) to be 2953 gill nets license per year. The Fox model estimated the MSY for the reservoir to be 97.04 kg/ha/yr and the fishing effort to attain the maximum sustainable fishing effort (fMSY) to be 3141 gill nets license per year. In order to re-establish fish production in the reservoir in a sustainable manner, the major recommendations of the present study are: i) stocking of large size IMC and common carp fish seed of >100 mm regularly and consistently @300 fingerlings/ha, ii) stocking of silver carp vigorously @300 fingerlings/ha (>100mm) for 5 years to develop auto-breeding population, iii) monitoring of the water spread area, maintaining the fishing effort of 2953 to 3141 gill nets license per year and iv) identification of the potential breeding grounds and protecting those habitats. The long-term studies on recruitment of silver carp and identification of breeding ground along with climate change impact and ecological modeling are proposed for sustainable fisheries in Gobind Sagar reservoir. The study identified the critical issues and demonstrated explicitly the need for implementing suggested management strategies for sustainable development.

Fish catch from Gobind Sagar reservoir

Project Title: Addressing skill gap in the FPO ecosystem in eastern and north eastern parts of India

Funding agency: Indian Council of Social Science Research (ICSSR)

Project Director: B. Saha, WBUAFS

Project Co-Director: Arun Pandit

Estimation of technical efficiency

Technical efficiency has both input and output orientations. The output-oriented approach measures the ability of a production unit to get the maximum outputs possible with a given combination of inputs and production technology. The second approach measures its ability to achieve a given output level with the smallest quantities possible of inputs. In this study, Data envelopment analysis (DEA), a non parametric technique of technical efficiency estimation is employed. It uses a mathematical program to estimate the efficiency frontier.

A comparative study has been conducted to assess the technical efficiency of crop farming, vegetable farming and fish farming. The case of single output, which is the gross return and five inputs was considered. All the inputs were converted into money for using across different farmers. The inputs were field/pond preparation, seed (including seed treatment), labour, fertilizer/feed/chemical/micronutrients and others. The technical efficiency obtained in DEA model consists of pure technical efficiency and technical efficiency of scale. Pure technical efficiency reflects the way in which production unit resources are managed while scale efficiency or scale technical efficiency determines whether production unit operates at an optimal scale or not. The optimal scale is understood here as the best situation that can achieve the production unit by increasing proportionally the quantity of all its factors. If for a given farm, there is a difference in efficiency ratios measured by these two types of DEA, this indicates that the firm is not operating at an optimal scale.

The average measure of overall technical efficiency was estimated at 22.2 % for crop farmers,44.3 % for vegetable farmers and 63% for fish farmers. Average scale efficiency was estimated at 79.4 %, 96.8 % and 98.6 % for the above categories of farmers, respectively. The results indicated that the fish farmers were more efficient in all the three measures of technical efficiencies. Further, the minimum TE score was also low in crop sector. The average efficiency scores indicate that pure technical inefficiency was primarily responsible for overall technical inefficiency in crop and vegetable. All the fish farmers have efficiency score of above 0.60. The analysis indicates crop, vegetable and fish farmers can, on an average, increase their output by 78%, 56% and 38%, respectively by operating at an optimal scale and by eliminating pure technical inefficiencies.

Computation of scale efficiency scores proves that on average the farmers suffer from scale inefficiency at a level of 21%, 0.04% and 0.01%, respectively for crop, vegetable and fish, respectively. Both management practices (pure technical inefficiency) and production scale (scale inefficiency) affect efficiency level.

All the rice farmers and a sizeable population (35%) of vegetable farmers were operating under sub-optimal scale. All the crop farmers

Table: Distribution of farmers by TE scores under VRS and CRS assumptions (% of farmers)

Overall TE	Crop (N = 30)	Vegetable (N=20)	Fish (N=30)
Score <0.5	100	60	20
Score > 0.5	0	35	80
On the frontier score = 1	0	5	0
Pure TE			
Score <0.5	93	60	20
Score > 0.5	7	35	77
On the frontier score = 1	0	5	3

Table: Efficiency measures of farms

Particular	Overall technical efficiency			Scale efficiency			Pure technical efficiency		
	Crop	Vegetable	Fish	Crop	Vegetable	Fish	Crop	Vegetable	Fish
Average	0.222	0.443	0.630	0.794	0.968	0.986	0.287	0.452	0.642
Minimum	0.08	0.108	0.351	0.357	0.818	0.773	0.117	0.132	0.354
No. of farms with efficiency score 50% and above	0	7	24	29	20	30	2	7	6
Standard Deviation	0.089	0.206	0.194	0.116	0.044	0.040	0.160	0.202	0.182

were operating below 0.5 efficiency level, whereas, majority of the vegetable and fish growers were within the group of 0.5 and above. The same trend was followed for pure technical efficiency. Overall, the study indicates that the fishfarmers were more efficient than crop and vegetable farmers. Technical inefficiencies could be improved through adoption of best practices of the efficient farms.Hence extension efforts need to be enhanced to educate farmers regarding scientific production practices.

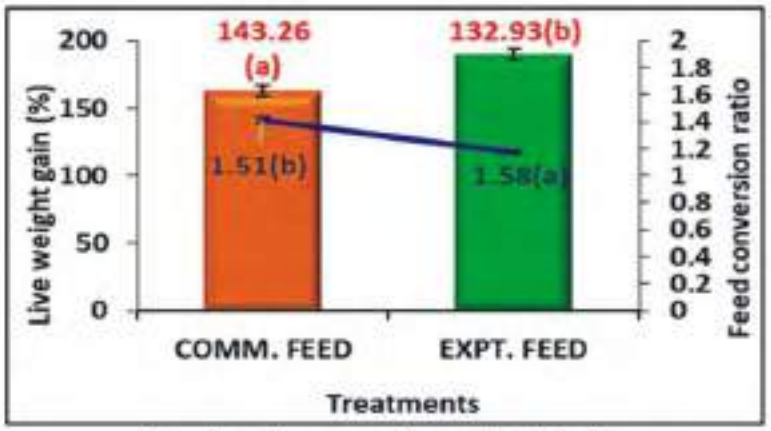
Project Title : Utilization and diversification of silkworm pupae products for human & animal consumption and composting

Funding Agency: Central Silk Board (CSB), Ministry of Textiles, Govt. of India

Scientific Personnel: B. K. Das (P.I.), M. A. Hassan, D. K. Meena, R. Das

Silk production generates a significant amount of wastes and this project aims to utilize the silkworm pupae waste in fish feed development for waste to wealth conversion. In this direction, four fish feed of different pellet sizes and nutrient contents were formulated using silkworm (*Antheraea mylitta)* pupae meal for various life stages of fishes for location specific feeding trials.

After lab-based experiments, a 150-days grow out feed trial with silkworm pupae-based feed (SPBF) and commercial feed on *Pangasianodon hypophthalmus* was conducted in cages. The study revealed a significant ($p<0.05$) difference in terms of growth, nutrient utilization, flesh quality, and survivability of fish. The live weight gain percentage (WG %) and Feed Conversion Ratio (FCR) of silkworm pupae meal based feed and commercial feed were 132.93 % and 143.29 %, 1.58 and 1.51, respectively. In another 90-days trial, silkworm pupae meal-based experimental feed exhibited better nutrient utilization and growth performance in *P. hypophthalmus* juveniles compared to the commercial feed in field condition. The WG % and FCR for SPBF and commercial feed were recorded as 231.02, 171.74, 1.59 and 2.00, respectively. Thus, silkworm pupae meal showed better growth performances in juvenile culture as compared to commercial feed in grow out culture of *P. hypothalmus* in cages. A 30-days feeding trial with *Catla catla, Oreochromis niloticus,* and *Cyprinus carpio* indicated highest WG % (58.38 %) in *O. niloticus* followed by mixed culture of *C. carpio* (51.43 %), *L. rohita*



Growth performances of pupae based feed in grow out culture of *P. hypohthalmus* in cages

Reshmeen | Reshmeen Amrit | Reshmeen Gold | Reshmeen Gold+

Fish feeds prepared using silkworm pupae waste

(47.05 %), and *C. carpio* monoculture (44.84 %). The FCR also followed the same trend.

It was also observed that the experimental group fed diet containing 50:50 non-defatted *Antheraea mylitta* and defatted *Bombyx mori* pupae meal as a major protein source, yields significantly better nutrient conversion and growth performances in case of *L. rohita* compared to the other two fish species (*O. niloticus* and *P. hypophthalmus*). Moreover, an icorporation of 75% defatted *Bombyx mori* with addition of 25% of *Antheraea mylitta* pupae meal in feed for *O. niloticus* and *P. hypophthalmus* showed similar growth performances and nutrient utilization efficiencies among themselves.

Based on the indoor and field trials, four commercial feeds have been developed with different size and nutrient quality for various life stages of stages of fishes. These are: (i) Reshmeen: 1mm pellet for fry (38% crude protein and 6% crude lipid), ii) Reshmeen Amrit: 2mm pellet for fingerling (32% crude protein and 6% crude lipid), iii) Reshmeen Gold+: 3mm pellet for grow-out (28% crude protein and 5% crude lipid), and iv) Reshmeen Gold: 4mm pellet for grow-out and brood stock (25% crude protein and 5% crude lipid). The feeds have been released in National Symposium on Vanya Sericulture: Opportunities Galore in the presence of Padma Shri Dr. S. Ayyappan, Former DG, ICAR and Secretary DARE in October, 2022. Efforts have been taken towards popularization of the feeds.


दैनिक दबंग दुनिया

कचरे से कंचन मिशन के अंतर्गत सिफरी ने रेशम कीट अपशिष्ट से किया मत्स्य आहार विकसित

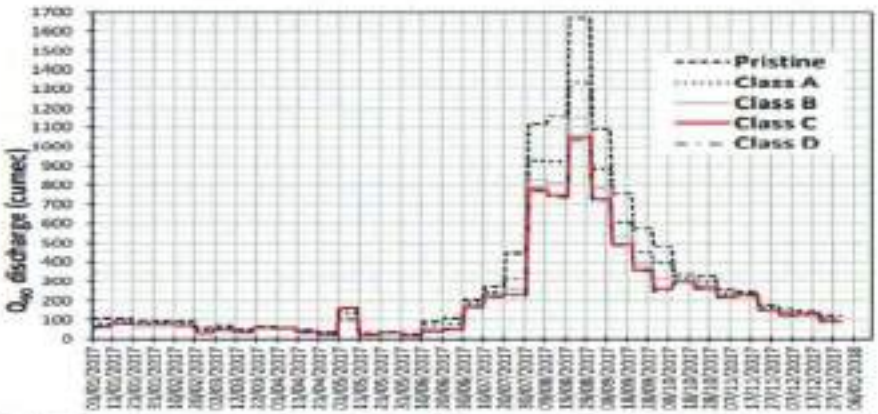
Creating public awareness about the feed

Project Title: Environmental flows for river ecology with focus on downstream fisheries of Sardar Sarovar Dam (SSD) in Narmada River

Funding Agency: SSNL, Gujarat

Scientific Personnel: B. K. Das and A. K. Sahoo

Fish diversity of river Narmada in the stretch from downstream of Sardar Sarovar Dam (SSD) to the estuary mouth was studied with a major objective of environmental impact analysis. For estimation of environmental flows two sampling sites viz. Kevadia, and Garudeshwar were selected below SSD. The study recorded presence of large bodied fish belonging to *Tor* spp., *Sperata* spp., *Notopterus* spp. and *Labeo* spp. in the stretch. Of these, *Tor tor* (Mahseer) was recorded inpre-monsoon and monsoon seasons. Though detailed study on the breeding migration could not be studied, juveniles were recorded at water depth of 0.5 to 0.8 m and water velocity of 0.3 to 0.5m/s.



Daily flow release pattern from the Garudeshwar weir for different EMCs using the FDC analysis for any typical year

Based on the preliminary data on fish diversity collected from the field and secondary data on the hydrological time series data and river cross sections, environmental flows was estimated both by hydrological and hydraulic simulation methods. During the estimation it has been recorded the stretch between downstream of SSD and Garudeswar weir as lentic ecosystem due to the crest level of the weir at Garudeswar. Extrapolating the similar river bed habitat between upstream and downstream of the Garudeswar weir and considering the key fish species, *Tor tor*, the estimates are recommended based on FDC and habitat simulation method. As Mahseer migration requires water discharge during early monsoon and post-monsoon, minimum prescribed water discharge from the weir is estimated to be 53.1 cumec during lean season, 162.9 cumec during pre-monsoon and 407.8 cumec during monsoon season.

Project Title: Planning and design of fish hatchery at Bichom dam site along with studies on reproductive biology of snow trout, *Schizothorax richardsonii* for conservation and artificial propagation in River Bichom, Arunachal Pradesh

Funding Agency: NEEPCO

Scientific Personnel: B. K. Das, B. K. Bhattacharjya, A. K. Sahoo, D. K. Meena, S. Borah

Towards conservation and artificial propagation of snow trout *Schizothorax richardsonii* in river Bichom, Arunachal Pradesh the project has the following objectives: 1) planning and design of fish hatchery at Bichom dam site, 2) study on breeding season and maturity stages of the targeted fish species in River Bichom, 3) study on water availability and quality of water at the dam site, 4) study based recommendations towards improving snow trout population in the selected study stretch. The river stretch of approx. 10 km was surveyed in May, 2022 representing pre-monsoon and September, 2022 representing monsoon season and five sampling sites. For construction of hatchery, site selection was made after investigating water sources availability and water quality.

Suitability of fish hatchery establishment

Schizothorax richardsonii, *Garra gotyla*, *Neolissochilus hexagonolepis*, *Schistura rupecula*, *Cyprinus carpio*, and *Glyptothorax cavia* were recorded in the Bichom

Schizothorax richardsonii in the Bichom River

Bichom Reservoir, Arunachal Pradesh

Cyprinus carpio captured from the reservoir

river. *S. richardsonii* was found to be the most abundant in the lotic zones, upstream and downstream of the dam, followed *by N. hexagonolepis, Garra gotyla,* and in lentic zone exotic *Cyprinus carpio* was found to be the most dominant. Gravid males and females of *Cyprinus carpio* were observed in the catches indicating that this species has established itself in the reservoir. Gonado-somatic index, fecundity, and sex ratio study showed that *S. richardsonii* was in immature and mature/ pre-spawning stage before the breeding season. This indicates monsoon season is ideal for the brood-stock collection and rearing in large tanks for the breeding/artificial propagation in hatchery condition.

Project Title: Imparting state of art knowledge on fish breeding to the local fisherman for livelihood improvement and enhancing the native fish population through ranching programme in River Ganga

Funding Agency: NTPC, Farakka

Scientific Personnel: B. K. Das, A. K. Sahoo and D. K. Meena

Fisheries at Farakka, West Bengal majorly dependent on the capture fisheries from the river Ganga, feeder canal and river Padma (lower stretch of river Ganga at Farakka). Looking into livelihood of fishers, it was realized that initiation of the fish culture through scientific method would be a good option for the local youth, fisher women and men. Therefore, state of art the facilities and training to the fish farmers was developed/organized. Under the CSR scheme of NTPC, Farakka ICAR-CIFRI carried out the societal developmental activities with major focus on 1) Developing state of art knowledge centre (small scale) on fish breeding and rearing units for Indian Major Carp for ranching, 2) providing handson training to the local fishermen on fish breeding and rearing for the livelihood improvement, 3) ranching the native fish fingerlings developed through captive breeding for a period of 3 yrs. During 2022, suitable site for establishment of the small scale FRP carp hatchery near the Farakka barrage was demarcated. A total of 12 pairs of *Labeo rohita, Labeo catla* and *Labeo calbasu* brood fish were stocked in pens in river Ganga for brood stock development. Towards conservation of native fish species germplasm in river Ganga, one lakh

Rearing brood-stock of IMC in pens in river Ganga

Creating awareness on indigenous fish breeding and culture

Ranching of IMC fingerlings in River Ganga at Farakka

fingerlings of IMC were ranched. During the awareness, fishermen were advised not to catch small size fishes and to allow brooders to breed in the river. More than 500 fishermen have been educated on the IMC breeding, and ranching.

Project Title: Study on impact of water intake due to Gadarwara STPP on ecology of Narmada River

Funded by: National Thermal Power Corporation

Scientific Personnel: B. K. Das, S. Samanta, S. K. Das, A. K. Sahoo and Vaisakh G.

Survey-cum-sampling was conducted during December 2022 at 4 sampling sites at Kakraghat pump houses and settling tank of NTPC, Sangam-Sokalpur, Usray Ghat-Tuiyapani, and Sitareva river - discharge site of NTPC, Gadarwara. During the survey no apparent adverse effect of the Gadarwara Super Thermal Power Project was noticed on the river Narmada. As per the set-up, Gadarwara STPP is a zero effluent discharge system. Water quality parameters were at its normal range with 8-12 ppm of dissolved oxygen. A total of 46 fish species belonging to 12 families were recorded from the study sites with dominance of barb, minnow and loaches. The stretch contains some of the IUCN threatened species including Tor tor. Wide variations among the sampling sites were recorded on fish species diversity.

The following research and development activities, in form of a comprehensive project, were carried out by the Institute under the NEH programme:

Project Title: Refinement of management strategies for openwater fisheries of Northeastern India through location and ecosystem-based approaches

Project Code: NEH/20-23/03

Project Coordinator: B. K. Das

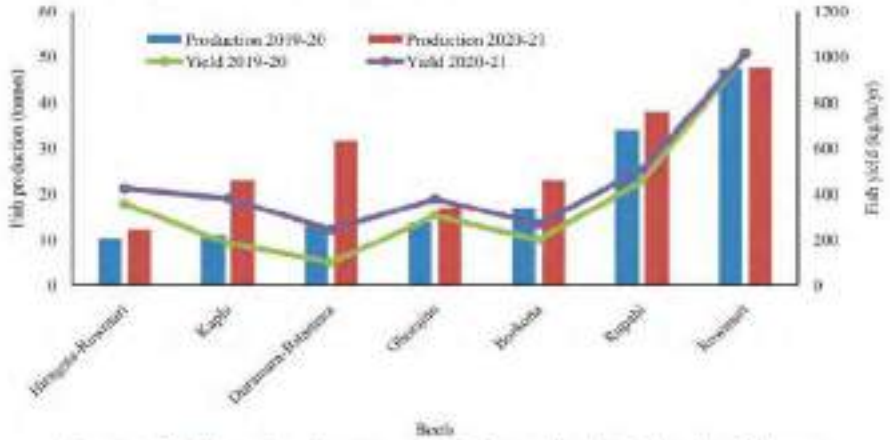
Principal Investigator: B. K. Bhattacharjya

Sub Project I: Sustainable utilization of openwater fisheries in Assam and Nagaland through community participation

Scientific Personnel: S. Borah (Sub-project Leader), A. K. Yadav, P. Das, S.C.S. Das, R. Baitha, Aparna Roy (w.e.f. 01.04.22)

Impact of fish Stock enhancement on fish production in beels of Assam

Impact of fish stock enhancement on fish yield after intervention by ICAR-CIFRI was assessed in 7 beels located in five districts of central and lower Brahmaputra valley of Assam. A total of 2.82 lakh advanced fingerlings of IMCs and minor carps were stocked in Rowmari, Rupahi, Kapla, Borkona, Ghorajan, Hiragota-Rowmari-Dighali, and Duamara-Batamara (40,000 no.) beels. Following the supplementary stocking average fish catch of the beels has increased from 20.90 tonnes during 2019-20 to 27.40 tonnes during 2020-21. Average fish yield of the beels has increased from 372.50 kg/ha/yr during 2019-20 to 458.60 kg/ha/yr during 2020-21. Maximum increase in fish production was recorded for Duamara-Batamara beel followed by Kapla, Borkona, Ghorajan, Hiragota-Rowmari, Rupahi and Rowmari beel. Thus, fish stock enhancement has led to 31% increase in fish production following ICAR-CIFRI's intervention.



Impact of fish stock enhancement on fish prodcution in beels of Assam

Pen culture in beels for raising stocking materials

CIFRI HDPE Pen (44 nos.; 0.05 ha each) were installed in 6 beels located in Dibrugarh (Mer beel, Pani beel and Natun Bolai Erasuti beel), Tinsukia (Maguri beel and Dhelakhat beel) and Dhemaji (Boruahghuli beel and Kuhimari beel) districts of upper Assam. Fish seed (fry) were stocked in these pens and will be reared till fingerling stage which will be used for stocking for stock enhancement in the beels. The stocked species comprised of three Indian major carps and minor carp *Labeo bata*.

Cage culture in Doyang reservoir, Nagaland

Doyang (26°13'10" N and 94°17'90" E) is a medium reservoir (2258 ha)

Stocking of fish seed (fry) in pens in wetlands of Assam

Stocking of fish seed in cages in Doyang reservoir, Nagaland

located in Wokha district of Nagaland and has potential for augmenting fish production in the state. The reservoir is being managed by Department of Fisheries & Aquatic Resources (DoF&AR), Nagaland. Total fish production from the reservoir was 358 tonnes during 2016-17. More than 250 fisher families including 100 full-time fishers depend on the reservoir for their livelihood. However, fish yield rate in the reservoir is slighily on the lower side (157.2-158.5 kg/ha/yr). ICAR-CIFRI initiated culture of Pangas (*Pangasianodon hypophthalmus*), Common carp (*Cyprinus carpio*) *and* Silver barb (*Barbonymus gonionotus*) in cages installed in the reservoir in collaboration with the DoF&AR, Nagaland to augment fish production. A total of 21,600 fingerlings of Pangasius, Common carp and Silver barb were stocked in ten cages during October 2022. Fishes were stocked in three different ratios of 60:30:10, 70:20:10 and 80:10:10 (Pangasius: Common carp: Silver barb) in triplicates.

Sub Project II: Enclosure culture in openwaters of Manipur incorporating locally important fish species

Scientific Personnel: Sona Y. (Sub-project Leader), D. Debnath, T. Nirupada Chanu, N. Sharma, (w.e.f. 01.04.21), N. Samarendra Singh (upto 30.04.22)

Demonstration of cage culture technology in Mapithel reservoir

Mapithel reservoir located in the mid-altitude region (899 m ASL) at Kamjong district, Manipur is a medium reservoir with 1182 ha total water-spread area. ICAR-CIFRI successfully demonstrated cage culture in the reservoir with the locally preferred common carp (*Cyprinus carpio*). Approximately, 25,000 numbers of common carp fingerlings (avg. weight 35.65 g) were stocked in the cages in five different stocking densities i.e., 10, 20, 30, 40 and 50 fingerlings/m^3 for rearing them to marketable size. Fish were fed with pelleted feed containing 28% CP @ 3-5% body and reared for 5 months. Growth of the fish was similar at stocking density of 10, 20, 30 fingerlings m^{-3} while a lower growth was reported at 40 and 50 fingerlings m^{-3}. The specific growth rate at the different stocking densities were 1.08, 1.07, 1.00, 0.88 and 0.84 respectively. High survival rate (81.7-93.5%) with fish production ranging from 200 kg/cage at low stocking density to 550 kg/cage at high stocking density were observed.

Demonstration of cage culture technology in Takmu lake of Manipur

ICAR-CIFRI in collaboration with the Department of Fisheries, Govt. of Manipur has demonstrated cage

Cages installed in Mapithel reservoir

Haul of Common carp reared in cages in Mapithel reservoir

Cages in Takmu pat, Manipur

culture technology in Takmu pat (lake) of Manipur since 2020. In the first trial, monoculture of *Osteobrama belangeri* (Pengba) was carried out and a stocking density of 30 fingerlings/m^3 was found to give good growth. In the second trail, monoculture of pengba, *Ctenopharyngodon idella* (grass carp) and *Labeo bata* was carried out to compare growth and economics of its production in cages. The three species were stocked at 30 fingerlings/m^3 and fed pelleted diet containing 28% CP at 3-5% body. After rearing for 2 months, grass carp was found to have the highest growth followed by pengba and *L. bata*. The specific growth rate and weight gain% were 2.26 and 287.8% for grass carp, 1.88 and 209.3% for pengba and 1.29 and 117.45% for *L. bata*.

Pen culture of *Amblypharyngodon mola* and major carps in Takmu lake

Pen culture of small indigenous fish *Amblypharyngodon mola* as monoculture and along with major carps was initiated in Takmu pat of Manipur in collaboration with the Department of Fisheries, Govt. of Manipur. Six rectangular pens (individual dimension 25 m x 20 m) were constructed using HDPE nets, FRP poles, bamboos and macrophyte mass (phumdi) as floating structure. The pens have been stocked with *A. mola* (mola), *Ctenopharyngodon Idella* (grass carp) and *Labeo rohita* (rohu) in monoculture or in different combinations. Experiment is going on to find best pen culture option in the lake.

Sub Project III: Refinement of cage culture and species enhancement in Dumbur reservoir of Tripura

Scientific Personnel: S. C. S. Das, (Sub-project leader), D. Debnath, A. K. Yadav, M. Shaya Devi (on leave 10.10.22-31.12.22), P. DebRoy (w.e.f. 01.04.22)

Ecology and fisheries of Dumbur reservoir

The Dumbur reservoir, the only reservoir in Tripura, was constructed across the river Gumti in the year 1977 for generation of hydroelectricity. Department of Fisheries, Government of Tripura is the apex body for overall development of fishers and fisheries of this reservoir. Presently, there are six fishermen cooperative societies operating in the reservoir with about 23573 licensed fishers. Investigations were carried out seasonally from the lacustrine, transitional and riverine zones of the reservoir.

Water pH was slightly acidic to alkaline (6.8-7.2). Water has low to moderate specific conductance (37-115 µs/cm) and total dissolved solids (24-73 mg/l); high dissolved oxygen content (6.3-8.6 mg/l), moderate total alkalinity (42-50 mg/l). A total of 15 (fifteen) macrobenthic fauna comprising of 2 insect, 4 bivalve, and 9 gastropods were recorded from different sampling stations and their populations ranged from 354-528 nos./m^2. There were patches of macrophytes infestation near the marginal area of the reservoir. A total of 14 macrophytes comprising of

Pen with macrophyte mass as floating structure in Takmu lake, Manipur

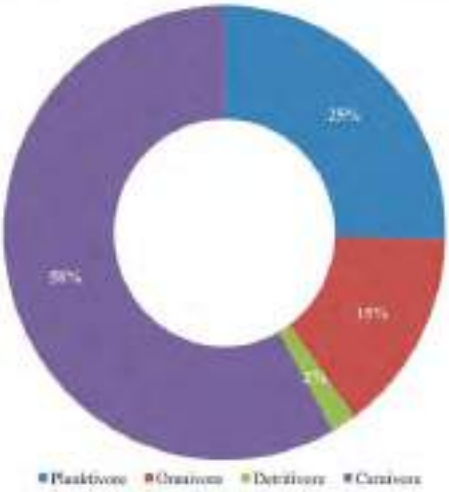
Amblypharyngodon mola stocked in pens

emergent (*Typha* sp., *Colocasia* sp., *Ipomea* sp. and *Scirpus* sp.), rooted floating macrophytes (*Nymphoides* sp., *Nelumbu* sp.); Submerged macrophytes (*Hydrilla* sp., *Najas* sp., *Vallisneria* sp., *Potamogeton* sp.), and free floating macrophytes (*Eichhornia crassipes* and *Pistia stratiotes, Lemna* and *Azolla)* were recorded.

A total of 55 finfish species were recorded from the reservoir belonging to 9 orders, 23 families and 41 genera. The maximum fish species richness was contributed by Cypriniformes (23), followed by Perciformes (12), Siluriformes (10), Synbranchiformes (4), Osteoglossiformes (2), Clupeiformes (1), Cyprinodontiformes (1), Tetradontiformes (1), and Beloniformes (1). Among the fifty-five fish species, five exotics viz., *Cyprinus carpio, Ctenopharyngodon idella, Hyophthalmichthys molitrix, Oreochromis niloticus, H. nobilis* were documented. The maximum fish species richness was observed in monsoon (48 species), followed by summer (37), and winter (36). Riverine zone showed highest diversity (46 species), followed by transitional (40) and lacustrine zone (37). The projected fish species richness expected for the entire reservoir by Chao1, Jacknife1, Jacknife2, and Bootstrap techniques were 58, 62.5, 63.5 and 58.94, respectively.

Trophic guilds and conservation status of fishes

In the reservoir carnivorous fishes (58.18%) were the main trophic guild, followed by planktivores (25.45%), omnivores (14.55%), and detritivores (1.82%). Based on IUCN standards, three species (*Ompok bimaculatus, O. pabda,* and *Chitala chitala*) were near threatened (NT), while *Wallago attu* and *Clarias magur* were vulnerable (VU) and endangered (EN), respectively; other species were in least concern (LC) category.



Trophic guilds of fishes from Dumbur reservoir

Cage culture demonstration in Dumbur reservoir

ICAR-CIFRI has demonstrated *cage culture technology with common carp (Cyprinus carpio) in the reservoir. A* total of 20,000 fingerlings of *Cyprinus carpio* were stocked @ 30 no./m^3 in eight cages (6 x 4 x 4 m^3 each) installed in the reservoir in winter season. The stocked fishes were fed twice-a-day with CIFRI Cage Grow floating feed @ 7% body weight for initial 3 months; afterwards it was reduced to 5% of body weight. The health and growth of stocked fishes were monitored. The average weight of common carp after one year of culture was 557.55±3.32 g with estimated growth rate of 34316.7%, specific growth rate of 1.60 and survival of 86%. On an average, 900-1000 kg fish was harvested from each cage with yield of 10.70-11.90 kg fish/m^3. Another demonstration/ experiment on grass carp, *Ctenopharyngodon idella* to determine its suitability as a species for cage culture in the reservoir has been initiated. A total of 7,000 fingerlings with initial weight of 8.19 ± 0.44 g have been stocked in 10 cages. Reportedly, there are 888 cages in the reservoir and it is expected that the fishers will take up the cage culture technology as a profitable venture.

Cage culture activities in Dumbur reservoir

Sub-project IV: Refinement of cage aquaculture technology in reservoirs of Mizoram

Scientific Personnel: D. Debnath (Sub-project Leader), S. C. S. Das, N. Samarendra Singh(upto 30.04.22), Lianthuamluaia

Status and prospect of cage culture in Mizoram

Northeast India has 23 reservoirs with 28,510 ha water-spread area, which are amenable to fisheries enhancement and cage culture. Cage culture is yet to make an impact in the region mostly because of limited adoption and low-level of management. Status of cage culture in the reservoirs of Mizoram was studied to address low fish productivity of reservoirs. Seven batteries, each with 16 cages were installed in Serlui-B reservoir in Kolasib district in 2012-13 and 2014-15 under RKVY scheme of the Department of Fisheries, Govt. of Mizoram. Reportedly, after installation one production cycle was completed with *Pangasius* sp.; *after that* the cages were left unutilized likely due to low local demand of the catfish. Hence, species selected for cage culture should depend on market demand, high value and seed availability. Later, grass carp (*Ctenopharyngodon idella*) was cultured in cages in Mizoram, reportedly without remunerative returns. Need to train departmental staff and prospective cage fishers before initiation of cage culture was felt during the survey.

Ecology and fisheries of Serlui-B reservoir

Water quality in the reservoir was found to be productive with water temperature ranging from 22.90 to 31.23°C, pH 6.80 to 7.23, dissolved oxygen 7.02 and 7.57 mg/l, electrical conductivity 95.40 to 125.60 µS/cm, total dissolved solids 33.35 to 39.67 mg/l, total alkalinity 39.00 to 42.30 mg/l and Sechhi disk transparency 2.90 to 3.60 m. The depth of the reservoir ranged between 8.63 and 12.60 m. Soil was mostly sandy loam in texture and was porous with poor water holding capacity. Soil was acidic in nature with pH4.5-6.0.

Total plankton population in Serlui-B reservoir ranged from 757-1500 units/litre. Chlorophyceae (42-44%) dominated the plankton community followed by Bacillariophyceae (20-24%), Cyanophyceae (16-19%), Euglenophyceae (9-13%) and Zygnematophyceae (6-8%). A total of eight macrobenthic fauna comprising of only gastropods namely *Bellamya bengalensis, Pila globosa, Melanoides tuberculata, Brotia costula, Tarebia lineata, Lymnaea acuminata, Gyraulus convexiusculus* and *Paludomus conica* were recorded with population density ranging from 22 to 333 nos./m^2.

A total of forty-six (46) fish species belonging to 6 orders, 18 families and 35 genera were identified that included five exotic fish species, viz. *Oreochromis niloticus, Cyprinus carpio, Hypophthalmichthys molitrix, Pangasianodon hypophthalmus* and *Ctenopharyngodon idella*. Large size fishes such as *Labeo catla* (76-86 cm range; 6.00-11.06 kg range), *Cirrhinus mrigala* (57-68 cm; 2.10-3.00 kg), *Labeo rohita* (25.5-60 cm; 0.17-3.50 kg), *Notopterus notopterus* (22-274 cm; 0.09-0.23 kg) and *Channa marulius* (25-82 cm; 0.18-3.50 kg) were dominant. However, dominant fish species by numbers were *Rasbora daniconius, Osterobrama cotio, N. notopterus, Chanda nama* and *Xenentodon cancila.*

Baseline information on Tuirial reservoir

Tuirial HEP is a 60 MW plant built by NEEPCO during 1998-2004 on river Tuirial and started functioning in 2019. ICAR-CIFRI made an exploratory visit to the reservoir for the first time. The reservoir is about 4000 ha in size, similar to Serlui-B, however, fisheries were not a formal activity in the reservoir as yet. It has not yet been leased for utilization of fisheries resources. Reportedly, there are few fishermen in the upstream areas who catch fish from the reservoir.

State of previously installed cages in Serlui-B reservoir

A view of Serlui-B reservoir

Table. Salient water quality of Tuirial reservoir (Mean±SD)

Sites	Air Temp (°C)	Water Temp (°C)	pH	DO (mg/l)	EC (µS/cm)	TDS (mg/l)	TA (mg/L)	Free CO_2 (mg/l)	Depth (ft)	Trans - parency (ft)
Near dam	30.73± 0.15	30.60± 0.31	6.90± 0.06	7.63± 0.42	34.33± 1.86	32.67± 1.20	42.00± 0.58	0.57± 0.28	5.17± 0.12	4.57± 0.12
Middle of dam	32.10± 0.67	29.60± 0.31	6.53± 0.09	7.53± 0.32	35.67± 2.33	33.00± 1.73	37.67± 1.86	0.77± 0.38	21.33± 0.88	5.17± 0.09
Far from dam	31.27± 0.37	30.80± 0.42	6.60± 0.12	7.87± 0.19	36.33± 2.60	36.67± 1.20	36.00± 0.58	1.17± 0.09	22.67± 0.88	5.67± 0.18

A view of the Tuirial reservoir

Exploration of edible freshwater crabs and molluscs in Mizoram

People of Mizoram have special preference for freshwater crabs and snails which are considered as delicacy and hence are highly priced. The Institute conducted a survey to assess diversity of the commercially harvested crabs and snails in Mizoram. It was observed that fishermen collected crabs from rocky streams. Three freshwater crabs from Sialsuk village (23°24' 0.20" N & 92° 45' 47" E), Aizwal district, namely, *Maydeliathelphusa lugubris, M. falcidigitis* (locally called *aikam*) *and Sartoriana spinigera* (locally called *dum chakai*) having high market

Maydeliathelphusa falcidigitis

M. lugubris

Sartoriana spinigera

Brotia costula

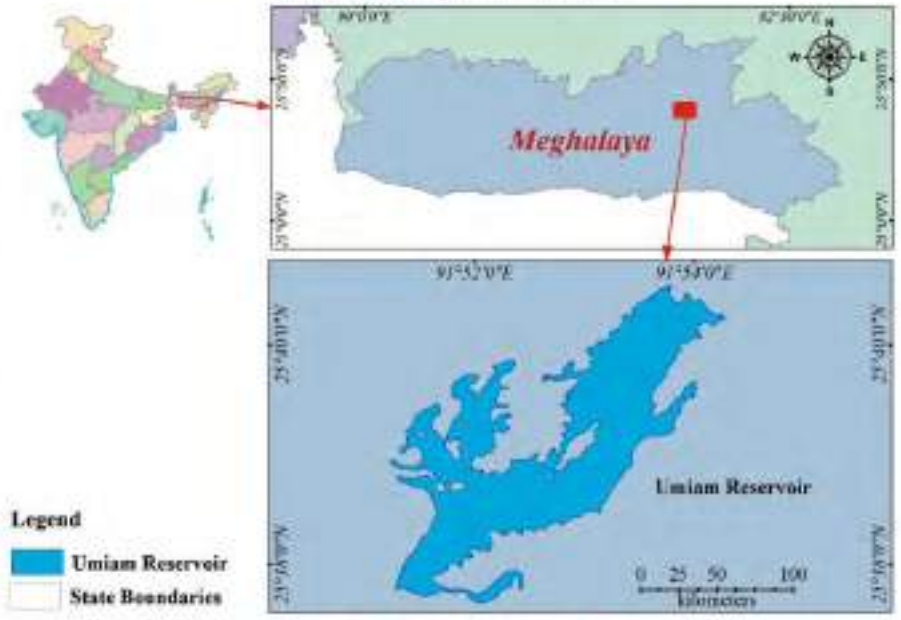
Paludomus conica

Melanoides tuberculata

Commercially important crabs and molluscs recorded in Mizoram

demand were identified. These crabs were mostly caught using a trap made of bamboo (locally called *aiawt*) – the crabs are lured with cooked or fried corn and wheat flour inside the trap. Crabs are normally marketed live in bamboo baskets or banana bark wrapped cones. A total of 8-10 *M. lugubris* and *M. falcidigitis* packaged live were sold at ₹250. Three molluscan (snail) species, namely, *Paludomus conica, Brotia costula (chengkawl bial)*, and *Melanoides tuberculata (chengkawl sawl)* were collected from Tut River in Dapchhuah village (23°46'17" N & 92°31'18" E) in Mamit district. These snails were sold in live condition as portions – about 250 g would be sold at ₹30-50. Considering its high consumer preference and demand, one progressive fish farmer in Dumlui Zau in Kolasib district had initiated crab farming in 2020 with financial assistance from Department of Fisheries, Govt. of Mizoram. Individuals of Maydelliathelphusa spp. were collected from rivers and stocked in cemented ponds. As per information shared by the fishermen, there was limited success in crab farming so far as large-scale mortalities were reported.

A view of the Umiam reservoir



Map of the Umiam reservoir

Sub Project V: Sustainable utilization of reservoir fisheries of Meghalaya through community participation

Scientific Personnel: P. Das (Sub-project Leader), Sona Y., S. Borah, D. K. Meena

Ecology and fisheries of Umiam reservoir

The Umiam reservoir located in Ri-Bhoi District of Meghalaya at an altitude of 900 m ASL is a small reservoir with water spread area 500 ha. The reservoir, commissioned in 1965, falls under jurisdiction of Khasi Autonomous District Council. Study was conducted to assess ecology and fisheries of the reservoir in monsoon (Jun-Aug), post-monsoon (Sep-Nov), winter (Dec-Feb) and pre-monsoon (Mar-May) seasons.

Most of the critical water quality parameters such as temperature (16.50-28.55 °C), pH (5.98-8.9), dissolved oxygen (5.62-8.68 mg/l), dissolved oxygen (1.5-5.5 mg/l), total alkalinity (22-56 mg/l), transparency (1.65-2.27 m), total phosphorous (45-125 µg/l) cholorophyll-a (22-45 µg/l), specific conductivity (38-87 µS/cm) and total dissolved solids (15-44 mg/l) were in favourable conditions for fisheries. Sediments are sandy loam in nature with highest contribution by sand (65-75%) followed by silt (15-25%) and clay (10-20%). The sediment pH (5.45-6.25) was acidic. Phytoplankton population was dominated by Bacillariophyceae (47.15-74.34%), followed by Chlorophyceae (16.76-29.73%), Desimidaceae (2.74-14.11%), Myxophyceae (4.07-

Water quality study at Umiam reservoir

9.01%) and Gonatozygaceae (2-2.81%). Periphyton population dominated by Bacillariophyceae (47.60-62.13%) followed by Chlorophyceae (14.9-20.65%), Myxophyceae (14.16-19.52%), Gonatozygaceae (6.29-8.17%) and Desimidaceae (1.29-3.45%). Plankton (663.64-848.49 no./l) and periphyton density (565-975 no./cm^2) were moderately high and varied among stations and seasons. Gross primary productivity (130-250 mgC/m^3/day), assessed using light and dark bottle method, indicated productive ecosystem for fisheries.

There is no organized fishery in this reservoir and it has remained an open-access capture fishery. Subsistence fishing and limited commercial fishing (using gill nets) by some local people (belonging to Khasi tribe) in an unorganized manner is being carried out in the reservoir. Gill net, cast net and angling are major fishing gears used for fishing. Angling has been major tourist attraction in the reservoir as sports fishing. The common carp (*Cyrprinus carpio*) has established in the reservoir and dominates the fish catch from the reservoir with indigenous chocolate mahseer (*Neolissocheilus hexagonolepis*) occurring in low numbers. A total of 38 fish species has been documented from primary and secondary sources with dominance of members of the Cyprinidae family. Highly carnivorous, *Clarias gariepinus* was also recorded from the reservoir, and is a major threat to icthyofaunal diversity of the reservoir.

Varieties / strain of *Cyprinus carpio* recorded from Umiam reservoir

Different varieties / strains of common carp (*Cyrprinus carpio*) have established and dominate fish catch from the reservoir. During the study, five varieties/strains of *Cyprinus carpio*, viz. *Cyprinus carpio* var. communis (Scale carp), *Cyprinus carpio* var. specularis (Mirror carp), *Cyprinus carpio* var. nudus (Leather carp), *Cyprinus carpio* var. koi (Koi carp) and *Cyprinus carpio* var. haematopterus (Amur carp) were recorded. Among them, scale carp was recorded most frequently and contributes significantly to livelihood of the fishers' population in Umiam reservoir since the catches of the indigenous fish including *Neolissochilus hexagonolepis* has been declining in the reservoir.

Evaluation of *Cyprinus carpio*, *Barbonymous gonionotus* and *Labeo rohita* in cages at mid-altitude

A battery of six CIFRI-GI cages were installed in the reservoir and fingerlings of Rohu, *Labeo rohita* (20%), Common carp, *Cyprinus carpio* (60%) and Silver barb, *Barbonymous gonionotus* (20%) were stocked at 3 stocking densities *viz.*, 10, 15 and 20 nos./m^3. Fish fingerlings were brought from Fish

Cyprinus carpio var. specularis (Mirror carp) caught from Umiam reservoir

Cyprinus carpio var. koi (Koi carp) caught from Umiam reservoir

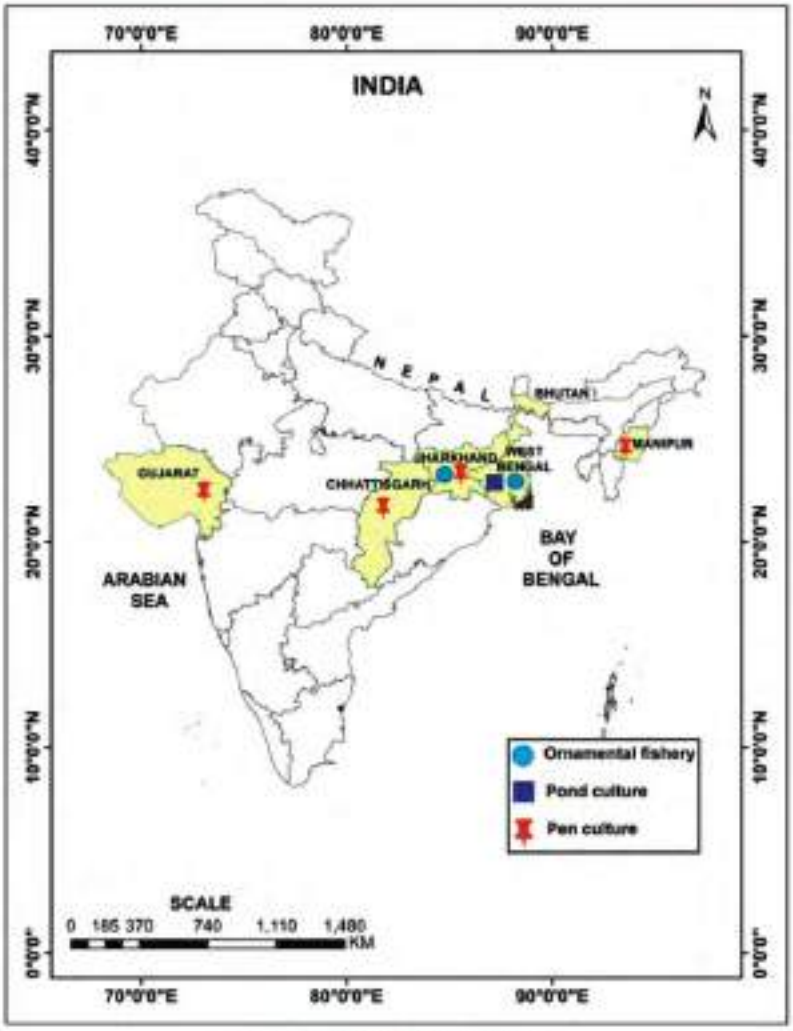
Cage culture in Umiam reservoir

Feeding by fisherwomen in cages

farm of ICAR Research Complex for NEH Region, Umiam. Fishes were fed twice daily with CIFRI-CAGEGROW (Crude protein- 28%) floating feed @2-5% of their body weight. Growth and water quality are being monitored regularly by ICAR-CIFRI Regional Centre, Guwahati and ICAR-RC-NEHR, Umiam, whereas daily feeding is being done by the local fisherwomen of Ri-Bhoi Farmers Union. After six months of rearing, an average fish production of 500 kg/cage was achieved. *C. carpio* was the best performing species in cages in mid-altitude region. *B. gonionotus* also performed well in terms of growth and act as cleaner of cages; growth performance of *L. rohita* was comparatively low. Thus, Common carp in combination of Silver carp may be a model for cage culture in mid-altitude NE India as a summer crop. Management of cages through community participation is the key to good result and sustainability. The final harvests of the cages would directly benefit the 25 fisherwomen families of the locality under Ri-Bhoi Farmers' Union.

Tribal Sub-Plan (TSP) came into existence in 1974-75 as a strategy for the development of areas having tribal concentration. After merger of Plan and Non-Plan, the TSP was renamed as Scheduled Tribe Component (STC) by Ministry of Finance. The TSP/STC aims to bridge the gap between the Schedule Tribes (STs) and the general population with respect to all socio-economic development indicators in a time-bound manner. ICAR-CIFRI has taken several initiatives to impart scientific knowledge, distributed fisheries inputs, conduct demonstrations with the objective to improve the livelihoods of the tribal populace of the country.

In the year 2022 ICAR-CIFRI have undertaken several activities covering around 1067 beneficiaries in five states namely Jharkhand, Chhattisgarh,Gujarat, Manipur and West Bengal.



Location of STC Programmes

Introduction of ornamental fish culture in Tribal villages of Jamshedpur and Bokaro

The ornamental fish industry provides a great alternative livelihood opportunity to the rural people as well as the women of tribal villages. Jamshedpur, a city of Jharkhand has approx. 64 retail and wholesale ornamental fish shops depending on the supply of ornamental fishes from Kolkata market, West Bengal. To sustain the ornamental industry from production to marketing, ICAR-CIFRI in collaboration with the Department of Fisheries, Govt. of Jharkhand, initiated ornamental fisheries backyard units to support the livelihoods of tribal women of Jamsedpur and Bokaro, Jharkhand. DoF, Govt. of Jharkhand identified 25 tribal women from rural villages i.e. Punsa, Naga, and Shiling villages of East Shinghbhum, Jamshedpur and 15 tribal women from Keshridi village of Bokaro. An off-campus training was conducted at the district headquarter. Under the leadership of Dr. B. K. Das, Director, initially, CIFRI distributed inputs for the ornamental unit, including 400L fibre tank, fish seed, fish feed, aerator and

accessories. Dr. A. K. Das, Principal Scientist, and Dr. Raju Baitha, Scientist coordinated the programme. The programme was conducted at Jamshedpur and at Bokaro. The efforts taken by the CIFRI for the first time in these two districts of Jharkhand will immensely help the envisaged vision of the Hon'ble Prime Minister and can boost the rural economy in the long run as well as the target under the PMMSY.

Fish production enhancement in reservoirs of Chhatishgarh - A virtual stakeholders' meet

ICAR-CIFRI undertook reservoir production enhancement programme in a participatory mode involving Department of Fisheries, Chhattisgarh, Tribal-Fishermen Cooperative Societiesat ten selected reservoirs, dominated and managed by tribal community. Under the leadership of Dr. B. K. Das, Director, ICAR-CIFRI has provided 2 nos of pen, boat with engine and 2 tons of fish feed for the penculture in the reservoir for *in-situ* raising of fish seed to be stocked in the reservoirs. Due to pandemic COVID situation and to speed up the process, a virtual meeting was organised to discuss the plan of action. The meeting was attended by Shri N. S. Nag, Director of Fisheries, Chhattisgarh; twelve Officers (ADF, Fisheries)State Fisheries Department; and the members of ten numbers of Primary Fishermen Co-operative Societies (PFCS) of Chhattisgarh. Dr. B. K. Das greeted the participants and narrated the importance of pen culture in improving fish production levels and productivity of inland open waters of Chhattisgarh. He remarked that twenty model pen demonstrations will be carried out in 10 different reservoirs of Chhattisgarh with CIFRI's intervention for the first time. Dr. B. K. Das, Director, CIFRI and Shri N. S. Nag, Director of Fisheries, Chhattisgarh both agreed that PFCS members have a greater role in the planned activities of pen culture in the state. Shri N. S. Nag, Director of Fisheries, Chhattisgarh, assured in the meeting that they are ready for pen installation in the inland openwater bodies and to provide logistic support to ICAR-CIFRI in this planned activities. There were interactions between members of PFCS, ADFs of the State Department and Scientists of ICAR -CIFRI on pen culture management practices that would be carried out in the State.

Penculture demonstration cum awareness programme at Taurenga, Gariabad, Chhattisgarh in collaboration with DOF, Chhattisgarh

ICAR-CIFRI has undertaken fish production enhancement programme in small reservoirs in Chhattisgarh through participatory mode by involving the Primary Fishermen Co-operative Societies (PFCS) of selected reservoirs under the leadership of Dr. B. K. Das, Director, ICAR-CIFRI on 13 May 2022. The Institute has provided twenty numbers of pen, ten boats with engine, twenty coracles and twenty tonnes of CIFRI Cage Grow feed in ten selected small reservoirs of Chhattisgarh *viz.* Taurenga, Bahera Khar, Sutia Path, Matiamoti dam, Koserteda, Rabo, Ghunghutta, Gej, Kesavanala. ICAR-CIFRI organized

a Penculture demonstration programme in collaboration with DOF, Chhattisgarh at Taurenga Reservoir on 13 May 2022 with the objective to raise *in-situ* fingerling in the pen for enhancing the production of the reservoir in a cost effective way. Director, CIFRI and Director of Fisheries, Chhattisgarh released the fish seeds in the pen installed in the reservoir. After the demonstration, a sensitization programme was organized in the reservoir site. Dr. Das addressed the gathering and informed about the importance of Penculture for fish production enhancement in the reservoirs. A total of 56 tribal beneficiaries participated in that programme.

Capacity building programme for Tribal Fishers of Chhattisgarh

As a part of the mission mode livelihood improvement initiated, a capacity building program on "Production Enhancement in small reservoirs through pen culture" has been organized in ICAR-CIFRI, Barrackpore during 24-27 May 2022. In this program, a total of 29 participants including Fisheries inspectors and PFSC members of selected reservoirshave participated.

During this 4-day training program, they interacted with Dr. B. K. Das, Director, ICAR-CIFRI, on scientific fish farming fish production enhancement in small reservoirs. Dr. Das emphasized the *in-situ* raising of the fish seed through pen culture for enhancing fish production in reservoirs and also advised them to adopt the Grass carp model in aquatic weed-chocked reservoirs. The trainees were taught different aspects of pen culture such as site selection, water quality management, feeding management in pens, disease management in cultured species, and overall small reservoir management.

Tribal women from Jharkhand trained for coloured fish farming

Prof. Chanchal Guha, Vice Chancellor of West Bengal University of Animal and Fishery Sciences (WBUAFS) inaugurated the five days long skill development training programme on ornamental

fish culture for the tribal women of Jharkhand on 30 May 2022.

In the inauguration programme of the training Dr. B. K. Das, Director, ICAR-CIFRI informed that 60 units of ornamental fish farming kit along with FRP tanks have been distributed among the beneficiaries in consultation with Department of Fisheries earlier in which the rural women have started the farming practice. This training programe was designed both on 'hand holding" in the ornamental fish hatcheries, visit to the ornamental fish farming village as well as classroom demonstrations and solving their problems during the rearing period. In the training, the trainees learnt the process of fabrication of aquarium, handling the ornamental fishes, breeding of different ornamental fishes like live bearer (guppy, molly, platy and swordtail) and egg layers (Gold fish, koi carp) were demonstrated. They also learnt about the feed requirement (both natural and artificial) and feeding time of fish; common disease and their treatment. They were also taught on common management practices in aquarium such as water exchange, use of thermostat, selection compatible aquarium fish species to keep them together in aquaria etc. Additionally, a local visit was also arranged for them to one ornamental village near Howrah to motivate them for ornamental fish farming.

In this program, a total of 28 participants have participated out of which 25 were women (including two fisheries officials). Among the women beneficiary, 13 women are ST and rest of are under SC categories. The beneficiaries belong to rural villages i.e., Punsa, Naga, and Shiling villages of East Shinghbhum, Jamshedpur and Ikti, Ranchi.

Livelihood support to fishers of Jharkhand

ICAR-Central Inland Fisheries Research Institute, Barrackpore extends its support to the fishermen cooperative societies belonging to Scheduled Caste communities for their livelihood improvement through distribution of fisheries FRP boats. Three boats were given to the cooperative societies (Schedule tribes) of the reservoirs, namely Getalsud, Karanji and Lotwa. The demonstration of the motorised FRP boats was organised on each reservoirs.

Training programme for displaced tribal people of Manipur

Manipur state is situated in the eastern-most corner of India and about 41% of population of the state is Scheduled Tribe. More than 95% of the populace of Manipur consumes fish. Despite the state is having production potential but, it has to import fish from other states of India. Construction of Mapithel Reservoir in Kamjong District Manipur caused displacement of more than 1600 tribal households and the agricultural land of the tribal populace was submerged. The primary occupation of the tribal populace was agriculture. Due to submergence of land, they compelled to shift to other occupation. Keeping this in mind ICAR-CIFRI has initiated reservoir fisheries development programme in selected reservoirs of Manipur to support the livelihoods of the tribal populace through alternative

livelihood generation *i.e* fisheries. An on-campus capacity building programme on 'Reservoir fisheries management for production enhancement' was organized at CIFRI, HQ during 22 - 28 July 2022, for selected fishers of the reservoir. The capacity building programme contained sessions on soil and water chemistry, basics of fish farming, pen culture, cage culture fish feeding, fish health and disease management, etc. including hands on training on fish feed formulation and analysis of basic water quality parameters followed by a feedback session from the trainees. The programme is

oriented to strengthen the practical skills of the farmers for enhancing the fish production in open waters through on-field exposure visits to Khalsi wetland, and Maithon reservoir. Gill nets were also distributed among the trainees in the valedictory session.

Livelihood improvement initiatives for dam-affected tribal fishers

ICAR-Central Inland Fisheries Research Institute undertook reservoir fisheries production enhancement programme involving the Department of Fisheries, Government of Manipur, Co-operative society of the reservoirs at three reservoirs *viz* Mapithel in Kamjong district, Khoupum in Noney district and Khuga in Churachandpur district of Manipur managed by the tribal community. The main objective of the programme was to improve the livelihood of the dam affected tribal community of the reservoirs through fisheries enhancement programme. The programme was initiated through the demonstration of pen culture

technology for *in-situ* raising of fish seed to be stocked in reservoirs.

ICAR-CIFRI HDPE Pen, 2 tonnes of CAGEGROW feed, 50,000 fish seed of Indian Major Carps to the selected societies of these reservoirs. The reservoir fisheries enhancement programme was inaugurated on 02 September, 2022 at Khoupum reservoir under the leadership of Dr. B. K. Das, Director, ICAR-CIFRI in the presence of Shri Aguilung Gangmei, Former Additional Director and District Fishery Officer, Tamenglong District, Shri Loveson Golmei, Fishery Inspector, DFO Tamenglong. Simultaneously, a mass awareness programme on reservoir fisheries management was conducted with the participation of about 50 fishers of Khoupum valley. In continuation of the flagship programme, Shri Leishiyo Keishing, Hon'ble MLA of Phungyar AC initiated the pen culture in Mapithel reservoir, Kamjong District on 03 September 2022. On this occasion, a mass awareness programme was also conducted at Ramrei village to raise the awareness among the fishers of reservoir fisheries.

The programme was started with the stocking of Indian Major Carp seed (50,000 numbers) in the installed pens, followed by the distribution of CIFRI CAGEGRROW Feed to the members the fisheries co-operative society. In the mass awareness programme, Ms. Thangjam Nirupada Chanu, Scientist, ICAR-CIFRI welcomed the participants and briefed the activities to be undertaken and also explained about the pen culture technology as well as reservoir fisheries.

The pen culture in Khuga reservoir was initiated by Shri Paolienlal Haokip, Hon'ble MLA, Saikot AC on 04 September 2022 with the stocking of IMC seed and distribution of CIFRI CAGEGROW fish feed. A mass awareness on the reservoir fisheries management was successfully conducted with the participation of more than the 100 fishers of Kuga Reservoir.

Fish production enhancement from backyard pond of Sagar Island

The ST beneficiaries supported through the STC programme in the previous year were also revived in the sensitization programme, fish seed and fish feed were distributed for livelihood development through fisheries on 29 September 2022.

Fishery inputs viz. fish fingerlings, fish feed, lime etc. were distributed to 150 ST beneficiaries at Ganga Sagar towards livelihood development and empowering Sagar Islands fishers. The initiative of ICAR-CIFRI for fish production enhancement from back yard ponds was highly appreciated by the Hon'ble Minister In Charge, Department of Sundarban Affairs, Shri Bankim Chandra Hazra. He also emphasized that the cyclone-prone Sunderban needs this type of intervention for their livelihood improvement.

ICAR-CIFRI demonstrates 'CIFRI HDPE Pen Technology' at Dev Dam, Panchmahal, Gujarat

Vadodara Research Station of ICAR-Central Inland Fisheries Research Institute (CIFRI) on 13 October 2022 demonstrated 'CIFRI HDPE Pen Technology' at Dev Dam, Panchmahal to the tribal fishers of 'The Dev Dam Asargrast Vikas Matsya Uchher Sahakari Mandali Ltd', Bhamariya Village. About 30,000 fish seeds of catla and rohu were released in the 0.1 ha CIFRI HDPE Pen for production of stockable size fish fingerlings for Dev Dam. Availability of stockable size fish fingerlings is one of the bottlenecks in increasing fish production from reservoirs in India. Duringthe programme tribal fishers of the *mandali* were trained on stocking of fish seed, feeding and other management aspects of the CIFRI HDPE Pen.

Initiatives to generate alternative livelihood options for tribal women of Malda

ICAR-CIFRI, Barrackpore has taken a new initiative to upscale the socio-economics of tribal women of 8 villages under Habibpur Gram Panchayet of Malda District, West Bengal in collaboration with CISH-KVK, Malda on 21 October 2022. A total of 150 tribal women were selected for livelihood improvement programme, out of which 120 were

selected backyard pond culture intervention and 30 women were for ornamental fish farming as a livelihood option to boost their household economy and security. These women groups formed a FPO to boost up their economy.Dr. B. K Das, Director, ICAR-CIFRI distributed 12.6 tonnes fish feed, 360 kg fish seed and 2.4 tonnes lime to 120 tribal women to support their livelihood through pisciculture in their household ponds and also conducted a mass awareness programme at Habibpur Gram Panchayat office.

Empowering tribal women of Jharkhand through ornamental fish culture

Empowering women through ornamental fish culture has been made involving 30 tribal women beneficiaries of Simdega district, Jharkhand, a down trodden district of the State with distribution of one 400 L tank each, ornamental fish culture kit comprising one thermostat, hand bet, one kg feed, aerator, suction cleaning pipe, aeration accessories, disease control chemical etc and ornamental fish to be grown further utilizing these supports. Director Dr. B. K. Das took a lead role in demonstrating through hand holding processes as how to make ample use of these materials, including how to grow such species in their backyard areas to those women beneficiaries. The beneficiaries were enlightened on knowledge strengthening as well as capacity building by the Director.

Input distribution programme at Gosaba, Sundarbans

ICAR-CIFRI organised an input distribution programme at Rangabelia village under Gosaba block, Sundarban on 28 October 2022. Fifty two tribal beneficiaries were given fisheries input for their livelihood support. Each beneficiary was given 5 kg fish fingerlings of Indian Major Carp, 20 kg lime and 105 kg CIFRI Cage Grow feed for culture of IMCs in their household ponds and that will meet their nutrition demand and also help them to earn better livelihoods.

Input distribution at Palotghat, Kakdwip, South 24 parganas

To commemorate the birth anniversary of Birsa Munda, one of the greatest Indian freedom fighters,

ICAR-CIFRI reached the remote villages of Sundarbans of West Bengal on 15 November 2022. On this occasion, Dr. B. K. Das, Director along with scientist, technical staff and research scholar organized a mass awareness - cum - input distribution programme at Palotghat, Kakdwip. On this day, Dr. Das distributed 750 kg fish seed, 15 tonnes fish feed and 3 tonnes lime to 150 number of tribal families. The overall programme was conceptualized and conducted by ICAR-CIFRI in collaboration of a local NGO named as Sagar Krishnanagar Swami Vivekananda Youth Cultural Society. In totality, the programme imbibed the local tribal fishermen with lots of motivation for scientific fish farming towards livelihood improvement.

The Scheduled Cast Sub-Plan (SCSP) has been implemented with an aim of developing skills through various capacity-building programs and improving the socioeconomic status of Scheduled Caste fishers by demonstrating fishery-related technology. The SCSP programme in the form of demonstration of pen culture and culture based fisheries in wetlands and reservoirs, ornamental fish culture, production enhancement from backyard ponds, capacity building and mass awareness campaign was benefited by more than 5000 beneficiaries from the state of West Bengal, Odisha, Jharkhand, Karnataka and Tamil Nadu.

Fish seed distribution in wetland

Pen culture and culture-based fisheries for enhancement of fish production in wetland

Culture based fisheries (CBF) along with in-situ seed raising through pen culture is one of the best options for development of floodplain wetland fisheries. ICAR-CIFRI is promoting this technology for uplifting the socio-economic status of the SC community by increasing the fish production. The pen culture technology and CBF was carried out in a participatory mode by involving the local SC fishers in the 11 wetlands of West Bengal. Fish feed and fish seed were provided to the adopted wetlands for fish seed raising. In Duma wetland, a pen culture demonstration and awareness program was conducted. Fish seed of 520 kg was stocked in six pens, including IMC and Grass carps for raising the fish seed to advanced fingerlings for CBF demonstration. With the active support of the cooperative society, ICAR-CIFRI has organized a Fish Harvest Mela where 250 kilograms of fish including IMCs and other indigenous fish was harvested on this occasion. Approximately 15 tons of fish was harvested over the course of two-month harvesting periods from the wetland. Six HDPE pen along with fish seed was provided to the fishers of Katiganga wetland, Murshidabad for in-situ fish seed raising in the wetland. A total of 125 kg of IMC fish seed with an average size of 2.5-3g were stocked in the captive nursery pond adjacent to Beledanga wetland. The fish seed were raised till they reached an average size of 20-30g before being released into the open wetland for CBF.

Reservoir fisheries management

ICAR-CIFRI is continuously providing technical assistance for reservoir fish production enhancement in different parts of the country. The institute is presently working on fisheries enhancement in 10 reservoirs in different states covering Jharkhand, Odisha, Karnataka and Tamil Nadu under SCSP programme since last few years. Demonstration of culture based fisheries with pen culture was going on since last few years in the adopted reservoirs. Seven FRP boats with outboard motors were distributed to the cooperative society of the reservoirs of Jharkhand namely Perkha, Bonda, Keredari, Ghaghra, Jarahiya, Kanke and Hatia. The demonstration of the motorised FRP boats was organised on each reservoirs. The FRP boat was efficiently used in monitoring fishing and fish culture activities in enclosure systems of the reservoirs. The Institute also gave technical

FRP boat with outboard motors operated in reservoir

Distribution of fishing nets

assistance for the fisheries management of Manchanbele reservoir in Ramanagara district, Karnataka and Poondi reservoir in Tiruvallur district, Tamil Nadu. Fishing nets were distributed to the SC beneficiaries in both the reservoirs.

Ornamental fish culture

Ornamental fish culture is an important option for generating extra income for women in the rural areas. Under SCSP program ICAR-CIFRI is extending support towards the establishment of ornamental fish culture units among the SC women of West Bengal, Jharkhand and Odisha. Awareness and hands-on training was given to the beneficiaries before initiating and establishing the ornamental fish culture unit.

The Institute developed an ornamental fish culture village by clustering 30 women beneficiaries under SCSP programme at Sargachi, West Bengal. The programme was carried out with the assistance of Dhanyaganga Krishi Vigyan Kendra, Sargachi to provide extra income to the rural women. Another cluster of ornamental fish culture comprising 50 women was developed in Kultali West Bengal. Each woman was provided with ornamental fish culture unit consisting of FRP tanks, aerator, heater, aquatic plant, medicines, feeds, covering nets, extension wire and ornamental fish. The Institute developed ornamental fish culture cluster in adopted villages of Nimpith with the help of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith by adopting 50 Scheduled caste women. The Institute distributed 50 units of FRP ornamental tanks with fish-feed, ornamental fish and other accessories to the SC women. The Institute also initiated ornamental fish culture in Darjeeling district of West Bengal under SCSP programme. Besides, need-based technical assistance and marketing support were also provided to ornamental fish culture cluster previously developed in West Bengal, Odisha and Jharkhand.

Distribution of ornamental fish culture units

Distribution of ornamental fish culture units

Fish production enhancement from backyard ponds in Sunderbans

The Institute developed the backyard pond fisheries in Sunderban area. Fisheries input including fish seed, fish feed, medicines and lime was distributed to 1000 people in Kultali, Sundarbans to provide extra income and nutritional security by utilizing their backyard ponds for fish production. The SC beneficiaries supported by the SCSP programme in the previous year were also revived in the sensitization programme, fish seed and fish feed were distributed for livelihood development through fisheries. Fishery inputs viz. fish fingerlings, fish feed, lime etc were distributed to 250 beneficiaries at Ganga Sagar towards livelihood development and empowering Sagar Islands fishers. ICAR-CIFRI is tirelessly extending need-based support to the rural distressed fish farmers of Sunderban by providing various technological inputs for rejuvenating their livelihood under the SCSP programs. The initiative of ICAR-CIFRI for fish production enhancement from back yard ponds was highly appreciated by the Hon'ble Minister In Charge, Department of Sundarban Affairs, Shri Bankim Chandra Hazra. He also

Distribution of fisheries inputs for backyard pond fish production enhancement

emphasized that the cyclone-prone Sunderban needs this type of intervention for their livelihood improvement

Capacity building of fishers

For capacity development of fishers two on-campus training programmes and three hands on training programmes were conducted by the institute under SCSP programme. Around 300 fishers were trained by the institute on fish production enhancement in inland water bodies, ornamental fish culture and pond management. Besides these, more than 1000 fisher were sensitized on inland fisheries development by conducting eight mass awareness programs and two stakeholder meetings.

Awarness and training programmes organised under SCSP programme

Conservation of pengba in Loktak lake of Manipur

Osteobrama belangeri (locally called pengba) is a near threatened medium carp endemic to Manipur of North East India, Myanmar and Yunan provinces of China. Towards conservation of this species, ICAR-CIFRI has taken initiatives through ranching of the seeds in the depleted stretches. In this regard, a mega ranching programmewas organized by the institute in collaboration with the Department of Fisheries (DoF), Manipur and the Loktak Development Authority (LDA) at the Loktak lake on 11 May, 2022 which was graced by the Hon'ble Chief Minister of Manipur Shri N. Biren Singh. Shri. Biren Singh Ji praised for the initiatives towards the conservation of state fish.

Exploration on the diversity of edible freshwater crabs and molluses in Mizoram

An exploration was initiated to document edible freshwater crabs in Aizwal district of Mizoram. During the survey three species namely *Maydeliathelphusa lugubris, M. falcidigitis* (locally called *aikam*) *and Sartoriana spinigera* (locally called *dumchakai*) having high market demand were recorded. In addition, three molluscan (snail) species namely *Paludomus conica, Brotia costula* (*chengkawl bial*), and *Melanoides proximate* (*chengkawl sawl*) were recorded in Tut River in Dapchhuah village (23°46'17" N and 92°31'18" E) of Mamit district. These records would help and catalogues the shellfish diversity in NE states.

Hilsa conservation and propagation through circular cage culture in river Ganga

An initiative of its first kind to develop captive hilsa brood stock was made through circular cages installed in river Ganga. Circular cages of 16 m diameter and 8 m depth were specifically designed for the hilsa was used. Total of 87 adult hilsa, with initial avg. weight of 275g and avg. length of 18.9 cm were stocked. Artificial feed was supplemented in addition to the available natural feed from the river. The preliminary results showed that acclimatisation of hilsa brooders plays critical role in deciding future hilsa aquaculture in captive conditions including cages.

Novel macrophyte-based floating pens for rearing high-value *Amblypharyngodon mola* along with major carps in Takmu Pat of Manipur, NE India

Fluctuation in water levels is common in natural water bodies like floodplain wetlands especially during the south-west monsoon season. Floating macrophyte mass, locally called *phumdi* in Manipur, was used to modify the floating pensto overcome the problem of pen submergence in collaboration with the local Meitei fishers' community. Six rectangular pens (individual dimension 25 m x 20 m) were constructed in Takmu Pat, Bishnupur district of Manipur using CIFRI HDPE nets supported with phumdis, ropes, bamboopoles and anchors. Phumdis present in the wetland was cut and used to form a floating rectangular structure on to which nets were fastened and suspended using plastic ropes. The height of the net wall was kept sufficient so that the structure can float up with the increase in water levels during rainy months. *Amblypharyngodon mola,* a locally preferred and high-value small indigenous fish (SIF), was stocked in the pens for monoculture or in combination with major carps *Ctenopharyngodon idella* (grass carp) and *Labeo rohita* (rohu). Initial length and weight of the stocked fish were: 0.5 g and 3.86 cm for mola, 206.7 g and 25.6 cm for grass carp and 61.9 g and 17.33 cm for rohu. After 5 months of culture, grass carp reaching marketable size of 2 kg or above was harvested. A total of 341 kg of fish was harvested and sold in the local market generating a revenue of Rs. 95,480/-. Final harvesting of the pens will be conducted in a period of two months.

State	Resource	Activity
Andhra Pradesh	Reservoir	• Interface meeting on "Encouraging fish culture technologies in large water bodies with special emphasis on enclosure culture in Andhra Pradesh" • Ecosystem health card for ecological management and fisheries enhancement of Nagarjunasagar reservoir (Andhra Pradesh and Telangana) • Ecosystem based fisheries management strategies in Upper Manair reservoir
	HRD	• Capacity building programme on tank based fish production model for 25 nos. DoF officials of Govt. of Andhra Pradesh
Arunachal Pradesh	River	• Planning and design of fish hatchery at Bichorn dam site along with studies on reproductive biology of snow trout, *Schizothorax richardsonii* for conservation and artificial propagation in River Bichom, Arunachal Pradesh
	Wetland	• Vulnerability assessment in Borbeel, Namsai district
Assam	River	• Estimation of fish landing and catch structure in river Barak
	Wetland	• Fish diversity in Mihi beel located in Kohora Range of the Kaziranga National Park • Ecology and fisheries of Dandua and 46-Morakolong in Morigaon district and Rupahi and Lakhanabanda beels in Nagaon district • Vulnerability of *Nandus nandus* in wetlands • Assessment of C-sequestration potential and GHG emission from 47-Morakolong, Jahuguti, Charan, Chatla,Urmal beels • Fish consumption pattern and socio economic status of beel fishers of Thekerabeel, Morigaon • Pen culture demonstration in 3 wetlands (i.e., Mer, Pani and NatunBolaiErasuti beels) of Dibrugarh district. • Pen culture demonstration in Maguri beel of Tinsukia district. • Distribution of CIFRI HDPE Pens in Kuhimari and Boruahghuli beels of Dhemaji District • Distribution of CIFRI CageGrow feed for pen culture in wetlands Barpeta, Morigaon, Dibrugarh, Dhemaji and Nagaon districts (24 beneficiaries) • Field day on 'Pen culture as a climate-resilient technology for beel fisheries enhancement' at 47-Morakolong beel, Morigaon district (no. of participants: 30) • World Wetland Day in Kamrup (Rural) district (no. of participants: 20) • Pen culture for livelihood improvement of tribal fishers in Charan, Bamuni, Urpad, Saren, Dhama beels of Assam • Assessed the effectiveness of stocking of Indian major and minor carps in 37 floodplain wetlands • Fish stock enhancement activities were carried out in 11 floodplain wetlands • Culture based fisheries for livelihood improvement of fishers in 4 beels
	HRD	• Orientation on Pradhan Mantri Matsya Sampada Yojanain Kamrup (Rural) district • Training programme on 'Ecosystem based integrated wetland management' in Guwahati • Skill development training program on 'Inland Fisheries Management' in Barpeta district • Training programme on 'Backyard ornamental fish farming for livelihood improvement and rural development' in South Salmara Mankachar • Users' meet on "Bio-sensors for aquatic ecosystem" in Guwahati • Interactive meeting on "Openwater fisheries development in Assam" in Guwahati • Training programme on fisheries and aquaculture in inland waterbodies of Assam • National campaign on "Non-conventional aquaculture systems" in Cachar district • National Fish Farmers' Day 2022 cum National campaign on "Emerging Aquaculture Systems and Practices" at Charan beel, Baksa district • Awareness programme on public participation at Deepor beel, Guwahati • Awareness camp on 'Sustainable production of climate-resilient nutri-fish from wetlands in Kamrup (Rural) district' • Awareness camp on 'Livelihood enhancement options in beel fisheries in Barpeta district' • Study on market trend of three endemic snakeheads of Northeast India • Capacity building on ecosystem modelling for management of inland fisheries for 22 nos. of officials from West Bengal, Assam, Jharkhand, Kerala

State	Resource	Activity
Bihar	River	• Estimation of fish landing and catch structure in Kosi • Assessment of fish and fisheries of the Ganga river system through NMCG programme • Breeding of wild fish germplasm and ranching in depleted stretches of river Ganga • Hilsa fisheries awareness and activities in Patna, Bhagalpur, Sahebganj
	Reservoir	• Exploratory survey and assessment of fish diversity in protected habitats -Nagi Bird sanctuary and Nakti bird sanctuary, Jamui district • Assessment of ecological and fisheries status of Jargo reservoir
	Wetland	• Exploratory survey on aquatic biodiversity in protected wetlands of KusheshwarAsthan Bird Sactuary, Darbhanga • Assessment of input cost and farm gate prices in wetland fisheries taking 10 wetlands • Assessment of ecology and fisheries of Manika, Simra and Bhusra wetlands
Delhi	HRD	• Capacity building on Inland Fisheries Management to 139 fishers/fish farmers of Katihar, Bhagalpur, Munger, Gopalganj and Sheikhpura districts • Exhibition stalls at KVK, Piprakothi, East Champaran
Chhattisgarh	River	• Estimation of fish landing and catch structure in Mahanadi
	Reservoir	• Investigation on status of fisheries in Kodar reservoir • Demonstration of pen culture in these five reservoirs of Chhatisgarh viz. Tawarenga, Kesavanala, Gej, Koserteda, • Matiamoti dam, Paralkot • Fish production enhancement in 10 reservoirs though distribution of pen, boat with engine and fish feed for the pen culture in the reservoir for in situ raising of fish seed • Penculture demonstration cum awareness programme at Taurenga, Gariabad reservoirs • Capacity building programme for Tribal Fishers
	HRD	• Capacity development of 29 fishers/ farmers on production enhancement of small reservoirs through pen culture
Goa	Estuary	• Assessment of the Mandovi-Zuari estuarine fishery resources
Gujarat	River	• Fish catch estimation of river Tapti • Assessment and spatial database for ecology, biodiversity, ecohydrology of river Narmada • Environmental flows for river ecology with focus on downstream fisheries of Sardar Sarovar Dam (SSD), in Narmada River • Study on impact of water intake due to Gadarwara STPP on Ecology of Narmada River
	Reservoir	• Assessment of ecology and fisheries of Panam reservoir • Cage culture activity in different reservoirs • Demonstrates 'CIFRI HDPE Pen Technology' at Dev Dam, Panchmahal, Gujrat
Haryana	River	• Eco-variability study of river Yamuna
Himachal Pradesh	Reservoir	• Assessment of ecology and fisheries and impact of stocking of Gobind Sagar reservoir • Exploratory survey on status of fish and fisheries of Koldam reservoir
Jharkhand	Reservoir	• Assessment of economic loss from diseases in cage culture • Efficacy of floating feed CIFRI-CAGEGROW was tested in a farmer's cage installed in Chandil reservoir • Fish disease investigations in Patratu, Tenughat, Chandil and Getulsud reservoirs • Assessment of fisheries potential, socio economic study of Patratu reservoir • Livelihood improvement programmes of fishers of Getalsud, Karanjiand Lotwathrough distribution of FRP boats to the cooperative societies • Grow-out culture of amur carp in cages at Maithon reservoir • Experiment with new design of pens at Maithon reservoir • Production enhancement through pen and feed distribution in 13 blocks of five districts • Livelihood support to fishers of Jharkhand cooperative societies (Schedule tribes) of the reservoirs namely Getalsud, Karanji and Lotwa • FRP boats with outboard motors were distributed and demonstrated to the cooperative society of Perkha, Bonda, Keredari, Ghaghra, Jarahiya, Kanke and Hatia reservoirs of Jharkhand

State	Resource	Activity
Jharkhand	Backyard ornamental fishery	• Empowering tribal women of Jharkhand through ornamental fish culture in Jamshedpur, Bokaro and Simdega districts • Women empowerment through ornamental fish culture in Simdega, East Singhbhum, Bokaro and Ranchi
	HRD	• Capacity development on inland ornamental fisheries management for income generation & livelihood enhancement of 25 fisher women • Training on inland fisheries management to 16 nos. M.Sc. Zoology *(Spl. Fish & Fisheries)* students of Vinoba Bhave University, Hazaribag • Training on inland fisheries management to 45 nos. M.Sc. Zoology *(Spl. Fish & Fisheries)* students of Binod Bihari Mahto Koyalanchal University, Dhanbad • Capacity building on ecosystem modelling for management of inland fisheries for 22 nos. of officials from West Bengal, Assam, Jharkhand, Kerala • Training of 25 tribal women from of East Shinghbhum, Jamshedpur and Ikti, Ranchi of on ornamental fish farming
Karnataka	River	• Investigation on genetic stock characterization of *Mystus cavasius* of River Cauvery
	Estuary	• Assessment of Netravati-Gurupur estuarine fishery resources for sustainable management
	Reservoir	• Tropho-dynamic modelling of Gayathri reservoir for ecosystem based fisheries management • Exploratory survey on status of fish and fisheries, including habitat characteristics and fish assemblage of Gayathri reservoir • Sensitization programme and distribution of fishing implements on "Reservoir Fisheries Management at Manchanbele reservoir, Ramanagara district, Karnataka under SC-SP programme • Participatory management for sustainable fisheries and biodiversity conservation, for fishermen/farmers at Kakolu village • Sensitization of inland fish farmers and fishers on the "Antimicrobial Resistance in Culture-based Fisheries" at Vanivilassagar and Gayathri reservoir • NFDB sponsored Skill development programme on "Reservoir fisheries management for employment generation" in Harangi and Manchanbele reservoirs
	HRD	• Mass awareness and pen culture demonstration in Harangi reservoir under TSP program • National Fish Farmers Day and National Campaign on Emerging Aquaculture Systems and Practices at Vanivilas Sagar Reservoir, Karnataka • Awareness programme on "Reservoir Fisheries Management for Sustainable Development" at Manchanabele reservoir, Ramanagara district
	Aquaculture	• Demonstration of Biofloc aquaculture, non-conventional aquaculture systems, for farmers of Singanayakanahalli village, Bangalore rural, Karnataka
Kerala	Fish Feed	• Demonstration on mass production of Black Soldier Fly for utilization as fish feed at Govt fish seed hatchery, Peechi, Kerala
	Estuary	• Temporal assessment of Vembanad estuarine fisheries resources
	Reservoir	• Dynamic modeling in Karapuzha reservoir to simulate the fisheries and fish catch in the reservoir on a time scale • Status on fisheries, fish assemblage structure and ecological status of Idukki reservoir • Established linkages with major stakeholders of Idukki reservoir for implementing fisheries enhancement practices

State	Resource	Activity
Kerala	Backwaters	• Demonstration of climate resilient culture based fishery of pearlspot (*Etroplus suratensis*) in Vembanad lake under SCSP programme • Estimation of vulnerability index of inland fishery of Vembanad lake • Distributed 6000 seeds of pearlspot (*Etroplus suratensis*) and 262 kg fish feed to fishermen of Ochanthuruth, Vypin for culture based fishery under NICRA-SCSP programme
	Wetland	• Study on impact of climate change and development of adaptation strategies in Vemanand lake • Pen culture activities in Thycauttuserry and Muhamma in the Alleppy district • Exploratory surveys in coastal backwaters for ecological assessment in relation to climate change • Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising in Vembanad lake
	HRD	• Capacity building on ecosystem modelling for management of inland fisheries for 22 nos. of officials from West Bengal, Assam, Jharkhand, Kerala • Awareness programme on 'emerging • aquaculture systems and practices' as alternative • livelihood options for fishers of Chulliyar and Meenkara • reservoirs, and fish farmers
Madhya Pradesh	River	• Fish catch estimation of river Tapti • Study of fisheries and socioeconomics of river Tapti • Studies in Ken river and associated water bodies around Panna National Park for ecology and fish diversity
	Wetland	• Resource assessment and pen culture in Loni wetland of Rewa district • Assessment of ecology and fisheries of Govindgarh, Devendra Nagar, Lokpal Sagar, and Man Sagar wetlands
	Reservoir	• Fish disease investigation in cage culture • Status of fish diversity, abundance and population dynamics of tilapia in Halali reservoir • Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar reservoir • Impact of fingerling stocking in enhancing fish yield in Indirasagar, Bansagar, Barna, Halali reservoirs
	HRD	• Exhibition stalls at Shahadol
Maharashtra	River	• Fish catch estimation of river Tapti • Investigation on habitat characterization, fisheries and socioeconomics of River Tapti
	Reservoir	• Disease investigations in Pench and Bor reservoirs • Assessment of economic loss from diseases in cage culture
	HRD	Capacity development on inland Fisheries Management of 6 nos. M. F. Sc (FRM) students of CIFE, Mumbai
Manipur	River	• Assessment of heavy metals and micro-plastics in Imphal and Nambul rivers
	Wetland	• Mega ranching-cum-mass awareness programme in Loktak lake in which 1 lakh fingerlings of Pengba (*Osteobrama belangeri*) were released. • Cage culture of *Ctenopharyngodon idella* (grass carp), *Labeo bata* and *Osteobrama belangeri* (pengba) in cages at Takmu lake, Bishnupur district • Distribution of 10 no. cage nets to the cage culturists of Loktak lake • Pen culture of the small indigenous fish *Amblypharyngodon mola* along with *C. idella* and *Labeo rohita* in HDPE pens in Takmu lake • Distribution of 5 no. CIFRI HDPE pens to fishers of Takmu lake, Bishnupur district • Distributed 5 tonnes CIFRI CageGrow feed to 50 pen culturists of Bishnupur District

State	Resource	Activity
Manipur	Reservoir	• Cage culture of common carp (*Cyprinus carpio*) in cages at different stocking densities in Mapithel reservoir. • Distribution of 10 no. cage nets to the cage culturists of Mapithel reservoir. • Distributed 5 tonnes CIFRI CageGrow feed to cage culturists of Kamjong District (40 beneficiaries). • Field day on the occasion of "Final fish harvest from cages at Mapithel Dam" in Kamjong district. • Assessment of fish and fisheries of the Mapithel dam • Provided inputs like pen, feeds, seed of Indian Major Carps to the societies of reservoirs Mapithel, Khoupum, Khuga, Khoupum, Khuga • Pen culture in demonstation in Khuga reservoir
	HRD	• Awareness programme on "Responsible fishing at Mapithel reservoir for sustainable fisheries" • Capacity development on reservoir fisheries management for production enhancement of 13 fishers • Training programme for the fishers of Mapithel Reservoir
Meghalaya	Reservoir	• Studies on ecology and fisheries and demonstration of cage culture in Umiam reservoir • Distribution of CIFRI CageGrow feed to cage culturists and fishers • Field Day on "Cage culture in reservoirs of Meghalaya" in Ri-Bhoi district • Interactive meeting on prospects of cage culture in Meghalaya at Umiam reservoir
	HRD	• Awareness-cum-feed distribution programme in Ri-Bhoi district • Brainstorming session on 'Fish production statistics in the state of Meghalaya' for fishery officials of the state at Shillong
Mizoram	Reservoir	• Assessment of ecology, fisheries and feasibility of cage culture in Serlui-B and Tuirial reservoirs, Kolasib district. • Fish diversity study inSerlui-B reservoir of Kolasib • Exploratory survey conducted in rivers of Mamit and Aizwal districts and recorded 6 edible and commercially important species of crabs and snails
Nagaland	HRD	• Awareness programme on cage culture in Doyangreservoir, Wokha district
	Reservoir	• Cage culture of Common carp (*Cyprinus carpio*), Pangas (*Pangasianodon hypophthalmus*) and Java puthi (*Barbonymus gonionotus*) in cages at different stocking densities in Doyang reservoir (in 10 cages) • CIFRI CageGrow feed distributed to cage culturists of Doyang Reservoir
Odisha	River	• Estimation of fish landing and catch structure in Mahanadi
	Estuary	• Study of ecohydrological dynamics in relation to fish fauna and their recruitment in Rushikulya estuary • Fish diversity study at selected stretches of river Brahmani and Baitarani estuarine complex (Bhitarkanika)
	Reservoir	• Fisheries and ecological status of Hirakud reservoir • Impact of stocking and effectiveness of CBF practices in Hirakud reservoir • Fish diversity and status of fisheries in Sunei and Kalo reservoirs of Mayurbhanj District • Impact assessment of stocking and effectiveness of CBF practices in Sunei reservoir • Assessment of ecology and fisheries and the trophic state index (TSI), fish production potential and impact of fish seed stocking on yield of Derjang, Salia, Kalo and Budhabudhiani reservoirs • Technical guidance on cage culture in Salia dam • Tribal Sub Plan activities with distribution of inputs, training to the fishers in Kalo reservoir • Circular cage installation in Hirakud reservoir • Cage culture and ecological assessment of Balimela reservoir • Demonstration of seed raising in pen in Salia and Kalo reservoirs • Demonstration of production enhancement in reservoirs of Kalo, Salia, Baghua • Training, awareness, installation and demonstration of pen culture in 67 reservoirs in 15 districts under World Fish project • Environmental & aquatic animal health monitoring in Hirakud reservoir

State	Resource	Activity
Odisha	Wetland	• Demonstration of culture based fisheries and pen culture in Keshpura wetland, Jaleswar • Vulnerability assessment and sensitization programme on climate change impact on the coastal wetland Astaranga (Puri, Odisha)
	Ornamental Fisheries	• Distribution of FRP tanks to SC women of Bhadrak for ornamental fish culture • Women empowerment through ornamentalfish culture in Bhubaneswar, Bhadrak
	HRD	• Exhibition stalls at Baleswar and Puri
Sikkim	River	• Impact of Rangit dam on fish diversity
Tamil Nadu	River	• Monitoring of pesticides and emerging contaminants in River Cauvery
	Reservoir	• Assessment of ecological and fisheries status in Poondi reservoir, Thiruvallur district • Ecosystem health card to restore and maintain the ecological balance of Mettur reservoir in Salem district • Ecosystem health card for pollution mitigation and ecosystem restoration in Krishnagiri reservoir, Krishnagiri district • Evaluation of impact of stocking in 62 reservoirs in Tamil Nadu • Demonstration of Electronic Data Acquisition System (eMatsya) at Chennai • Assessment of ecological and fisheries status in Mettur, Krishnagiri reservoirs • Technical assistance for the fisheries management and net distribution in Poondi reservoir
	HRD	• Sensitization programme on fisheries enhancement and distribution of fishing implements under SC-SP in Poondi reservoir, Thiruvallur district • NFDB sponsored Skill development programme on "Reservoir fisheries management for employment generation" in Mettur, Krishnagiri reservoirs
Telangana	Reservoir	• Assessment of economic loss from diseases in cage culture • Collaborative cage culture programme with DoF, Telangana • Fish disease investigation in Sriramasagar reservoir • Implementation of eMatsya for fish catch data collection • Dissemination of in situ fish seed rearing technology in cages and pens
Tripura	Reservoir	• Assessment of ecology and fisheries of Dumbur reservoir, Gomti and Dhalai districts. • Cage culture of grass carp (*Ctenopharyngodon idella*) in Dumbur reservoir
	HRD	• 3-days training programme on Cage culture technology for enhancing reservoir productivity in Dhalai district for officials of the Dept. of Fisheries, Govt. of Tripura and cage fishers of Dumbur reservoir • Awareness programme on 'Cage culture in reservoir for enhancing fish production' in Dhalai district • Fish health and disease management camps in West Tripura, South Tripura, Gomati, Khowai, Sipahijila districts of Tripura • Exhibiton stall at CoF, Lembucherra
Uttar Pradesh	River	• Assessment of ecology and fish and fisheries of river Ganga • Breeding of wild fish germplasm and ranching in depleted stretches of river Ganga • Eco-variability and impact study of river Yamuna on river Ganga including environmental parameters and fish diversity • Environmental flows for the river Ramganga
	Wetland	• The ecology and fisheries of the four wetlands in Uttar Pradesh viz. Kitaman (Kushinagar), Jatiya, Bakwa, and Ramgarh (Gorakhpur) tals
	Protected Area	• Documentation of aquatic assets in Dudhwa National Park of Lakhimpur Kheri distict and Parvati Arga Bird Sanctuary of Gonda District of Uttar Pradesh (involving wetlands of Arga, Parvati, Majihar and Jainagra)

State	Resource	Activity
Uttarakhand	River	• Study of fisheries of Ganga under NMCG • Eco-variability and impact study of river Yamuna on river Ganga • Breeding of wild fish germplasm and ranching in depleted stretches of river Ganga • Survey of Fish diversity in Goriganga River in Munsiyari, Pithoragadh district of Uttrakhand for Uttarakhand Jal Vidyut Nigam Ltd.
	HRD	• Exhibition stalls at Pantnagar and Bhimtal • Mass awareness during ranching in the Ganga river
West Bengal	River	• Investigation on emerging contaminants in river Torsa and Teesta • Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan • Breeding of wild fish germplasm and ranching in depleted stretches of river Ganga • Hilsa fisheries ranching and awareness and activities under NMCG • Investigation on fish diversity in river Torsa (Jaldapara stretch) • Ranching of hilsa at Farakka • Dolphin awareness programme among fishers in river Ganga • Microbiome metatranscriptomics assessment of Ganga river basins for ecosystem health monitoring
	Estuary	• Fish and shellfish assemblage study in relation to ecological variability at Hooghly-Matlah estuary • Study of environmental parameters, mangroves and other biota at Jharkhali, Dhamakhali and Patharpratima stations of Indian Sundarbans • Input distribution programme among tribal fishers of Rangabelia village under Gosaba block, Sundarban • Celebration of Tribal Pride Day at Sagar islands • Distribution of fisheries input including fish seed, fish feed, medicines and lime for the backyard pond fisheries in Sunderban in Kultali, Sundarbans under the SCSP
	Pond	• Study of arsenic contamination in nine ponds and six wetlands of North 24-Parganas district • Screening for selected pathogens for antibiotic resistance in fish culture farms • Input distribution, capacity building programmes in Gosaba, Sagar Islands, PalotGhat of Sundarbans • Antimicrobial Resistance surveillance in 128 freshwater farms of Burdwan, North 24 Parganas, Hooghly, East Midnapore and Howrah districts • Antimicrobial awareness week was celebrated at Chandannagore, Hooghly • Rearing of hilsa in the ponds of river-water at Kolaghat, West Bengal • Provision of inputs for alternative livelihood options for tribal women of Malda
	Reservoir	• Exploratory survey in five small reservoirs of Purulia district, viz. Beko, Futiyari, Paltoi, Loharshol and Murguma to assess the ecology and fisheries potential
	Ornamental fish units	• Developed ornamental fish culture villages by clustering 30 women beneficiaries under SCSP programme at Sargachi, Nimpith, Darjeeling and Kultali • Ornamental fish exploratory survey • Sensitization of SC women and distribution of FRP tanks and ornamental fish seed in Amtoli and Kachukhali in Indian Sunderban and Khalsi wetland • Women empowerment through ornamentalfish culture in Amtoli and Kultali of Sundarbans

State	Resource	Activity
West Bengal	Wetland	• Demonstration of Climate Resilient Culture based Systems of small indigenous fishes (SIF) along with Indian major carps in Media beel • Stock enhancement of Chand beel of Nadia district by stocking Indigenous carps like *Labeo bata, Systomus sarana* and IMC. • Exploratory survey and stakeholder vulnerability assessment at four estuarine/coastal sites (Sahidpur, Kulti, Diamond harbor, Madanganj, Bhetua and Harwa) • Carbon sequestration and reproductive vulnerability studies in Katiganga, Motijhil, Paharpur, Bhandardaha of Murshidabad district • Exploration of temporal variations in abundance of key fish species like *Macrognathus aral* in Gangetic floodplain wetlands for assessing their conservation priority • Study of the emerging contaminants in East Kolkata Wetlands • Exploratory surveys in four floodplain wetlands for ecological assessment in relation to climate change • Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising in Mathura and Bhomra beels • Arsenic contamination in Khalsi and Chandania beels and Arsenic contamination in surface water and its accumulation in fishes in Daulatpur and Meena villages of Habra-II block of North 24 Parganas district • Monitoring of arsenic and other heavy metals in drinking water unit and in Media beel • Disease investigation in Khalsi, East Kolkata and Moyna wetlands • AMR exploratory survey • Assessment of fisheries potential at Nayachara, Sahebganj, Katiganga, Bishnupur wetlands • Climate resilient pen system and vulnerability assessment, trophic status studies on Mathura and Bhomra beel • Demonstration of culture based fisheries and seed raising of fish seed in pen in Beldanga, Chamardaha, Duma, Sindrani and Chamta wetlands • National campaign on antimicrobial resistance in fish for fishers of East Kolkata wetland • Monitoring aquatic environmental pollutants in water, sediment and biota of sewage fed East Kolkata wetalnds (Borochoinavi and Bheri no. 4) and freshwater wetlands (Borti beel and Raja beel). • Monitoring of heavy metals in Bheri No. 4, Borochoinavi beel and Borti beel • Carbon sequestration and green house gas (GHGs) emission study in Khalsi and Bhomra beel • Assessment of ecology and fisheries of the five wetlands viz. Rampara, Chhar, Beloon, Daserchak and Magradaha of Murshidabad, West Bengal • Metagenomic profiling of Sardar Bherry (East Kolkata wetland) • Microbial diversity and pollution status of Mirik Lake • Socio-economics of fishers of Sagar Island • Pen culture demonstration to popularize the climate resilient species and study on nutritional security of fishers in the Duma wetland. Provided seed and feed • Developed food web of Beledanga wetland • Mapping of wetlands associated with Ganga River • Vulnerability of *Nandus nandus* in wetlands • Time series analysis on climatic and environmental parameters in 67 wetlands in the Indo-Gangetic plain • Assessment of ecosystem services and Stakeholder driven vulnerability assessment in 15 wetlands from 3 districts of West Bengal • Surveillance has been conducted in the farmers' field of East Medinipur, Howrah, South 24 Parganas district of West Bengal for diseases • Upscaling of the socio-economics of tribal women of villages under Habibpur Gram Panchayet of Malda District through ornamental fish farming • The pen culture technology and CBF was carried out in the 11 wetlands under SCSP • HDPE pen, fish seed was provided to the fishers of Katiganga wetland, Murshidabad for in-situ fish seed raising in the wetland • Fish seed stocking in the captive nursery pond adjacent to Beledanga wetland • Fishers' Field School at Khalsi Beel, Haringhata, Nadia

State	Resource	Activity
West Bengal	HRD	• Capacity building on 'Inland fisheries management with special reference to Hill fisheries development' to farmers / farmers from Mirik, West Bengal • Capacity building on 'Inland fisheries management for livelihood improvement' fishers/ farmers from rural populace of Sundarbans • Capacity building programme on 'Inland fisheries management' of 23 nos. final year B. F. Sc. students of The Neotia University, West Bengal • Capacity development on advanced methodological approach on benthos in the inland open waters to 18 nos. students from Kerala and West Bengal • Capacity building on ecosystem modelling for management of inland fisheries for 22 nos. of officials from West Bengal, Assam, Jharkhand, Kerala • Exhibition stalls at Chotojagulia, Kultoli, CIFRI, Barrackpore • Stakeholder meeting cum awareness program on pen culture technology for integrated wetland management at Beledanga beel and at Chamta beel • Awareness campaign on "Climate-resilient inland fisheries'at Media and Panchpota wetlands

Demonstration of cage culture of common carp in reservoirs of Manipur, Meghalaya and Tripura

The Institute demonstrated cage culture of *Cyprinus carpio* (common carp) in Umiam (Meghalaya), Mapithel (Manipur) and Dumbur (Tripura) reservoirs of Northeast India. In Umiam reservoir, common carp in combination with *Barbonymous gonionotus* (silver barb) and *Labeo rohita* (rohu) in 60:20:20 ratio showed superior growth with total fish production of 5.6 kg/m^3 in 6 months culture period. Cage culture of common carp for production of table fish was demonstrated in Mapithel reservoir in different stocking densities. A stocking density of 30 fish/m^3 was found to be optimum for culturing common carp. Marketable size of the fish (250-300 g individual weight) was achieved in 5 months culture period with production ranging from 3-8 kg/m^3. Demonstration of cage culture of common carp was also carried out in Dumbur reservoir. A total of 20,000 fingerlings were stocked in the cage at a stocking density of 30 fish/m^3 and reared for one year. Fish production in the cage was estimated at 10.7-11.9 kg/m^3.

Cage culture of *C. carpio* in Umiam (Meghalaya)

Stocking programme at Mapithel reservoir

Cage culture of common carp in Dumbur reservoir

Demonstration of culture-based fisheries in wetlands of Assam

ICAR-CIFRI Regional Centre, Guwahati demonstrated culture-based fisheries in Bamuni and Charan beels of Assam. Fingerlings rearing was carried out *in-situ* in pens erected in the beels. Advanced fingerlings raised was then released to the beel for further growth. Rohu was raised in Bamuni beel and mrigal in Charan beel. Successful implementation of pen culture and CBF in Bamuni and Charan beels led to 117% and 64% increase in total

Culture-based fisheries in Bamuni beel

Penculture demonstration at Taurenga Reservoir, Chhattisgarh

Climate resilient pen systems in Media beel, West Bengal

fish production and 153% and 106% increase in net annual income of fishers respectively.

Demonstration of penculture at Taurenga, Gariaband, Chhattisgarh

ICAR-CIFRI has taken initiatives to uplift the socio-economic status of the tribal populace of Chhattisgarh by joining the hands with Department of Fisheries, Chhattisgarh.

ICAR-CIFRI organized a Penculture demonstration programme in collaboration with DOF, Chhattisgarh at Taurenga Reservoir on 13th May 2022 with the objective to raise in situ fingerling in the pen for enhancing the production of the reservoir in a cost effective way.

Demonstration of climate resilient fisheries (CRF) at Panchpota and Media wetlands, West Bengal

The institute has undertaken Climate resilient pen systems in wetlands of West Bengal, Assam and Kerala for farming of fish and shellfish and conservation of SIFs. The climate resilient pen systems (CRPS) and cage system (CRCS) have high tensile strength HDPE net material, provision to withstand flood, wind action and is used for culturing resilient indigenous species. Stocking of climate resilient indigenous fish species are encouraged in pen and cages to adapt to changing climate.

Demonstration of Pearl spot (*Etroplus suratensis*) culture based fishery (CBF) in Vembanad lake, Kerala

The aim of the demonstration programme was to improve the adaptability of the climate resilient technology and to boost fish production. About 6,000 seeds of

climate resilient fish species viz. *Etroplus suratensis* and *Liza* sp. were stocked and reared in the climate resilient culture-based fisheries (CRCBF) pond and harvested on 30th September 2022. This multi species stocking system using *E. suratensis* and *Liza* sp. ensured complete utilization of the niche of the ecosystem. Nearly 60 kg of climate resilient species and 22 kg of minor fish varieties worth ₹ 37,000 were harvested from the CRCBF technology of which *E. suratensis* earned an amount of ₹30,000 alone.

Culture based fishery in Vembanad lake, Kerala

Demonstration of Pen technology in Dev Dam and Ukai Reservoir, Gujarat

The Vadodara research station demonstrated the CIFRI HDPE pen installation in a small reservoir named Dev dam and a large reservoir in Ukai, Gujarat for the purpose of rearing fingerlings of Indian major carps for stocking in the reservoir. The fishers were made familiar with method of pen installation and stocking of fish seeds in pen.

CIFRI HDPE pen installation in Ukai, Gujarat

Demonstration of "CIFRI ARGCURE" for argulosis control in cultured fishes

The institute has developed a nano formulation of antiparasitic molecule (CIFRI ARGCURE) for effective control of argulosis in freshwater cultured fishes. "CIFRI ARGCURE" was tested in freshwater cultured fishes of Odisha, West Bengal and Bihar. The recommended dose of 40-80 ml/acre-m water depth have been found effective with application of second dose of same quantity after 5-7 days, if not eradicated. The application performance of the developed formulation was found better than conventional antiparasitic formulations with their highly variables dose (≥ 100 ml/acre-m) and application frequencies.

Farmers' Training Conducted

Sl. No.	Name of the training	Date	Venue	No. of participants
1.	Orientation on Pradhan Mantri Matsya Sampada Yojana (PMMSY)	09 February, 2022	Hiragota-Rowmari-Dighali beel, Kamrup (R), Assam	50
2.	Ecosystem based integrated wetland management (Online)	15 February, 2022	ICAR-CIFRI Regional Centre, Guwahati	97
3.	Inland Fisheries Management, Katihar district, Bihar	15-21 February,2022	ICAR-CIFRI Barrackpore	30
4.	Skill development training program on Inland Fisheries Management	16-18 February,2022	Borkona beel, Barpeta, Assam	50
5.	Cage culture technology for enhancing reservoir productivity	15-17 February,2022	SF Office, Gandacherra, Tripura	60
6.	Inland fisheries management with special reference to Hill fisheries development, Mirik, West Bengal	22-26 February, 2022	ICAR-CIFRI Barrackpore	30
7.	Inland Fisheries Management, Bhagalpur district, Bihar	25-03 March,2022	ICAR-CIFRI Barrackpore	30
8.	InlandFisheries Management, Munger district, Bihar	08-14 March,2022	ICAR-CIFRI Barrackpore	30
9.	Inland Fisheries Management, Gopalganj district, Bihar	19-25 March,2022	ICAR-CIFRI Barrackpore	19
10.	Backyard ornamental fish farming for livelihood improvement and rural development	28-30March, 2022	South Salmara Mankachar, Asssam	30
11.	Inland Fisheries Management, Sheikhpura district, Bihar	31-06April,2022	ICAR-CIFRI Barrackpore	30
12.	Production enhancement in small reservoirs through pen culture, Chhattisgarh	24-27 May,2022	ICAR-CIFRI Barrackpore	29
13.	Inland ornamental fisheries management for income generation & livelihood enhancement, Jharkhand	30-03June,2022	ICAR-CIFRI Barrackpore	25
14.	Reservoir Fisheries Management for Production Enhancement, Manipur	22-28 June,2022	ICAR-CIFRI Barrackpore	13
15.	Inland Fisheries Management for Livelihood Improvement of Rural Populace of Sundarbans, West Bengal	05-08 September,2022	ICAR-CIFRI Barrackpore	24
16.	Demonstration and Harvest-mela of CRCBF (Climate Resilient Culture based fishery) (under NICRA and SCSP programme)	30 September, 2022	Ochanthuruthu, Vypin, Kochi	5
17.	Fisheries and aquaculture in inland waterbodies of Assam	24-26 November,2022	ICAR-CIFRI Regional Centre, Guwahati	15

Students' Training Conducted

Sl. No.	Title of the training programme	Date	Venue	No. of participants
1.	Inland Fisheries Management	16-22 June,2022	ICAR-CIFRI Barrackpore	16 (M.Sc. Zoology *(Spl. Fish & Fisheries)* students of Vinoba Bhave University, Hazaribag, Jharkhand)
2.	Inland Fisheries management	26-01 September,2022	ICAR-CIFRI Barrackpore	23 (Final year B.F.Sc. students of The Neotia University, West Bengal)
3.	Inland Fisheries Management	09-16 November,2022	ICAR-CIFRI Barrackpore	45 (M.Sc. Zoology (Spl Fish and Fisheries) students from Binod Bihari Mahto Koyalanchal University, Dhanbad)
4.	Inland Fisheries Management	06-20 November,2022	ICAR-CIFRI Barrackpore	6 (M.F.Sc (FRM) students of CIFE, Mumbai)
5.	Advanced methodological approach on benthos in the inland open waters	27-29 December,2022	ICAR-CIFRI Barrackpore	18 (Kerala and West Bengal)

Official's Training Conducted

Sl. No.	Name of the training	Date	Venue	No. of Participants
01.	Ecosystem modelling towards management of Inland Fisheries	27-02 August,2022	ICAR-CIFRI Barrackpore	22 (West Bengal, Assam, Jharkhand, Kerala)
02.	Tank based fish production model	20-24 September, 2022	ICAR-CIFRI Barrackpore	25 (DoF officials of Govt. of Andhra Pradesh)

Online Training, Awareness and Capacity Building Programme sponsored by NFDB

Sl. No.	Name of the training	Date	No. of Participants	Venue
1.	Webinar on "Sustainable Reservoir Fisheries Management Towards Income Generation" (Training)	14 February,2022	100	Bangalore
2.	Webinar on "Ecosystem-based Integrated Wetland Management for Doubling Farmers" (awareness)	15 February,2022	97	Guwahati
3.	Webinar on "Impact of anthropogenic interferences in river ecosystem and fisheries" (awareness)	17 February,2022	100	Barrackpore
4.	Webinar on "Sustainable reservoir fisheries for employment generation" (ToT)	22 February,2022	200	Barrackpore
5.	Webinar on "Wetland Fisheries Management Towards Livelihood Improvement" (awareness)	25 February,2022	112	Barrackpore

Exposure / Educational Visits

Sl. No.	Particulars of visitors	Date of visit	Venue
1.	26 students from Dept. of Zoology, Kalyani University	14 March, 2022	Barrackpore
2.	Hemnandan Bahuguna Inter College visited the ICAR-CIFRI Prayagraj	14-15 March, 2022	Prayagraj
3.	28 students from CoF, Gumla, Jharkhand	06 April, 2022	Barrackpore
4.	23 B.F.Sc. students from CoF, AAU, RAHA, Assam	25 April, 2022	Barrackpore
5.	48 students from Bhubaneswar, Odisha (48 students)	17 May, 2022	Barrackpore
6.	6 M.Sc. Zoology students from Raiganj University	26 May, 2022	Barrackpore
7.	14 M.Sc. Zoology students from Hooghly Mohsin College	02 June, 2022	Barrackpore
8.	25 Students from CoF, Gumla	22 September, 2022	Barrackpore
9.	Two fishers and President, Raichur District Fisheries Co. Operative Society, Okkutta, Raichur	13 October, 2022	Bangalore
10.	27 students from BKC college	03 November, 2022	Barrackpore
11.	9 students from Zoology Dept, D.M. College, Imphal	03 November, 2022	Barrackpore
12.	B.Sc./ Masters students from Nehru Gram Bharti University (Deemed to be University), Prayagraj	16 December, 2022	Prayagraj
13.	33 nos. 4th year B.F.Sc. students from CoF, RPCAU, Dholi, Bihar	20 December, 2022	Barrackpore
14.	16 nos. B.Sc. Zoology Hons. 1st year students of Bethun College, Kolkata	20 December, 2022	Barrackpore
15.	29 nos. 4th year B.F.Sc students from the CoF, Udgir, Latur, Maharashtra	21 December, 2022	Barrackpore

Participations in Exhibitions/Mela

Sl. No.	Name of the Exhibition	Date	Venue
1.	Manomohan Mela o Loko Sanskriti Utsav	20 February, 2022	Chotojagulia, WB
2.	Kultoli Krishi o Sanskriti MeLA, WB	28 February, 2022	Kultoli, WB
3.	Smart Aqua Expo India 2022	04-05 March,2022	Baleswar, Odisha
4.	The first Indian Fisheries Outlook-2022	22-24 March,2022	CIFRI, Barrackpore, WB
5.	Pashu Aryogya Mela organized by Dr.RPCAU, Pusa, Bihar	15-17 April,2022	KVK, Piprakothi, East Champaran, Bihar
6.	National Seminar on "Contemporary issues in fisheries and aquaculture" organized by CoF, GBPUAT, Pantnagar, Uttarakhand	19-20 May,2022	Pantnagar, Uttarakhand
7.	13th Krishi Fair- 2022 organized by Shrikshetra Soochana	20-24 June,2022	Puri, Odisha
8.	33rd AICZ and National Seminar on "Emerging Trends in Biological Science in the Light of Environmental Degradation and Life Sustainability" organized by the Dept. Of Zoology, Pandit S. N. Shukla University, Shahdol, MP	10-12 August,2022	Shahadol, MP
9.	National Symposium on Fisheries and aquaculture for livelihood and nutritional security organized by ICAR-DCFR in association with CFSI, Bhimtal, Uttarakhand	18-19 November,2022	Bhimtal, Uttarakhand
10.	37th Manomohan Mela o Lokosanskriti Utsav organized by Srijani Sanstha	11-18 December,2022	Chotojagulia, North 24 PGS, West Bengal
11.	International conference on Responsible Aquaculture and Sustainable Fisheries Interact (RASHI) organized by CoF, Tripura in collaboration with COFLAA and NESFA	13-16 December,2022	CoF, Lembucherra, Tripura

Interface meeting with fishery officials of Andhra Pradesh

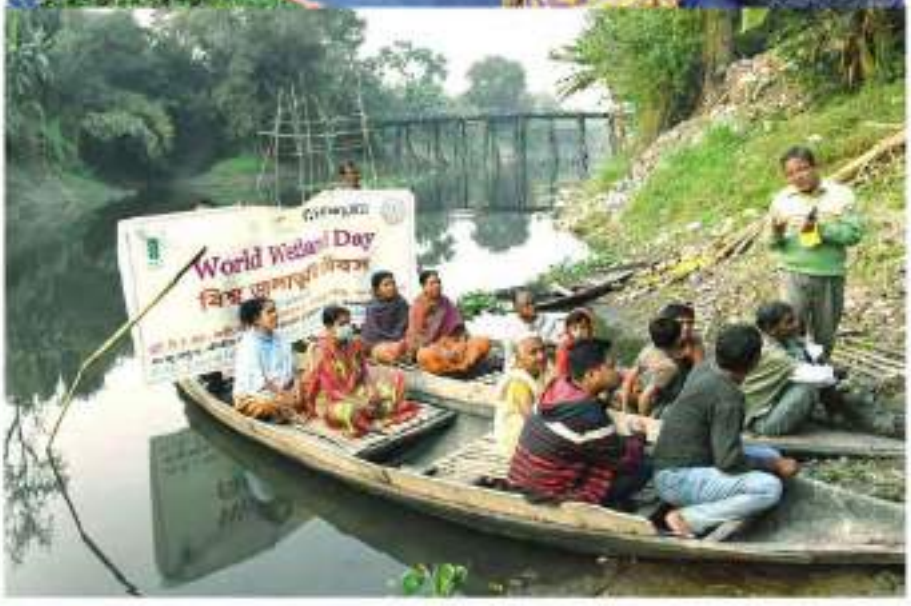
Dr. Poonam Malakondaiah, IAS, Special Chief Secretary, Agriculture and Cooperation, AHDD & Fisheries, Govt of Andhra Pradeshalong with Shri K. Kanna Babu, IAS, Commissioner of Fisheries, Govt of Andhra Pradesh visited ICAR-CIFRI on 08 January, 2022. An interface meeting on 'Encouraging Fish Culture Technologies in Large Waterbodies with Special Emphasis on Enclosure Culture in Andhra Pradesh' was held. The Special Chief Secretary pointed out the major areas of concern for fisheries in Andhra Pradesh.The Commissioner stressed on the partnership with CIFRI for promoting cage culture in reservoirs of Andhra Pradesh. Dr. B. K. Das, in his presentation, focused on the importance of cage culture and production enhancement programmes as well as thepotential of Indian reservoirs. He explained the guidelines for cage culture andinstallation procedures in reservoirs and also discussed the CIFRI GI cage, CIFRI Cagegrow feed and CIFRI Pen HDPE.

National girl child day

ICAR-CIFRI has celebrated National Girl Child Day on 24 January2022. The day has been created by the Ministry of Women and Child Development to make awareness on gender-based discrimination in society and to bring about a change in behaviour towards girls in this male-preferred world. ICAR-CIFRI has prepared a beautiful collage of the photographs and has also felicitated six young achievers of extended CIFRI family.

Republic Day

The 73rd Republic Day was observed on 26 January, 2022at ICAR-CIFRI with great enthusiasm and joy. Dr. B. K. Das, Director hoisted the National Flag and addressed the staff. He



emphasized that the Institute progressed in spite of difficulties and limited resources during that COVID period. He praised the staff members for their untiring and sincere efforts as well as encouraged all to work hard to keep the Institute's success on the higher note. Cultural programme was also organized on the occasion. On this special Day, the Institute awarded the best scientific, technical, administrative, skilled support staff and research scholars.

World wetland day

World wetland day was fervently observed by the institute at Bortibeel, N 24 Parganas district of West Bengal under the theme 'Wetlands action for people and nature'. A total of 60 stakeholders took active part. Dr B K Das, Director, CIFRI urged all the stake holders for wise-use of wetland towards societal benefits. Dr. U K Sarkar, Head, RWF Division, Dr. A. K. Das, In-charge, Training & Extension Unit addressed the gathering. The Guwahati Regional Centre of the Institute celebrated this day at Garjan-Bullutjanbeel, Kamrup district, Assam in collaboration with the Assam Fisheries Development Corporation (AFDC) Ltd. Dr. B.K. Bhattacharjya, Head, discussed the importance of wetlands, their valuation, management, restoration

and need for caring these precious water resources. Mr. Himanshu Bora, Manager, AFDC Ltd. was also present on the occasion.

Interactive meeting with the fishery officials of Meghalaya

Mr. S.P. Ahammed, IAS, Principal Secretary to Govt. of Meghalaya (Fisheries) visited the cage culture site in Umiam reservoir on 03 February 2022 along with the Smt. A.L. Mawlong, MCS, Director (Fisheries); Mr. Paul Tariang, Superintendent of Fisheries, Ri-Bhoi district and other fisheries officials of Meghalaya. On this occasion, an interactive meeting on prospects of cage culture in Meghalaya' was organized at the cage culture site at UmniuhKhwan village. Scientists and technical personnel of the ICAR-CIFRI Guwahati regional centre and NE Centre of NFDB participated in the interactive programme. The programme was also attended by the local tribal fishers and farmers (including 18 women) under the Ri-Bhoi Farmers' Union.

Workshop on "Inland fisheries in India and the creation of capacity in the collection and analysis of Inland Fisheries Statistics"

This FAO & ICAR-CIFRI workshop was organized on 08 February 2022 for discussion on inland fisheries documentation strategies and to provide critical review and expert opinion on the first draft report on 'comprehensive document on inland fisheries resources of India'. Dr. V. V.Sugunan, Senior Expert, FAO-CIFRI project, Dr. B. K. Das, Director, Dr. JohnValbo-Jorgensen, Fisheries Resource officer (inland fisheries) of FAO, Dr. Ferge-Smith Simon, FAO representative, Dr. M. V. Gupta, World food Laurette, Representative of NFDB, Fisheries departments of Andhra Pradesh, Tripura, Assam, Chhattisgarh, Madhya Pradesh, Mizoram and ICAR-CIFRI scientists were present in the meeting. The participants provided critical input and expert opinion on the draft report.

Webinar on "Impact of anthropogenic interferences in river ecosystem and fisheries"

The institute organized this webinar sponsored by National Fisheries Development Board (NFDB), Hyderabad on 17 February 2022. Dr. B.K. Das stressed on the present fish diversity in river Ganga and major activities undertaken by ICAR-CIFRI towards fish species conservation and restoration. Dr. S. Karketta, Advisor, MoEFCC, Dr. N.N Rai, Director, CWC, Dr. Sandeep Kumar Behera, Biodiversity consultant, NMCG, Dr. Hemant Bherwani, Scientist NEERI, Dr. S. Samanta, Head, REF Division of ICAR-CIFRI delivered lectures on the occasion. More than 100 persons, includingofficials from State Fisheries Department, researchers from various colleges and universitiesparticipated in the programme.

Fishers field school for ecosystem-based integrated wetland management

The institute organized Fisher Field School at Khalsibeel, Haringhata, Nadia West Bengal under a DBT scheme to promote ecosystem-based integrated wetland management on 18 February 2022. The Fisher Field School is based on the principle of Farmer Field School Approach of FAO, which is a group-based adult learning process. Forty women beneficiaries from fishermen community were selected for two interactive learning schools. Components like Pen culture, Culture Based Fisheries, Ornamental Fish Culture, Backyard poultry farming, Kitchen gardening and Mushroom cultivation have been discussed for economic empowerment of the fishermen community. A multidisciplinary team of scientists was constituted to establish Fisher Field School at the beel area. The team was led by Dr. Aparna Roy, which also includes researches from BCKV.

Annual sports

The institute organized the annual sportsduring 16-17 February 2022 at Barrackpore Head Quarters. The event was inaugurated by Dr. B.K. Das, Director. He encouraged all the staff including contractual and research scholar to involve in sports events with true sportsman spirit and develop kinship among others. Various sports like tug of war, 100 m race, badminton, chess, TT and other outdoor sports events (athletics) were conducted for both the men's and women's participants including team events like cricket, volleyball, etc.

Interface meeting among farmers, planners and researchers, West Bengal

The institute in collaboration with the Sundarban Dreams (NGO) hosted an interface meet for 24 Farmers Producers Organizations of 8 districts (Nadia, Malda, Murshidabad, Birbhum, Burdwan, North 24 Parganas, South 24 Parganas, Darjeeling) and 20 hill fishers from Darjeeling of West Bengal and 30 farmers from Bihar on 26 February, 2022 at institute HQs, Barrackpore. A total of 125 stakeholders participated in this interface meeting. The key discussions were made for their livelihoods, governance pattern and net economic returns from the agricultural practices including fisheries. Dr. M. V. Rao, Additional Chief Secretary, Govt. of West Bengal addressed the gathering through online mode. The occasion was graced by Shri Santhosha Gubbi, IFS, Additional Secretary, Panchayat & Rural Development Department, Shri S Jones Justin, Deputy Field Director, Sundarban Tiger Reserve, Shri S. Niyogi, DGM, West Bengal State Corporative Bank Limited, Shri Radhakrishna Mondal, Asst. Director, Department of Consumer Affairs, Government of West Bengal and Dr. B. K. Das, Director, ICAR-CIFRI. On this occasion eleven farmers from various parts of the West Bengal were felicitated for their outstanding contribution in agriculture and allied sectors.

International women's day

The institute organized a seminar on hybrid mode to celebrate the occasion of International Women's Day on 08 March 2022 on the theme of "Gender Equity for a Sustainable Tomorrow: Special Reference to Inland Fisheries". Dr. B. K. Das, Director highlighted the role of fisherwomen in the inland fisheries. He also mentioned about CIFRI's role in empowerment of women in the form of encouraging their involvement in canal fisheries or fisheries based in

rain-fed pond and also through SHGs. Dr. Vijaya Lakshmi Saxena, President, Indian Science Congress Association, graced the programme and Chief Guest. Prof. Baskaram Manimaran, Former VC, TN Dr. Jaylalitha Fisheries University and Chairman RAC, Dr. S. K. Jain, Member RAC was also present.Dr. (Smt.) Leela Edwin Director (Acting) ICAR-Central Institute of Fisheries Technology and Prof. Suhrita Chakrabarty (Das), Professor and HOD, Bidhan Chandra Krishi Viswavidyalaya delivered lectures. A total of 114 participants participated in online or offline mode.

Research Advisory Committee (RAC) Meeting

The Research Advisory Committee meeting of ICAR-CIFRI was held during 08-09 March 2022 through hybrid mode. The Chairman Prof. (Dr.) Baskaran Manimaran and Members of RAC, Dr. Sharad Kumar Jain and Dr. B. P. Mohanty attended the meeting physically while Dr. K.G. Padmakumar, and Dr. S. C. Pathak participated in the meeting through online mode. Dr. B. K. Das, Director appraised about the various research and developmental activities of the Institute highlighting new research initiatives, research achievements, outreach programmes, technologies and products developed, high impact publications and infrastructure development. Chairman, Prof Manimaran appreciated the achievements of the institute. He urged the scientists of the Institute to play pivotal role in providing technical guidance and management plans in the context of increasing focus on inland fisheries for production enhancement and to prioritise the research activities in the context of emerging challenges. Heads of Divisions, Heads/ In-charges of the Regional Centres presented achievements made under different institute projects and other activities at their respective Divisions/Centres. The Chairman and Members made remarks with critical reviews and suggestions towards research activities and made recommendations of RAC.

Platinum jubilee lecture series #4

The Institute organized the fourth lecture of the series by Prof. Bhaskaran Manimaran, Former Vice Chancellor of Tamil Nadu Dr. J Jaylalithaa Fisheries University, Nagapattinamon 9 March, in a hybrid mode. He delivered his lecture on 'Productivity enhancement in open water fisheries development: Strategies for improved ecological and carbon foot prints'. More than 146 persons participated in the lecture session.

National campaign on diversification in aquaculture

To commemorate India @75, ICAR-CMFRI jointly with other ICAR fishery institutes viz. CIFRI, CIFE, CIFT, CIFA, CIBA, NBFGR and DCFR organized a webinar as a part of National Campaign on Diversification in Aquaculture on 10 March, 2022. A series of three lectures was delivered by the eminent researchers across the globe. Dr. Krishna R. Salin, School of Environment, Resources and Development (SERD), Asian Institute of Technology (AIT), Thailand on "Aquaculture system diversification: Successful examples from Asia" was the first lecture. The second lecture was on "Towards Industrial Microalgae production for food and feed application" by Prof. (Dr.) Rene H. Wijffels, Wageningen University, The Netherlands and the third was by Dr. Jorge Dias, Co-founder & CEO and Production Manager, Sparos LDA, Portugal on "Umlocking the potential of Microalgae in aquafeeds". Scientists, technical officers of CIFRI, HQ along with the centres attended the webinar.

76th Foundation day of the institute

The Institute celebrated its 76th Foundation day on 17 March 2022 at Institute Headquarter, Barrackpore. Dr. B. K. Das, Director recalled that the institute has played a pioneering role in ushering fisheries and aquaculture revolution in India through its research and technology development that has enabled the country to increase the production of fish by 12 times, since 1950-51, thus making a visible impact on the national food and nutritional security. Swami Mahadevanand Maharaj Ji, Assistant Secretary, Bharat Sevashram Sangha, and Chief Guest of the foundation day stressed upon the importance of integrated fish farming technology and expects more collaborative work among all institutes to explore more opportunity. Shri Rajiv Kumar, GM,

Metal and Steel Factory, Ministry of Defence, Prof. A.P. Sharma, Former Director, ICAR-CIFRI, Prof. S. K. Sanyal, Former Vice Chancellor, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Dr. Gauranga Kar, Director, ICAR-CRIJAF, Barrackpore also graced the occasion. The medals to the winners of annual sports events were presented to awardees by Chief guests and guests of honors. Medical cards for staff members were distributed by the dignitaries.

Indian Fisheries Outlook 2022 "Priming Indian Fisheries in Attaining Sustainable Development Goals"

The institute, in collaboration with Inland Fisheries Society of India (IFSI) and Professional Fisheries Graduate Forum (PFGF), Mumbai organized this mega event during 22-24 March, 2022.

The inaugural function was graced by Shri Bankim Chandra Hazra, Hon'ble Minister of Sundarban Affairs and Development, Government of West Bengal. While Swami Suparnanada Maharaj, Honorary Secretary, Ramakrishna Mission Institute of Culture, Kolkata, Dr. Riji John, Vice Chancellor, Kerala University of Fisheries and Ocean Studies (KUFOS) were the Guests of Honour. The inaugural function was presided over by Dr. J. K. Jena, Deputy Director General (Fishery Science). Dr. B. B. Nayak, General Secretary PFGF, briefed about the conference while Dr. B. K. Das, Director, ICAR-CIFRI, highlighted the importance of the theme of the conference.

Dr. J. K. Jena, DDG (Fishery Science) ICAR, New Delhi and Chief Guest in his address emphasized on the importance of fisheries sector in Indian agricultural and rural economy. He highlighted that for fisheries and aquaculture SDG goal 2 zero hunger, goal 3 good health &well being, goal 14 life below water and goal 15 life on land are more relevant.

Shri Bankim Chandra Hazra, Honourable Minister of Sundarban affairs, Government of West Bengal in his address highlighted the important role played by fisheries sector in the economic development of West Bengal and India. Swami Suparnanada Maharaj, Honorary Secretary, Ramakrishna Mission Institute of Culture, Kolkata delivered the 4th P. C. Thomas lecture on Civilization, Culture, Science and Religion. On this occasion, Honourary Fellowship of Inland Fisheries Society of India (IFSI) was awarded to Prof. P. C. Thomas, Ex Director, College of Fisheries, OUAT and Dr. A. Eknath, Ex Director General, NACA. On this occasion conference souvenir, book of abstracts and several books were released by the dignitaries. More than 500 researchers, academician, scientists, students, representatives of industries and 100 farmers of West Bengal participated in the conference.

Satellite symposium on "Hilsa Dialogue: A Bay of Bengal (BoB) Perspective"

ICAR-CIFRI, Barrackpore organized a satellite symposium as a part of 1st Indian Fisheries outlook 2022 and *Azadi ka Amrit Mahotsav* on 23 March 2022. The symposium was conceptualized to develop a regional policy and management plan towards Hilsa conservation and propagation through exchange of scientific intellectuals among hilsa experts representing India, Bangladesh, Myanmar and Norway. Dr. B. K. Das, Director, briefed the hilsa research activities carried out by the institute in recent years including tagging to understand the migratory path, cyro-preservation of hilsa spermatozoa. Prof. Abdul Wahab, Advisor, Worldfish (Bangladesh), presented the current status and policy of hilsa in Bangladesh while Dr. Michael Akester, Country Director (Worldfish), Myanmar highlighted the management policy towards hilsa fishing in Myanmar. Dr. Atle Mortensen, Norway shared the scientific knowledge and experiences on Salmon breeding and captive bloodstock development. Dr. P. Krishnan, Director Bay of Bangal Project, India, briefed the role Bay of Bengal Project in hilsa fishery management.

Dr. B. P. Mohanty, Assistant Director General (Fishery Science), ICAR, Dr. Md. Jalilur Rahman, Scientist (Ecofish II) Worldfish, Bangladesh, Prof. Ashim Kumar Nath, Professor of Zoology, SidhoKanho University, Dr. Arnab Biswas, MD, Director, Alo Eye Hospital, Kolkata, were also present. Dr. K. K. Vass, former Director of ICAR-CIFRI, and chairman of the symposium brought out important suggestive measures and recommendations.

IRC meeting

Institute Research Committee Meeting for the year 2021-22 was held during 21-23 April 2022 at the Institute headquarters in off-line mode. The meeting was started with a welcome address by Dr. Arun Pandit, Member Secretary IRC. He briefed the house regarding the areas of the projects being executed at the

institute. The Director gave a brief overview of the recent developments in the research, extension, linkages, and other areas of the Institute. The Chairman motivated to build rapport with foreign researchers working in the same field and for exchanging ideas. He urged that a close contact may be maintained with the state department while sampling. Dr. A. K. Das, Member Secretary, RAC highlighted the recommendations of RAC meetings conducted in this year. The Chairman instructed that the recommendations should be included in the current projects. Head of Divisions and Heads of Centre also offered their comments. Following this Scientists presented their achievements and future work plan for discussion. New project proposals were also presented in the IRC.

Webinar on natural fish farming

The institute organized a national webinar on natural fish farming as a part of the campaign "*Annadata Devo Bhava*" under the aegis of*Azadi Ka Amrit Mahotsav* on 23April 2022 in hybrid mode. The webinar was organized to recognize the role of the fish famers and the importance of natural fish farming practices in the making of a sustainable society in terms of food and nutritional security.

Dr. B. K. Das, Director, ICAR-CIFRI emphasized on incorporating our ancient traditional practices in current scientific fish culture activities. Dr. Das also elaborated the benefits of natural fish farming in preserving the aquatic environment. A total of 228 participants including 69 scientists, 32 students, 21 farmers, 17 technical officers participated in offline mode while 89 farmers, students, Deans of the College of Fisheries participated through online mode.

CIFRI CAGEGROW feed distribution among wetland fishers of Dhemaji district, Assam

A total of 5.25 tonnes of CIFRI CAGEGROW feed was distributed

among 50 wetland fishers of by the Guwahati Regional Centre on 27April 2022. Shri Pradan Baruah, Hon'ble Member of Parliament (MP), Lakhimpur, and Dr. Ranoj Pegu, Hon'ble Minister of Education and WPTBC Department, Govt. of Assam graced the feed distribution program. The Hon'ble MP urged the people to adopt scientific fish farming practices and highlighted the role of fisheries in rural employment and livelihood. Mr. Lakhinath Lagachu, DFDO, Dhemaji, Dr. Ranoj Pegu, Hon'ble Minister of Education and WPTBC Department, Govt. of Assam also addressed the gathering.

Fish harvest mela at Duma wetland of West Bengal

Duma in North 24 Parganas of West Bengal is one of the largest horseshoe-shaped wetlands of Asia having an area of 257 ha with a water depth of 8-17 ft. The fisherfolk families of 9 villages surrounding the wetland are fully dependent on this waterbody. The institute has adopted this wetland for production enhancement demonstration and started pen culture demonstration in February 2021 with a target of increasing the fish production up to 1000kg/ha/year within three years period. Six numbers of CIFRI Pen HDPE® of 0.1 ha were installed in the wetland and fingerlings of Indian major carp and grass carp were stocked in 5 pens. One pen has been stocked with fish seeds of small indigenous fish (SIF) *Systomus sarana*. ICAR-CIFRI is promoting the Sarana Model in the wetland fisheries to enhance the SIFs production and to provide additional nutritional security to the rural households. Besides technical support and guidance, the institute is providing inputs like fish feed and fish seed to the society. On 18 April 2022, the 63rd day of harvesting, a Fish Harvest Mela has been organized in the presence of Dr. B. K.

Das, Director. Inspite of losses due to water flooding the fishermen harvested a total of 79 ton fishes as compared to 73 tonnes during the year 2020-21.

Release of Kisan Samman Nidhi instalment by Honourable PM

The state level programme was organised by ICAR-CIFRI in collaboration with Eastern Railway at Railway Indoor stadium, Behala, Kolkata. Shri Ashwini Vaishnav, Hon'ble Minister of Railway, Communication and Electronics & IT was the chief guest and Shri Suvendu Adhikari, the Leader of Opposition, West Bengal Legislative Assembly was the guest of honour. On this occasion Honourable Prime Minister also released the 11th instalment of the Kisan Samman Nidhi to more than 10 crore farmers. At Kolkata the Hon'ble Minister and other Dignitaries interacted with the beneficiaries, farmers and other stakeholders. In addition to the beneficiaries, staff members of ICAR institutes located in and around Kolkata, staff members of Eastern, South Eastern and Metro Railway Kolkata, Officers of Department of Post were present on this occasion.

National fish farmers day

The institute celebrated the National fish farmers' day at Moyna fisheries hub, East Medinipur, West Bengal in collaboration with Moyna Ramkrishnayan Association. On this day ICAR-CIFRI also celebrated the National Campaign on 'Emerging Aquaculture Systems and practices' with the sub theme of intensive and industrial aquaculture systems to promote innovation and entrepreneurship initiatives in aquaculture sector. Every year on July 10th, National Fish Farmers' Day is observed to honour the path-breaking accomplishment of the induced breeding technique by Dr. Hira Lal Chaudhury and Dr. K. H. Alikunhi.

Interactive meeting on 'Open water fisheries development in Assam

ICAR-CIFRI Barrackpore and Directorate of Fisheries (DoF), Govt. of Assam jointly organized an interactive meeting on 'Open water fisheries development in Assam' on 21 July 2022 at Meen Bhawan, Guwahati. It was inaugurated by Mr. Rakesh Kumar, IAS, Commissioner & Secretary to Govt. of Assam, Fisheries department. He appreciated past collaborative activities by both the organizations and urged them to continue to work together for open water fisheries development for enhancement and conservation of the resources.

हिन्दी संगोष्ठी "स्वाधीनता के 75 बरसों में भारत में विज्ञान और प्रौद्योगिकी का विकास"

A Hindi workshop on "Development of Science and Technology in India" was organized by ICAR-CIFRI, Barrackpore during 29-30 July 2022. It was aimed at showcasing the developments in the field of science and technology in the country in the last 75 years and to highlight the latest research and development schemes and technologies in the inland fisheries sector. The Workshop was attended by Dr. (Mrs.) Vijayalakshmi Saxena, General President, Indian Science Congress Association, Kolkata, Indian Science Congress Association; Dr. Ashok Kumar Saxena, Former General President, Indian Science Congress Association, Kolkata; Mr. Priyankar Paliwal, Secretary, Town Official Language Implementation Committee, Kolkata (Office-2), Department of Official Language, Ministry of Home Affairs, Government of India, Kolkata; Shri Kamakhya Narayan Singh, Assistant Director (R.I.), Department of Science & Technology; New Delhi; Revered Swami Vishwamayanand Ji Maharaj, Ramakrishna Mission, Saragachhi, Murshidabad.

Inauguration of the Hindi Sangosthi

Participatory management for sustainable fisheries and biodiversity conservation

ICAR-National Bureau of Fish Genetic Resources (ICAR-NBFGR) jointly with seven ICAR Fisheries Research Institutes (CIFRI, CMFRI, CIFE, CIFT, CIFA, CIBA & DCFR) has organized a National Campaign on 'Participatory Management for Sustainable Fisheries and Biodiversity Conservation' on 04 August, 2022. On the occasion a Kisan Gosthi was organized at Ramghat, Varanasi, U. P., Fourteen fishers participated in the programme. Bangalore Research Centre organised the campaign at Kakolu village, Bangalore North on 04 August 2022. About 24 fishermen and stakeholders of the Kakolu village had attended the programme.

Staff at Headquarters at the campaign

Staff of Bangalore Research Centre at the Kakolu village

76th Independence Day "Har Ghar Tiranga"

The institute celebrated 76th Independence Day on 15 August 2022 with great fervour. As part of *Aazaadi Ka Amrit Mahotsav*, *Har Ghar Tiranga* campaign was launched from 13-15 August at Institute headquarters Barrackpore, Kolkata and all the regional centres. The Independence Day celebration initiated with the march past by the members of security staff from the Director's residence to the main building of the institute. Cultural programme was also organized on the occasion.

Solidarity programme at old age homes

The staff of the institute led by Dr. B. K. Das, director, visited the old age home run by the Ramakrishna Mission at Barrackpore on14 August 2022. Staff interacted with them, tied rakhi distributed sweets to them. The National flag was also handed over to unfurl in the premises. The institute also distributed bed covers and entertained them by playing games, narrating stories, entertainment videos and short movies, riddles, etc. The objective of this activity was to

sensitize the staff about the problems faced by the elderly, learn how to respect them, care for them, and listen to their experiences and their advice. The same programme was also organized at an old age home, Agarpara, North 2 Parganas, West Bengal on 15 August 2022.

Fit India freedom run 3.0

The institute organized *Fit India Freedom Run 3.0* under the aegis of *Azadi Ka Amrut Mahotsav* on 14 August and 02 October 2022 at Barrackpore. The institute staff resolved to include physical activity of at least 30 minutes daily in their lives. The run was also aimed at making the general public aware of this noble initiative. The Run commenced at 7.00 am from the Institute Hqs. at Fisheries Gate, Manirampur and came back after reaching Chiriamore, Barrackpore which is around 5 km from the institute headquarters. All the staff members (including contractual) joined the run. The Director led the team and encouraged the general public to make fitness activities a daily routine in their life.

Fit India freedom run on 14 August

Fit India freedom run on 02 October

Workshop on fish production enhancement through cage culture

On 17 August 2022, ICAR-CIFRI conducted one-day workshop with the objectives to discuss the potential

for increasing fish production in West Bengal reservoirs through cage culture and to train DoF officials in WB on different aspects of cage culture. Dr. B. K. Das, Director emphasised that improvement of fish production from the state's reservoirs and wetlands is possible through scientific management and technical intervention. He promised to provide DoF with all necessary assistance, technical support, and handholding for the implementation of cage culture programmes. Detailed discussion took place on design, construction, operation, and culture protocol of commercially important species, food, feedingand fish health management in cages.

Hindi Saptah

'Hindi Saptah' was organized from 14 to 20 September 2022 at the ICAR-CIFRI, Barrackpore. It was inaugurated on 14 September 2022 at the institute headquarters in both offline and online mode. The chief guest of the function, Mr. Naveen Kumar Prajapati, Senior Advisor and Officer-in-Charge, Central Translation Bureau, Kolkata, explained the importance of Hindi in his speech and discussed the role of foreign writers in the promotion of Hindi. Various competitions were organized on the occasion. The winners were given prizes in the concluding ceremony.

World rivers day

World rivers day celebrated on the fourth Sunday of September every year to increase public awareness about rivers and to encourage their conservation. The theme of this year World Rivers Day was "the importance of rivers for biodiversity". The Institute celebrated the Day on 25 September 2022 at Karela Bagh ghat, Prayagraj, Uttar Pradesh & Sonia Vihar, Delhi on the bank of river Yamuna and Kodalbasti, Subhasini area on the

bank of river Torsha in Jaldapara National Park Complex, West Bengal.

Mahila kisan diwas

ICAR-CIFRI celebrated 'Mahila Kisan Diwas' with the presence of Swami Vishwamayanandaji, Secretary, Ramakrishna Mission, Sargachhi, Murshidabad as a chief guest on 15 October 2022. Around 100 progressive women farmers from various agriculture and allied sectors were invited in this programme many of whom shared their experiences. A scientist-farmer women interactive sessions was organised. The day was celebrated by ICAR-CIFRI with an aim to empower and leverage farm women with fisheries sector to bring second blue revolution in the country.

National dolphin day

Dolphins are the ideal ecological indicators of a healthy aquatic ecosystem. On 15 August 2020, the "Project Dolphin" was launched by the Hon'ble Prime Minister Shri Narendra Modi to include both river dolphins and marine dolphins in its conservation program. Hon'ble Environment Minister Shri Bhupendra Yadav declared October 5th as "National Dolphin Day", to be observed annually to raise awareness for dolphin conservation. The Institute commemorated 'National Dolphin Day' on 05 October 2022 at Farakka, Nabadwip, Tribeni, and Balagarh on the bank of river Ganga under Namami Gange Program. On this occasion, more than 200 personnel including active fishers, social activities, and students gathered.

Vigilance awareness week

The Institute observed "Vigilance Awareness Week" during 31 October to 06 November 2022 focusing on the theme area "Corruption free India for a developed nation". The weeklong observance was started with administration of integrity pledge to the officials and staff on 31 October by the Director. Many of the staff also took e-pledge. Large numbers of posters, banners, placards were displayed at the campus premises. On the next day all the staff formed a human chain showing the solidarity

and unity in fighting the corruption. The human chain was followed by a walkathon up to local ferry ghat, a busy commuting point. The week-long celebration was culminated through a concluding ceremony on 7 November in which Shri Alok Rajoria, IPS, Commissioner of Police, Barrackpore Police Commissionerate was the Chief Guest.

Tribal pride day

To commemorate the birth anniversary of Birsa Munda, one of the greatest Indian freedom fighters, ICAR-CIFRI reached to the remote villages of Sundarbans of West Bengal on 15 November 2022. On this occasion, Dr. B. K. Das, Director along with his team comprising scientists, technical staff and research scholars organized a mass awareness – cum- input distribution programme under the Scheduled Tribe Component in the village of Palotghat, Kakdwip. The Director distributed 750 kg fish seed, 15 tonnes fish feed and 3 tonnes lime to 150 number of tribal families for improving their livelihood.

World fisheries day

World Fisheries Day is observed every year on 21 November to show solidarity with all fisherfolk, fish farmers, and concerned stakeholders of fisheries throughout the world. To commemorate this day and raise awareness about sustainability in the

management of fisheries of inland waters in the country, ICAR-CIFRI celebrated World Fisheries Day on 21 November 2022 at its headquarters (Barrackpore). Shri Swami Shivapurnananda, Asstt. Administrative Head, IRDM F/C and Vice Chairman SSKVK, and Chairman RKMVERI (Ramakrishna Mission Vivekananda Educational and Research Institute) was the Chief Guest and Prof. Ashis Kumar Panigrahi, Pro-Vice Chancellor, University of Burdwan was the Guest of Honour.

World antimicrobial resistance awareness week

The institute celebrated the World Antimicrobial Awareness Week (WAAW) with a theme "Preventing antimicrobial resistance together" at different locations of West Bengal during 18 to 24 November 2022. The aim of the programme was to create awareness among the fishermen and fish farmers to reduce the misuse of antibiotics/chemicals in the aquaculture and open water fisheries and to encourage best management practices for sustainable fish production. More than 250 farmers participated the programme.

Communal harmony campaign week & flag day

The institute observed Communal Harmony Campaign Week from 19-25 November 2022 and the Flag Day on 25 November 2022 to spread

message on peace, harmony and national integration and to foster and reinforce the spirit of communal harmony among the staffs of the organization. The ICAR-CIFRI observed this campaign as partner of National Foundation for Communal Harmony, New Delhi, an autonomous organization with the Ministry of Home affairs, Govt. of India.

World soil day

The institute celebrated 'World Soil Day-2022' with the theme "Soils: Where the food begins" on 05 December 2022. Dr. J. C. Tarafdar, former National Fellow, and Principal Scientist, ICAR-CAZRI was Guest-of-Honour, and Dr. R. K. Basak, Retd. Professor, BCKV was Chief Guest of the programme. The programme witnessed more than 50 farmers, scientists and non-scientific staff of ICAR-CIFRI.

Hon'ble Minister of Fisheries, Govt. of Manipur visited the CIFRI cage culture site at Dumbur reservoir

Hon'ble Shri Heikham Dingo Singh, Minister of Fisheries, Social Welfare, Skill, Labour, Employment and Entrepreneurship, Government of Manipur along with Shri Heisnam Balkrishna Singh, Director, Department of Fisheries, Govt. of Manipur visited Dumbur reservoir, Tripura on 14 December 2022 to see the cage culture experiments conducted in the reservoir. He appreciated the efforts of ICAR-CIFRI in developing the fisheries sector in the North-Eastern States, especially Manipur and constructed the state department to adopt the CIFRI technologies for inland open water fisheries production enhancement in the state.

OTHER IMPORTANT EVENTS

Field day at 47-Morakolong beel of Assam on 31.01.22

World wetland day at Garjan-Bullutjan beel, Kamrup, Assam

World environment day on 05.06.2022 at Barrackpore and Bengaluru

National campaign on fish for health and prosperity on 16.07.2022

Meeting of animal ethics committee on 18.07.2022

National campaign on
non-conventional aquacultural systems on 27.07.2022

Ganesh Puja on 31.08.2022

Dr. (Mrs.) Vijayalakshmi Saxena, General President, Indian Science Congress Association, Kolkata on 15.10.2022

The Government of India has launched the *Azadi Ka Amrit Mahotsav* to celebrate and commemorate 75 years of the country's illustrious history, culture, and accomplishments. It is dedicated to the Indians who have contributed significantly to the development of India. All Departments and Ministries, including ICAR, are hosting a series of programmes and events to commemorate the event. The official journey of "*Azadi ka Amrit Mahotsav*" commenced on 12 March 2021 which starts a 75-week countdown to our 75th anniversary of Independence and will end on 15 August 2023. ICAR-CIFRI has also conducted a series of events, including workshops, webinars, campaigns, awareness, sensitization, lectures etc. to commemorate *Azadi Ka Amrit Mahotsav* in the year 2022.

Lecture by Prof. Saroj Sanyal

Platinum jubilee lectures #4 and #5

The Institute organized the fourth lecture of the series by Prof. Bhaskaran Manimaran, Former Vice Chancellor of Tamil Nadu Dr. J Jaylalithaa Fisheries University, Nagapattinam in a hybrid mode, both online and off-line on 09 March. As a Founder Vice-Chancellor, he is an architect of State funded Fisheries University, first of its kind, in India imparting professional education research and training to enhance fish production and its utilization by following SAU pattern and syllabi. He delivered his lecture on 'Productivity enhancement in open water fisheries development: Strategies for improved ecological and carbon foot prints'. The lecture was very informative and a vibrant interaction session was held after the lecture. More than 146 persons participated in the lecture session.

On 17 March, on the occasion of 76th Foundation Day ICAR-CIFRI organized another platinum jubilee lecture by Prof. Saroj Sanyal, former Vice-Chancellor of Bidhan Chandra Krishi Viswavidyalaya, West Bengal (BCKV) on 'Arsenic contamination of ground water: Build-up in soil-crop-human continuum system and mitigation'. Around 87 participants, including scientists, technical officials and students were enriched by his lecture.

Lecture by Prof. Bhaskaran Manimaran

National webinar on Natural Fish Farming "*Annadata Devo Bhava*"

ICAR-CIFRI organized a National Webinar on Natural Fish Farming as a part of the campaign "*Annadata Devo Bhava*" under the *Azadi Ka Amrit Mahotsav* on 23 April 2022 in hybrid mode. To celebrate and to acknowledge the contribution of the farmers in securing the nutritional needs of the nation, the Govt. of India called for this nation-wide campaign. On this occasion, ICAR-CIFRI organized the webinar to recognize the role of the fish famers and the importance of natural fish farming practices in the making of a sustainable society in terms of food security and nutritional security while keeping the environmental integrities undisturbed.

Dr. B. K. Das, Director, ICAR-CIFRI delivered a highly informative lecture on 'Natural fish farming'. He also highlighted on the significance of community participation in adapting natural farming.

Lecture by Dr. B. K. Das

A total of 228 participants including 69 scientists, 32 students, 21 farmers, 17 technical officers participated in offline mode while 89 farmers, students, Deans of the College of Fisheries participated through online mode. It is expected that this programme will have a positive impact on the attendees and therefore encourage the adaptation of natural fish farming practices at an individual as well as a community level.

Activities under 'Kisan Bhagidari, Prathmikta Hamari'@ Azadi Ka Amrit Mahotsav

ICAR-CIFRI organized a Quiz competition for 129 number of students and 21 number of farmers at the institute Head Quarters, on ornamental fisheries and nutritional importance of fish on 25 April 2022 as a part of 'Kisan Bhagidari, Prathmikta Hamari' campaign under *'Azadi Ka Amrit Mahotsav'* from 25 to 30 April 2022.

The Ministry of Agriculture and Farmers Welfare advised for organizing various farmer-centric campaigns, workshops, programmes, seminars, webinars, etc., to treat *'Azadi Ka Amrit Mahotsav'* as a people's participation festival.

Dr. B. K Das, Director, CIFRI presided over the programme. In his address he expressed his view upon the importance of organizing the 'Kisan Bhagidari, PrathmiktaHamari' campaign to fulfill the Hon'ble Prime Minister's vision of 'Bharat 2.0' for a self-reliant India. The quiz campaign ended with prize distribution programme.

Garib Kalyan Sammelan

As part of the *Azadi ka Amrit Mahotsav*, which celebrates the 75th year of Indian Independence, Hon'ble Prime Minister Shri Narendra Modi interacted with beneficiaries of sixteen schemes and programmes launched by Government of India in last 8 years at a national level event "*Garib Kalyan Sammelan*" held at Shimla through video conferencing on 31 May 2022. The state level event was organized by ICAR-Central Inland Fisheries Research Institute, Barrackpore in collaboration with Eastern Railway, Kolkata at Railway Indoor stadium, Eastern Railway sports complex, Behala, Kolkata.

Shri Ashwini Vaishnav, Honourable Minister of Railway, Communication and Electronics & IT was the chief guest, Shri Suvendu Adhikari, Honourable Leader of Opposition, West Bengal Legislative Assembly was guest of honour. As part of the event, Honourable Minister and other Dignitaries interacted with the beneficiaries of different schemes. After the interaction session, Main programme event at Shimla Himachal Pradesh was broadcasted live at the venue. More than 2500 participants including 3 MLAs, public representative, 2000 Farmers, beneficiaries of various schemes, Officers & staff members of ICAR institutes located in Kolkata and adjoining districts, Officers and staff members of Eastern, South Eastern and Metro Railway Zones, Officers of Department of Post were present on this occasion.

Shri Ashwini Vaishnav, Honourable Minister of Railway, Communication and Electronics & IT at Garib Kalyan Sammelan

National campaign on 'Emerging Aquaculture Systems and practices'

The ICAR-CIFRI conducted a National Campaign on 'Emerging Aquaculture Systems and practices' with the sub theme of intensive and industrial aquaculture systems to promote innovation and entrepreneurship initiatives in aquaculture sector at Moyna, Purba Mrdinipur. Approximately 500 farmers including 150 women, attended the programme. A farmer-scientist interactive session was organized in which the experts discussed the prospects and problems of inland fishery sectors and mitigation challenges.

A Radio talk in the community radio was delivered by Dr. B. K. Das and it was reached to around 50,000 audiences.

The campaign was also celebrated by the Guwahati Regional Centre at Charan beel, Baksa district, Assam. The programme was attended by more than 60 tribal fishers/farmers (including 15 women) of the locality under the Dhulabari Charanpar Janajati Unnayan Samity, Deulkuchi. An awareness programme on 'Emerging aquaculture systems and practices' held at Chulliyar Fish Seed Farm, Palakkad, Kerala on thisoccasion. Around 60 people including fishermen belonging to the Chulliyar and Meenkara Fisheries Co-operative Societies, fish farmers of the locality and officials of the Kerala State Fisheries Department participated in the programme.

National campaign on "Fish for health and prosperity"

ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) led the national campaign under the theme, 'Fish for health and prosperity' on 16 July 2022, along with other ICAR fisheries research institutes. MPEDA chairman Shri K. N. Raghavan, IRS inaugurated the campaign. Dr. Shivakumar Magada, Dean of the College of Fisheries in Mangalore, highlighted the efforts under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), which might lead to India producing 20 million tons of fish by 2025. During the campaign Dr. Chadag V Mohan, Principal Scientist, World Fish, Malaysia, advised the effective incorporation of aquatic items in daily meals through various initiatives. More than 195 ICAR-CIFRI staff, including scientists, technical officers and students participated in the campaign through online mode.

National Campaign on Non-conventional aquaculture systems

To commemorate 75 years of Indian Independence ICAR-Central Marine Fisheries Research Institute jointly with seven ICAR fisheries research institutes (CIFE, CIFRI, CIFT, CIFA, CIBA, NBFGR & DCFR) organized this National Campaign on "Non-conventional aquaculture systems" on 27 July 2022.

On this occasion, ICAR-CIFRI organized a webinar at CIFRI HQ on Smart Aqua farming in a hybrid mode. Dr. B. K. Das, Director, ICAR-CIFRI delivered a lecture on 'Smart Aqua farming'. About 63 scientists from HQ and Centres participated in

the programme. Other than that, about 23 technical officers, and 81 students from ICAR-CIFRI and outside CIFRI participated in the programme. An exposure visit was conducted to Mithon reservoir, Jharkhand for giving an orientation to the framers of Manipur (17 trainees) regarding non-conventional way of aquaculture system (Cage culture).

On this occasion, a demonstration programme was conducted by RRC-Bangalore on the utilisation of biofloc system for fish seed rearing. Shri J. K. Solanki, T.O. delivered lecture among the staff of ICAR-CIFRI Vadodara.

National Campaign on 'Participatory Management for Sustainable Fisheries and Biodiversity Conservation'

To commemorate 75th Anniversary of Indian independence – "*Azadi Ka Amrit Mahotsav*", ICAR-National Bureau of Fish Genetic Resources (ICAR-NBFGR) jointly with seven ICAR Fisheries Research Institutes (CIFRI, CMFRI, CIFE, CIFT, CIFA, CIBA & DCFR) organized a National Campaign on 'Participatory Management for Sustainable Fisheries and Biodiversity Conservation' on 04 August 2022. About 62 staff from CIFRI, HQ including 29 scientists joined the programme. A total of 12 staff from RRC Guwahati, 8 staff from RRC Bangalore, 5 staff from RRC Prayagraj, 4 staff from RRC Vadodara also joined the webinar.

On the occasion A Kisan Gosthi was organized at Ramghat, Varanasi, U. P. on 04 August 2022. Fourteen fishers participated in the programme.

ICAR-Central Inland Fisheries Research Institute, Bangalore Research Centre, successfully organized the National Campaign at Kakolu village, Bangalore North on 04 August 2022. About 24 fishermen and stakeholders of the Kakolu village had attended the programme.

Institute Tableau on *Azadi ka Amrit Mahotsav*

A Tableau displaying activities and achievements of ICAR-CIFRI was prepared and displayed in different parts of the Barrackpore city during 14-16 August 2023 to enhance people's awareness on the Institute activities and to commemorate *Azadi ka Amrit Mahotsav* of the nation.

Kisan Samman Sammelan

Kisan Samman Nidhi (PM-KISAN) through Direct Benefit Transfer. The Hon'ble Prime Minister, Shri Narendra Modi inaugurated PM Kisan Samman Sammelan 2022 at ICAR - Indian Agricultural Research Institute, New Delhi on 17 October 2022. He also inaugurated 600 Pradhan Mantri Kisan Samruddhi Kendras (PMKSK) under the Ministry of Chemicals & Fertilisers. Furthermore, the Prime Minister also launched Pradhan Mantri Bhartiya Jan Urvarak Pariyojana - One Nation One Fertiliser. During the event, the Prime Minister also released the 12th instalment amount of Rs. 16,000 crores under the Pradhan Mantri Prime Minister also inaugurated the Agri Startup Conclave and Exhibition. 250 Fish Farmers, farm

women of North and South 24 Parganas districts of West Bengal witnessed live web cast of Hon'ble Prime Minister address at the Institute during PM Kisan Samman Sammelan and Agri startup conclave organized at Indian Agriculture Research Institute, Pusa New Delhi on 17-18 October 2022.

Mera Gaon Mera Gaurav (MGMG) is flagship programme of Indian Council of Agricultural Research, with the objective to propagate scientific know-how from laboratory to the end users.

Ten multi-disciplinary teams was formulated incorporating five scientists in each team and ten clusters of villages (comprising 5 villages each and 50 villages in total) covering five district of West Bengal were selected to implement MGMG activities. This year ICAR-CIFRI has covered where 28 villages, more than one thousand farm families were covered; among them 76% belong to SC/ST and majority are landless and small farmers.

The institute has also provided technical literatures to the farmers of the MGMG adopted villages. Advisories were extended on impact of climate change in inland waters; pen culture technology; biodiversity conservation; small indigenous fish culture and conservation, etc. The farmers were also sensitized on various aspects of management such as fish disease control, soil fertility management, hilsa conservation, climate-change and adaptation, eco-system-based integrated wetland management etc.

Success story under MGMG

Ashadullapur village of Sriniketan block, Birbhum was adopted as MGMG village by the Institute. On-farm demonstration was conducted in the village to motivate the village population to adopt fish culture practices as an alternative way to earn their livelihoods. Under the Institute support and guidelines, atribal women-SHG, named Chandurakab SHG, of this village has adopted scientific fish culture practices in a community pond (1 bigha) and harvested 31% more fish than the last year. Each of the SHG members received around Rs. 910/- as net return from fish culture in one season. Moreover, the quantity of fish consumption by the SHG members and their families has also increased significantly providing quality protein. Now the SHG is planning to improve their fishing enterprise with support and guidance from ICAR-CIFRI.

Glimpses of swachhta campaign in 2022

Routine Swachhta program in the Institute HQs during the month of April 2022

Awareness programmme at ferry ghat, Barrackpore regarding cleanliness, conserving greenery and curbing plastic pollution on World Environment Day 2022

Leaflet distribution for awareness against single use plastics at Barrackpore Ferry Ghat

Routine Swachhta program at Guwahati centre

Glimpses of special Campaign 2.0 during 02 October 2022 to 31 October 2022 and Swachhata Pakhwada during 15-31 December 2022

Paying homage to the Father of Nation by the Director on 02 October 2022

Awareness at CIFRI campus 10 October 2022

Swachhta pledge at Kolkata Research Station

Swachhta campaign at HOUSEFED Complex, Guwahati

Laboratory cleaning at Barrackpore

Awareness at Sundarbans

Pledge at Barrakpore on 16 December 2022

Awareness at Diamond Harbour, West Bengal

Swachhta programme at Anchuruli district, Kerala

Awareness programme by Vadodara regional centre

Swachhta campaign at Mapithel reservoir, Manipur

Swachhta campaign by Prayagraj centre

सिफरी में "स्वाधीनता के 75 वर्षों में भारत में विज्ञान और प्रौद्योगिकी का विकास" हिन्दी संगोष्ठी का आयोजन

भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान (सिफरी), कोलकाता तथा भारतीय विज्ञान कांग्रेस संस्था, कोलकाता के समन्वित प्रयास से सिफरी मुख्यालय, बैरकपुर, कोलकाता में दिनांक 29–30 जुलाई एक हिन्दी संगोष्ठी आयोजित की गई जिसका विषय था – "स्वाधीनता के 75 वर्षों मे भारत में विज्ञान और प्रौद्योगिकी का विकास"। यह संगोष्ठी यह कार्यशाला आज़ादी का अमृत महोत्सव वर्ष के उपलक्ष्य में आयोजित किया जिसका उद्देश्य देश में विगत 75 वर्षों में विज्ञान और प्रौद्योगिकी के क्षेत्र में विकास को दर्शाना तथा अंतर्स्थलीय मत्स्य पालन क्षेत्र में नवीनतम अनुसंधान और विकास योजनाओं और प्रौद्योगिकियों पर प्रकाश डालना है। इस संगोष्ठी का उद्घाटन दिनांक 29 जुलाई को सिफरी मुख्यालय, बैरकपुर में हुआ जिसमें भारतीय विज्ञान कांग्रेस संस्था, विज्ञान और प्रौद्योगिकी विभाग, नई दिल्ली, नगर राजभाषा कार्यान्वयन समिति (नराकास), कोलकाता (कार्यालय–2), कोल इंडिया जैसे प्रतिष्ठित संगठनों के गणमान्य उच्चाधिकारीगण, वैज्ञानिक और शोध छात्रों ने भाग लिया।

उद्घाटन समारोह में, डॉ यू के सरकार, प्रभागाध्यक्ष, सिफरी, बैरकपुर ने अतिथियों का स्वागत किया। डॉ. अशोक कुमार सक्सेना, पूर्व महाध्यक्ष, भारतीय विज्ञान कांग्रेस संस्था, कोलकाता, सम्मानित अतिथि ने अपने सम्बोधन में सिफरी के हिन्दी गतिविधियों और उपलब्धियों की सराहना की। श्री प्रियंकर पालीवाल, सचिव, नगर राजभाषा कार्यान्वयन समिति, कोलकाता (कार्यालय–2), भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, कोलकाता ने विज्ञान और हिन्दी पर व्याख्यान प्रस्तुत किया। श्री कामाख्या नारायण सिंह, सहायक निदेशक (रा. भा), विज्ञान और प्रौद्योगिकी विभाग, नई दिल्ली ने हिन्दी, विज्ञान और दर्शनशास्त्र के बीच के सामंजस्य पर एक प्रस्तुति दी। इसी क्रम में श्रद्धेय स्वामी विश्वमयानन्द जी महाराज, रामकृष्ण मिशन, सारगाछी, मुर्शिदाबाद ने विज्ञान एवं भारतीय दर्शन शास्त्र पर एक व्याख्यान दिया। सिफरी के प्रभागाध्यक्ष, डॉ. एम ए हसन ने संस्थान द्वारा विकसित प्रौद्योगिकी और उपलब्धियों पर प्रकाश डाला। इस समारोह की मुख्य अतिथि, डॉ (श्रीमती) विजयलक्ष्मी सक्सेना, महाध्यक्ष, भारतीय विज्ञान कांग्रेस संस्था, कोलकाता ने अपने सम्बोधन में सिफरी के कार्यों की सराहना की। उन्होंने कहा कि उनका जुड़ाव इस संस्थान से लंबे समय से है। संस्थान के निदेशक, डॉ. बसंत कुमार दास ने पारंपरिक कृषि पर एक व्याख्यान दिया। दिनांक 30 जुलाई 2022 को श्री राजेश कुमार साव, उप–प्रबंधक (राजभाषा), कोल इंडिया लिमिटेड, कोलकाता ने आजादी 75 वर्षों में वैज्ञानिक क्षेत्र के विकास पर प्रकाश डाला।

इस संगोष्ठी में दो प्रतियोगितायें दृ निबंध तथा आशुभाषण आयोजित की गई जिनमें सिफरी, भारतीय विज्ञान कांग्रेस संस्था के साथ अनेक कार्यालयों ने भाग लिया और विजेताओं को पुरस्कृत भी किया गया। समारोह के अंत में डॉ. अतुल कुमार, कार्यकारी सचिव, भारतीय विज्ञान कांग्रेस संस्था, कोलकाता तथा डा. श्रीकांत सामंता, प्रधान वैज्ञानिक एवं सर्वकार्यभारी, हिन्दी कक्ष, सिफरी ने धन्यवाद ज्ञापन प्रस्तुत किया। यह संगोष्ठी सिफरी के निदेशक, डॉ. बसंत कुमार दास के मार्गदर्शन में भारतीय विज्ञान कांग्रेस संस्था और सिफरी द्वारा सम्पन्न किया गया।

भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान में हिन्दी सप्ताह 2022 का आयोजन

भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान में हिन्दी सप्ताह दिनांक 14 से 20 सितंबर 2022 के बीच आयोजित किया गया । इसका उद्घाटन दिनांक 14 सितंबर 2022 को संस्थान मुख्यालय में ऑफलाइन तथा ऑनलाइन दोनों ही मोड में किया गया,जिसमें संस्थान के विभिन्न क्षेत्रीय केंद्रों ने ऑनलाइन मोड में भाग लिया। उद्घाटन समारोह का शुभारंभ भारतीय कृषि अनुसंधान परिषद गीत और द्वीप प्रज्वलन के साथ हुआ। इस समारोह का शुभारंभ डा. सुबीर कुमार नाग, प्रभागाध्यक्ष के स्वागत सम्बोधन के साथ किया गया जिसमें उन्होंने संविधान सभा द्वारा राजभाषा हिन्दी की स्वीकृति तथा अनुमोदन के पृष्ठभूमि पर प्रकाश डाला। इसके बाद, राजभाषा प्रतिज्ञा ली गई। आगे संस्थान के वरिष्ठ अधिकारियों और क्षेत्रीय केंद्र प्रमुखों ने अपने–अपने विचार साझा किए। संस्थान के प्रभारी निदेशक तथा सर्वकार्याधिकारी, हिन्दी कक्ष, डा. श्रीकान्त सामन्ता ने राजभाषा हिन्दी के कार्यकलापों और उपलब्धियों पर प्रकाश डाला। समारोह के मुख्य अतिथि श्री नवीन कुमार प्रजापति, वरिष्ठ सलाहकार एवं प्रभारी अधिकारी, केन्द्रीय अनुवाद ब्यूरो, कोलकाता ने अपने संभाषण में यह कहा कि हमारी प्रथम पहचान हमारी भाषा होती है। पूरे विश्व की जनसंख्या लगभग 800 करोड़ है जिसमें हिन्दी बोलने वाले 80 करोड़ हैं। उन्होंने कामिल बुलके, मैक्समुलर और जॉन स्मिथ की संज्ञा देते हुए हिन्दी के प्रचार–प्रसार में विदेशी साहित्यकारों के भूमिका पर चर्चा की। इस अवसर पर संस्थान के मासिक हिन्दी न्यूजलेटर, अगस्त 2022 का भी विमोचन किया गया। हिन्दी सप्ताह के दौरान कई प्रतियोगिताएं आयोजित की गईं। दिनांक 14 सितंबर 2022 को हिन्दी निबंध प्रतियोगिता से शुभारंभ किया गया। इसके बाद दिनांक 15 सितंबर 2022 को हिन्दी अनुवाद, 16 सितंबर 2022 को आशुभाषण प्रतियोगिता, दिनांक 17 सितंबर 2022 को कविता पाठ तथा अंत में दिनांक 19 सितंबर 2022 को क्विज (प्रश्नोत्तरी)। ये प्रतियोगितायें दो वर्गों में आयोजित की गई– हिन्दी भाषी तथा हिंदीतर भाषी जिनमें प्रतिभागियों की संख्या लगभग 90 के आसपास थी। हिन्दी निबंध तथा आशुभाषण प्रतियोगितायें वर्तमान विषयों पर आधारित थीं, जैसे प्लास्टिक अपशिष्ट प्रबंधन, हर घर तिरंगा अभियान, आजादी के अमृत महोत्सव और हिन्दी की विकास यात्रा आदि।

हिन्दी सप्ताह का समापन, 20 सितंबर 2022 को किया गया। इस अवसर पर संस्थान के निदेशक, डा. बि. के. दास ने हिन्दी सप्ताह के सफल संचालन के लिए परिचालन समिति को धन्यवाद दिया और एक–दिवसीय वैज्ञानिक विषय पर हिन्दी कार्यशाला आयोजन का सुझाव दिया। साथ ही उन्होंने वार्षिक गृह पत्रिका, नीलाजलि को

विषय सदामत बनान पर जार दिया जिससे किसी महत्वपूर्ण मुद्दे से संबंधित विभिन्न पहलुओं पर ध्यानाकर्षण किया जा सके। उन्होंने कहा कि हिन्दी परिचालन समिति में नए सदस्यों को भी शामिल किया जाए। इस समारोह के मुख्य अतिथि, श्री राजीव लाल, संयुक्त सचिव, भाकृअनुप–केन्द्रीय मात्स्यिकी शिक्षा संस्था न, मुंबई ने हिन्दी सप्ताह 2022 से जुड़े परिचालन समिति और प्रतियोगिताओं से जुड़े कर्मियों की सराहना की। साथ ही उन्होंने यह भी कहा कि, हालांकि सिफली को हिन्दी कार्यों के लिए परिषद से कई बार पुरस्कार मिल चुके हैं, आगे संस्थान को भारत सरकार के राजभाषा हिन्दी संबंधित पुरस्कारों के लिए भी प्रयास करना चाहिए। समापन समारोह में मासिक हिन्दी न्यूजलेटर, सितंबर 2022 का विमोचन किया गया और प्रतियोगिता के विजेताओं को पुरस्कार दिया गया। हिन्दी सप्ताह 2022 का सफल कार्यान्वयन निदेशक, डा. बि. के. दास के मार्गदर्शन में डा. श्रीकान्ता सामन्ता, प्रभागाध्यक्ष एवं सर्वकार्याधिकारी, हिन्दी कक्ष; श्री संजीव कुमार साहु, वैज्ञानिक; श्री प्रवीण मौर्य, वैज्ञानिक; डा. सुमन कुमारी, वैज्ञानिक; सुश्री सुनीता प्रसाद, स.मु. तक.अधि. (हिन्दी) तथा श्रीमती सुमेधा दास, तकनीकी सहायक (हिन्दी) द्वारा किया गया।

हिन्दी संगोष्ठी / बैठकों में संस्थान की सहभागिता

1. दिनांक 24–25 अगस्त, 2022 को भाकृअनुप–केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता द्वारा आयोजित दो दिवसीय भाषा उत्सव एवं संगोष्ठी "स्वतंत्रता के 75 वर्ष और राजभाषा हिन्दी का विकास" में डा. बि. के. दास, निदेशक ने "अद्यतित प्रशासनिक नियम: परिचय एवं उनके अनुपालन संबंधी व्यवस्था" तथा भा.कृ.अनु.प. में "वित्तीय नियमों का अनुपालन" सत्र की अध्यक्षता की।
2. दिनांक 24–25 अगस्त, 2022 को भाकृअनुप–केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता द्वारा आयोजित दो दिवसीय भाषा उत्सव एवं संगोष्ठी "स्वतंत्रता के 75 वर्ष और राजभाषा हिन्दीय का विकास" में सुश्री सुनीता प्रसाद, स.मु.तक.अधि. (हिन्दी) ने भाग लिया।
3. दिनांक 14–15 सितम्बनर, 2022 को सूरत, गुजरात में आयोजित हिन्दी दिवस व द्वितीय अखिल भारतीय राजभाषा सम्मेलन में संस्थान मुख्यालय से श्री सुदीप्त गुप्ता, प्रशासनिक अधिकारी तथा बडोदरा अनुसंधान केंद्र से जे. के. सोलंकी, तकनीकी अधिकारी और श्री आर. के. साह, तकनीकी अधिकारी ने भाग लिया।
4. दिनांक 8 दिसंबर, 2022 को सीएसआईआर–खनिज एवं पदार्थ प्रौद्योगिकी संस्थान, आचार्य विहार, भुवनेश्वर–751013 में आयोजित पूर्व एवं पूर्वोत्तर क्षेत्रों का संयुक्त राजभाषा सम्मेलन एवं पुरस्कार वितरण समारोह में संस्थान मुख्यालय से सुश्री सुनीता प्रसाद, स.मु.तक.अधि. (हिन्दी) ने भाग लिया।
5. दिनांक 23.12.22 को भाकृअनुप–राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो, मऊ द्वारा आयोजित ऑनलाइन हिंदी कार्यशाला "कार्यालयी प्रणाली में हिंदी के प्रयोग में स्मार्ट टूल्स" में संस्थान मुख्यालय से सुश्री सुनीता प्रसाद, स.मु.तक.अधि. (हिन्दी) तथा श्रीमती सुमेधा दास, तकनीकी सहायक (हिन्दी) ने भाग लिया।




Library and Informatics section is the main repository where the publications from ICAR-CIFRI, e.g., annual reports, newsletters, bulletins, leaflets etc. and relevant publications received from other agencies/institutes are kept. The present total holding of books in the library is 12,737; 95 new books including Hindi publications were purchased during 2022. Besides, library subscribed 15 Indian journals and received 16 leaflets and 10 ICAR-CIFRI publications covering a wide area of subject matter. Library has also dispatched many of these publications to SMDs, important government offices, other institutes and universities of the country, besides the libraries of institute's own regional centres. Library section also has modern gadgets like book scanner and an Android Smart TV with Wi-fi internet connection. Most of the journal subscriptions are continued for the current year also. Physical verification of books and other documents in the library was completed for the periods 2019-20, 2020-21 and 2021-22 by the designated committee.

The Library and Informatic section is divided into four segments for ease in management or archiving books, journals, ICAR-CIFRI publications and Hindi books. The digitalized catalogue of the library is managed by KOHA Open-Source Library Management software and is accessible through ICAR-CIFRI website as well as through AGRICAT, a Union catalogue available to all NARS institutes. Being an active member of CeRA Consortium, ICAR-CIFRI has sent 28 documents to different NARS institutes through Document Delivery Request (DDR).

Patent

Three patents have been filed by the Institute in the year 2022. The details are as under :

- The patent application entitled "Fish anaesthetic/sedative formulations of plant essential oils and method of preparation thereof" has been filed to the Indian Patent Office, Kolkata on 02 March 2022 in the name of the Indian Council of Agricultural Research. Patent application No. is 202231011331.
- The patent application entitled "A Remote Controlled Drone Based Water Sampling System" has been filed to the Indian Patent Office, Kolkata on 17 December 2022 in the name of the Indian Council of Agricultural Research. Patent application No. is 202231073303.
- The patent application entitled "Sensor Device to detect toxic metalloids in water and thereof" has been filed to the Indian Patent Office, Kolkata on 29 December 2022 in the name of the Indian Council of Agricultural Research. Patent application No. is 202231076888.

Design Registration

- The design application entitled "Fibreglass Reinforced Polymer Coracle" has been filed on 04 March 2022 in the name of the Indian Council of Agricultural Research. Designapplication No. is 359898-001.
- The design application entitled "Fibreglass Reinforced Polymer Ornamental Breeding and Rearing Tank" has been filed on 04 March 2022 in the name of the Indian Council of Agricultural Research. Design application No. is 359899-001.

Trademark

- The trademark application entitled "CIFRI HDPE Circular Cage™" has been filed on 30 November 2022, under class 22 in the name of the Indian Council of Agricultural Research. Trademark application No. 5703691.

Commercialization and Licensing of Technologies

In the year 2022, three technologies have been commercialized and licensed on non-exclusive basis by the institute for five year duration.

- **CIFRI Circular Cage:** The Circular HDPE cages are structurally sturdier and therefore can withstand a higher degree of wave action and storms. CIFRI circular cage structure with 16 meter diameter and 5 meter depth has 900 cubic meter water area for cage culture. Trademark application "CIFRI Circular Cage" filed with application no. 5703691 dated 30 November 2022, under class 22 in the name of Indian Council of Agricultural Research. The product is commercialized through Agrinnovate India Ltd. and licensed to M/s. Das and Kumars, Varanasi, Uttar Pradesh on 27 September 2022.
- **FRP Coracle with seating arrangement:** The facility (FRP coracle) created with sitting arrangements will provide easy and fast transport than a wooden boat as well as the live fish can also be transported without much more additional investment. FRP coracle with seating arrangement design application No. 359898-001 dated 04 March 2022. The product is licensed to M/s. M. R. Aquatech, Bhubaneswar, Odisha on 08 March 2022.
- **FRP Ornamental Tank:** A single breeding and rearing tank unit is a basic requirement for rural ornamental fish farmers. To overcome the difficulties in a single tank breeding and rearing process, a specially designed tank will help in providing two separate spaces for breeding and rearing and also helps in overcoming the excessive expenses in the breeding. The product is licensed to M/s. M. R. Aquatech, Bhubaneswar, Odisha on 08 March 2022.

Technology Ready for Commercialization

Four technologies of ICAR-CIFRI as mentioned below have already been approved for commercialization through Agrinnovate India Ltd., commercial arm of Indian council of Agricultural Research.

- **BSF floating fish feed:** Black soldier fly (BSF), *Hermetia illucens* incorporated feed is a cost-effective feed formulation suitable for successful rearing and production of Pangas, GIFT Tilapia and Amur carps in cages. This feed has good acceptability and palatability. This feed will be made available with 24, 26 and 28% crude protein. An average FCR of 1.4 is obtained in cages at the temperature range of 28-32°C.The technology was developed by ICAR-CIFRI and ICAR-NBAIR. The product is ready for licensing through Agrinnovate India Pvt. Ltd., New Delhi.
- **CIFRI Fish Tanavhari:** CIFRI Fish Tanavhariis a unique sedative and anestheticplant essential oil formulation used for fish handling and transportation under laboratory and field conditions. This solution does not possess any side effects on fish health and has quick recovery to normal conditions. The formulation is prepared from plants, particularly edible plant-based materials so it is environmentally safe and very

much cost-effective. The product is ready for licensing through Agrinnovate India Pvt. Ltd., New Delhi.

- **Tissue Embedding Machine:** The machine is user-friendly equipment for histological laboratories with extremely low cost in comparison to automatic tissue embedding machines. Much skill is not required to operate, unlike an automatic tissue embedding machine. The machine can handle more than 500 samples at a time due to the large volume (8l) of the paraffin reservoir. The product is ready for licensing through Agrinnovate India Pvt. Ltd., New Delhi.

- **CIFRI Portable Assembly for Submersible Echo Sounder:** The portable assembly of an echosounder will make it easy to attach and unlatch the echosounder with pre-determined lodging positions. The progress made by this assembly will serve to use this application effectively and be more user-friendly. Using this assembly pre-set lodging positions of the lodging mechanism can be engaged. The product is ready for licensing through Agrinnovate India Pvt. Ltd., New Delhi.

Memorandum of Understanding (MoU) Signed

- A MoU was signed between ICAR-CIFRI, Barrackpore and NTPC on 16 July 2022 for imparting state of knowledge on fish breeding to the local fishermen for livelihood improvement and enhancing the native fish population through ranching programme in river Ganga.

- MoU was signed between ICAR-CIFRI, Barrackpore and Andhra Pradesh Fisheries Department on 21 November 2022 for development of sustainable fisheries model including Reservoir-wise management plan and Design framework for Cost Effective Laboratories at RBK level and vision building for Fisheries University.

- MoU was signed between ICAR-CIFRI, Barrackpore and M. R. Aquatech, Bhubaneswar on 08 March 2022 at Barrackpore for non-exclusive License agreement of "FRPCORACLE" Technology.

- MoU was signed between ICAR-CIFRI, Barrackpore and M. R. Aquatech, Bhubaneswar on 08 March 2022 at Barrackpore for non-exclusive License agreement of "FRP ORRNAMENTAL BREEDING & REARING TANK" Technology.

- MoU was signed between Das & Kumars, Varanasi, Agrinnovate India Ltd. (AgIn) and ICAR-CIFRI, Barrackpore on 27 September 2022 at Barrackpore for non-exclusive License agreement of "CIFRI CIRCULAR CAGE" Technology.

- MoU was signed between ICAR-CIFRI, Barrackpore and Hemnagar Sundarban Dream on 26 July 2022 for capacity building of Hemnagar Sundarban Dream trainers and progressive farmers on fisheries-related activities through providing training, exposures.

Research and Review Paper

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Pamphlets/Leaflets/Folders

- Debnath D, Das SCS, Yadav AK, Bhattacharjya BK and Das BK (2022). Cage culture technology for Dumbur reservoir of Tripura. ICAR-CIFRI Leaflet # 13.
- Debnath D, Das SCS, Yadav AK,Bhattacharjya, BK and Das BK (2022). খাঁচায় মাছ চাষ : ত্রিপুরার ডুম্বুর জলাধারের জন্য একটি আধুনিক মাছ চাষ প্রযুক্তি. ICAR-CIFRI Leaflet # 14.
- Das BK, Chanu TN, Yengkokpam, S, Debnath D and Bhattacharjya, BK (2022). Pengba ranching for sustainable fisheries in Loktak lake, Manipur. CIFRI/Leaflet/ 2022/12.
- Das BK, Yengkokpam, S, Debnath D, Chanu TN and Bhattacharjya, BK (2022). Technologies and guidelines for wetland and reservoir fisheries of Manipur. CIFRI/Leaflet/2022/13.
- Das BK, Chanu TN, Yengkokpam S, Debnath D and Bhattacharjya BK (2022). লোক্তাক পাৎ কী সংরক্ষণ ফিসরিজ কী দমক লোক্তাক পাৎ তা পেহবা থাদোকপা। CIFRI/Leaflet/2022/14.
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- Web based Indian Riverine Fisheries Information System (IRFIS) (http://14.139.208.122:81/river_portal/Index_river.html). ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700 120.

Hindi Publication

- राजू बैठा, हसन एम. ए., सुमन कुमारी, गुंजन कर्णाटक, गणेश चंद्र, मिशाल पी., लियनथुमलोईया, दास बी. के. 2022. सामुदायिक भागीदारी मत्स्योपादन से आयमें वृद्धि एवं स्थायी आजीविका का सृजन. सारांश पुस्तिका 'आत्मनिर्भर भारत के लिए टिकाऊ जलकृषि' पर राष्ट्रीय सम्मेलन, 23–24 सितम्बर 2022, मात्स्यिकी–सिफा, पृष्ठ संख्या 1–106. सारांश–NaCSAAB@SEL-08

Awards to the staff members

- Dr. A. Alam, senior scientist awarded the Fellow of Kalash Research & Welfare Society Award-2022 on the occasion of National Seminar on "Bhoomi Suposhan: Approaches and practices to enrich Soil and domestic animals for sustainable Rural development" on 08-09 January 2022 at Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidhyalaya, Chitrakoot, Satna, M. P.
- Dr. A. K. Sahoo, Senior Scientist received Padmashri Dr. S. Ayyapan Gold Medal Award from Inland Fisheries Society of India, Barrackpore in 2022. The Award was conferred in '1st Indian Fisheries Outlook (IFO)' held at ICAR-Central Inland Fisheries Research Institute, Barrackpore during 22-24 March 2022.
- Dr. A. K. Yadav, Senior Scientist received Best PhD thesis award by Society of Biotic and Environmental Research (SBER), Tripura for outstanding research and quality of PhD thesis during "2nd Biotic Congress 2022" and "International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research" held at Nowgong College, Nagaon, Assam during 08-09 August, 2022.
- Dr. Dibakar Bhakta, Scientist received the best oral presentation award for paper on "Winter migratory bag net fishery in Hooghly-Matlah Estuary: present predicament and prospects" at International Conference on 'Responsible Aquaculture and Sustainable Fisheries Interact (RASHI)-2022 held at College of Fisheries, CAU (Imphal), Tripura during 13-16 December 2022. He has also secured 1st position in the international photography contest at this conference.
- Dr. Dipesh Debnath, Senior Scientist received Life Fellow

Dr. A. K. Sahoo receiving Padmashri Dr. S. Ayyapan Gold Medal award

Dr. A. K. Yadav receiving Best PhD thesis award

Dr. Dibakar Bhakta receiving Best Oral Presentation and International Photography Contest award

Award of CFSI for his research contribution during the National Symposium on 'Fisheries and aquaculture for livelihood and nutritional security' held at ICAR-DCFR, Bhimtal during 18-19 November 2022.

- Dr. D. N. Jha, Senior Scientist was awarded the Best Oral presentation award in IFO-2022, organized by ICAR-CIFRI, Barrackpore during 22-24 March,2022.
- Dr. Dhruba Jyoti Sarkar received the Vigyan Sera Pratibha Award at the Vigyan Utsav on 04 December 2022 on the occasion of Silver Jubilee year in co-operation with Department of Science and Technology and Biotechnology, Government of West Bengal organized by Central Calcutta Science and culture Organization for Youth.
- Dr. Dhruba Jyoti Sarkar received the Best Oral presentation Award under the theme in 1st Indian Fisheries Outlook 2022 on "Priming Indian Fisheries in Attaining Sustainable Development Goal" held at ICAR-CIFRI during 22-24 March, 2022.
- Dr. Dhruba Jyoti Sarkar received the Scientist of the Year Award from ICAR-CIFRI on the occasion of the 73rd Republic Day of India on 26 January 2022.
- Mr. Mitesh H. Ramteke, Scientist received Appreciation Award for remarkable contribution in conducting 1st Indian Fisheries Outlook, 2022 held at ICAR-CIFRI, Barrackpore during 22-24 March 2022.
- Mr. Mitesh H. Ramteke, Scientist received first prize in Hindi poetry competition in Hindi Saptah 2022 held during 14-20 September 2022 at ICAR-CIFRI, Barrackpore.
- Ms. Niti Sharma, Scientist received best presentation award for a paper entitled 'Assessment of Ichthyofaunal diversity and

Dr. Dipesh Debnath receiving Life Fellow Award of CFSI

Dr. D. N. Jha receiving the Best Oral presentation award in IFO-2022

Dr. Dhruba Jyoti Sarkar receiving the Best Oral presentation award

habitat variables in Himalayan Brahmaputra River of Assam, North-eastern India' authored by Sharma, N.,Bhattacharjya, B. K., Debnath, D., Das, S.C.S., Kakati, A and Das. B. K at the 2nd International Conference on River Corridor Research and Management held during 30th May to 01 June 2022 organized by IIT, Guwahati and IIT, Jammu.

- Mr. Pranab Gogoi, Scientist received Appreciation Award for remarkable contribution in conducting 1st Indian Fisheries Outlook, 2022 held at ICAR-CIFRI, Barrackpore during 22-24 March 2022.
- Dr. Preetha Panikkar received the Best presentation award for the paper on Food web structure and trophic interactions in Stanley reservoir, Tamil Nadu at the 1st Indian Fisheries Outlook 2022 ICAR- CIFRI, Barrackpore, West Bengal held during 22-24 March 2022.
- Dr. Pronob Das, Senior Scientist received "Research Excellence Award 2022" awarded by Society of Biotic and Environmental Research (SBER), Tripura for his contribution in the field of Fisheries and Aquaculture Research during "2nd Biotic Congress 2022" and "International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research" held at Nowgong College, Nagaon, Assam during 08-09 August 2022.
- Dr. Pronob Das, Dr. B. K. Bhattacharjya and Dr. B. K. Das received Best oral presentation for a paper "Strategies for sustainable utilization of open water fisheries resources of Meghalaya: A way forward" at the "2nd Biotic Congress 2022" and "International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research" held at Nowgong College, Nagaon, Assam during 08-09 August 2022.

Dr. Preetha Panikkar receiving the best presentation award

Dr. Pronob Das receiving "Research Excellence Award 2022

- Dr. Raju Baitha received "Young Scientist award and Young Extension Scientist Award" in "Fisheries and Life Science Awards: 2022" from Society of Fisheries and Life Sciences, College of Fisheries, Mangaluru, Karnataka, India.
- Dr. Raju Baitha received "Best Oral Presentation Award" in the National Conference (Hindi) on "Sustainable Aquaculture for Atmanirbhar Bharat" during 23-24 September 2022 jointly organized by ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), Kausalyaganga, Bhubaneswar & Association of Aquaculturists, Bhubaneswar.
- Santhana Kumar V. received Prof. A. P. Sharma gold medal for outstanding contribution in the field of fisheries science at 1st Indian Fisheries Outlook 2022 on "Priming Indian Fisheries in Attaining Sustainable Development Goal" held at ICAR-CIFRI during 22-24 March 2022.
- Dr. Srikanta Samanta, Head, REF Division received the best oral presentation award for paper on "Conservation aquaculture initiatives for protection of hilsa fisheries in India" under the theme 'Fisheries Resources and Sustainability' at International

Conference on 'Responsible Aquaculture and Sustainable Fisheries Interact (RASHI)-2022 held at College of Fisheries, CAU (Imphal), Tripura during 13-16 December 2022.

- Dr. Srikanta Samanta, Head, REF Division received Dr. Hiralal Choudhury Gold Medal Award from Inland Fisheries Society of India, Barrackpore in 2022. Award conferred on the event of '1st Indian Fisheries Outlook' held at ICAR-Central Inland Fisheries Research Institute, Barrackpore during 22-24 March 2022.
- Dr. Suman Kumari got Best Presentation Awardat National Conference on "Sustainable Aquaculture for Atmanirbhar Bharat"(Hindi) held at ICAR-CIFA, Bhubaneswar during 23-24 September, 2022
- Dr. Suman Kumari got Padmashri Dr. S. Ayyappan Award by Inland Fisheries Society of India on the occasion of 1st Indian Fisheries Outlook held at ICAR-CIFRI during 22-24 March 2022.
- Dr. Suvra Roy received the Dr. M. L. Bhowmik Award for Best Young Scientist-2022 for the contribution in fisheries research at International Conference on Responsible Aquaculture & Sustainable Fisheries Interact (RASHI) 2022 College of Fisheries, Lembucherra, Tripura.
- Ms. T. N. Chanu, Scientist was awarded 3rd best oral presentation award in the Technical Session VI of the 6th International Conference on "Current Issues in Agricultural, Biological & Applied Sciences for Sustainable Development (CIABASSD-2022)" held at Kalimpong Science Centre during 11-13 June 2022
- Dr. Vikash Kumar received Best speaker award at the 3rd international conference on Aquaculture and marine biology held on 24-25 March 2022 organized by Conference mind.

Santhana Kumar V. receiving Prof. A. P. Sharma gold medal award

Dr. Srikanta Samanta receiving Dr. Hiralal Choudhury Gold Medal Award

Dr. Suman Kumari receiving Padmashri Dr. S. Ayyappan Award

Recognitions to staff members

- दिनांक 23–24 सितंबर 2022 को भाकृअनुपदृकेन्द्रीय मीठाजल जीवपालन अनुसंधान संस्थान, भुवनेश्वर और एसोसिएशन ऑफ एक्वाकलचरिस्ट (एओए) द्वारा 'आत्मनिर्भर भारत के लिए टिकाऊ जलकृषि' पर राष्ट्रीय हिन्दी सम्मेलन में निदेशक, डॉ. बि. के. दास को सम्मानित किया गया।
- Dr. Arun Pandit acted as advisory committee member of Ms. Waghmare Sneha Dadarao, for her M.F.Sc. (Fisheries Economics) thesis 'Ecosystem valuation and trophic structure dynamics for sustainable fisheries management in Dimbhe reservoir, Maharashtra' submitted to ICAR-Central Institute of Fisheries Education, Mumbai in July 2022
- Dr. Arun Pandit reviewed thesis and conducted viva voce for Shri Sagar Sitaram Rathod, and Shri Suresh Patro, MFSc scholars of ICAR-Central Institute of Fisheries Education, Mumbai, August 2022. He also reviewed PhD thesis of Sh. Dhande Kranthi Kumar of ICAR-Central Institute of Fisheries Education, Mumbai.
- Dr. Arun Pandit acted as committee member for career assessment scheme of Sh Ankush Lala Kamble, Scientist, ICAR-CIFE online, on 24 June 2022.
- Dr. Arun Pandit acted as the member of selection committee for selecting Field investigator and Research Assistant for 'Skill gap in FPO ecosystem' project of WB University on Animal and Fishery Sciences on 27 July 2022.
- Dr. Arun Pandit acted as Reviewer for Journal of the Inland Fisheries Society; Inland Journal of Fisheries, Frontiers in Sustainable Food Systems; Frontiers in Marine Science.
- Anjana Ekka served as invited speaker in 'International symposium on water sustainability, Challenges, Technology and opportunities' on 22-24 March 2022 organized by UNESCO Chair on Experiential Learning for Sustainable Innovation and Development, Amrita School for Sustainable Development (AST), India.
- Dr. A. K. Sahoo, Senior Scientist, served as the Guest Editor: Frontiers in Marine Science Hilsa Shad: Progress in Science and Management and Science and Culture, 88(11-12).
- Dr. A. K. Sahoo, Senior Scientist, served as the Associate Editor: Environmental Science and Pollution Research Environmental Science and Pollution Research | Call for papers: special issue on valorization of agroindustry and seafood waste towards blue economy: a waste to wealth concept (VAIWASFP-2022).
- Dr. A. K. Sahoo, Senior Scientist, served as the Guest speaker In Workshop on E-flows training on "Introduction to Interlinking of Hydraulic and Habitat Conditions Hosted by National Water Academy, Pune during 05-07 April 2022 on Fish assemblage life cycle and habitat characterization and their importance and use in E-Flows assessment".
- Dr. A. K. Sahoo, Senior Scientist, served as the External examiner for M. Phil degree in Fisheries Science, Vidyasagar University.
- Dr. A. K. Sahoo, Senior Scientist has been nominated as Technical Member: EAC, River valley Projects, MoEFCC, GoI. He has also been nominated as Technical Member: ISO, Biodiversity TC 331, GoI.
- Dr. A. K. Sahoo, Senior Scientist, served as the External Examiner in M.F.Sc. Thesis evaluation from Department of Aquaculture, Managalore Fisheries College, KVAFSU.
- Dr. Archana Sinha acted as the Editor on "Ornamental fishing industry" for Frontiers in Marine Sciences.
- Dr. Archana Sinha acted as an Outside expert for Five Yearly Assessment of Technical Officials of Category III under the Field & Farm Technician Group for considering them for promotion to the next higher grade or grant of advance increment(s) on 22 December 2022.
- Dr. Archana Sinha was nominated by ASRB, New Delhi as outside expert for Five Yearly Assessment of Technical Officers under the Field and farm Group (Group I) for Category III for next higher grade/Promotion on 22 July 2022.
- Dr. Archana Sinha acted as an examiner to set a question paper and evaluate answer scripts for examination of the M.F.Sc. programme for Course No. AQC-505: Fish Nutrition and Feed Technology (2+1).
- Dr. Archana Sinha evaluated the thesis entitled "Studies on morphometric analysis and stock status of *Pila globosa* (Swainson, 1822) from Manika Oxbow Lake, Muzaffarpur, Bihar." Submitted by Dikeshwar Prasad, M.F.Sc. student, Department of Fisheries Resource Management, College of Fisheries, Dholi, RPCAU, Pusa, Samastipur, Bihar as an External Examiner and conducted Viva-Voce examination on 05 December 2022.
- Dr. D. Bhakta, Scientist acted as invited speaker in a training programme at the Falta experimental Farm, Bose Institute on 16 November 2022.
- Mr. Mitesh H. Ramteke participated in discussion on river ranching of IMC & native fish species in Tamil Nadu under PMMSY with Commissioner of Fisheries and other officials of Tamil Nadu fisheries department in virtual mode on 31 May 2022.
- Dr. Preetha Panikkar has been nominated by the Ministry of Science and Technology for the project evaluation submitted to Technology Development Board.

- Dr. Preetha Panikkar as a lead speaker on Sustainable fisheries development in inland fisheries: prospects and challenges at the national conference on Interdisciplinary Approaches -The Keystone Towards Sustainable Future" in Bangalore on 22 September 2022.
- Dr. Preetha evaluated the thesis on "Assessment of litter with special reference to plastics and its impact on the biota of Vembanad wetland ecosystem, Kerala, India submitted to Cochin University of Science and Technology, Kerala.
- Dr. Preetha Panikkar delivered a Plenary Lecture speaker at the Annual National Conference on Sustainable Ecosystems, Aquaculture, Fisheries and Fisherfolk (ANCOSEAFF, 2022), organized by the Department of Aquatic Biology and Fisheries, University of Kerala at Kariavattom campus of University of Kerala, Thiruvananthapuram from 29 January 2022.
- Dr. Pronob Das acted as expert on Fisheries and Aquaculture in Krishi Darshan Program of DDK, Guwahati on 09 November 2022.
- Dr. Pronob Das acted as an Editorial Board Member of "Acta Scientific Agriculture" journal of Acta Scientific Open International Library.
- Dr. Pronob Das acted as Review Editor on the Editorial Board of Production Biology (specialty section of Frontiers in Aquaculture) of Frontiers.
- Dr. Pronob Das acted as Review Editor on the Editorial Board of Freshwater Science (specialty section of Frontiers in Environmental Science) of Frontiers.
- Dr. Pronob Das received Letter of appreciation from the Elsevier Journals Leadership Team for my Peer review of Elsevier Journals on 31 January 2022.
- Dr. Pronob Das acted as reviewer of peer reviewed journals *viz.*, Aquaculture, Aquaculture Research, Aquaculture Nutrition, Aquaculture International, Turkish Journal of Fisheries and Aquatic Studies, Fish Physiology and Biochemistry, Journal of Tropical Agricultural Science, Journal of Applied Aquaculture and Aquaculture, Fish & Fisheries.
- Mr. Pranab Gogoi, Scientist acted as an Expert Faculty in the training programe in Ecosystem Modelling: Towards Management of Inland Fisheries organized by ICAR-CIFRI, Barrackpore during 27 July to 02 August 2022.
- Mr. Roshith C. M., Scientist acted as invited speaker on "Coral Reef Management" in the NFDB Sponsored Awareness Webinar on "Biodiversity in Protected Ecosystems: Assessment and Conservation" organized by the Division of Fisheries Resource Management, Faculty of Fisheries, SKUAST – Kashmir, Jammu and Kashmir.
- Mr. Roshith C. M., Scientist acted as invited speaker on "Integrative Taxonomy – Concepts and Application in Identification of Fishes" during "Hands-on-Training on Basic Tools for Taxonomy and Biological Studies of Fishes". Organized by ICAR-Central Institute of Fisheries Education, Mumbai from 22-26 August 2022.
- Dr. S. K. Das, Dr. R. K. Manna, Dr. A. K. Sahoo, Mr. P Gogoi of the Division acted as Observers for conducting online Computer Based Test (CBT) for the post of Assistant and T1 held at different centers of West Bengal during 29 July 2022 and 28 February to 05 March 2022, respectively.
- Dr. S. Samanta, Head REF Division served as a member of the Evaluation Committee of ICAR-CRIJAF, Barrackpore for Institute Awards for the Best Scientist, Best Entrepreneur, Best Farmer, Best Self-Help Group on 28 January 2022 and for Best Technical Staff on 29 January, 2022.
- Dr. S. Samanta, Head REF Division served as an External Member in the Selection Committee constituted for selection of Research Associate in the DST-SERB project, Govt. of WB sponsored project at ICAR-CRIJAF, Barrackpore on 21 March 2022.
- Dr. S. Samanta, Head REF Division acted for providing input to United Kingdom based Food Journalist Ms. Mallika Basu on hilsa production, export and consumption associated aspects. The Journalist published the document on the topic 'How hilsa became one of the World's priciest fish' on 23 November 2022.
- Dr. S. Samanta, Head, REF Division served as the Guest Editor for 24(4) 2021 and 25(2) 2022 issues of the Journal Aquatic Ecosystem Health and Management.
- Dr. S. Samanta delivered lecture on Anthropogenic interferences in rivers vis-à-vis its impact on ecosystem and fisheries in the NFDB sponsored webinar on Impact of anthropogenic interferences in river ecosystem and fisheries.
- Dr. S. Samanata Head, REF Division is serving as a Member, Wetland Management Authority, Govt. of West Bengal
- Dr. S. K. Das, Principal Scientist acted as a Member of Judging Committee for evaluation of papers presented in the National Webinar on 'Managing Agro-Chemicals for Crop and Environmental Health' organized by the Society for Fertilizers and Environment during 25-26 February 2022.
- Dr. S. K. Manna acted as the Chairperson in poster presentation

session (Theme 4, Healthy aquatic for wealthy fish) in International Conference on Responsible Aquaculture and Sustainable Fisheries Interact (RASHI 2022) held at CoF, Lembucherra, Tripura during 13-16 December 2022.

- Dr. S. K. Nag was a member of judging committee for evaluation of papers presented in the National Webinar on 'Managing Agro-chemicals for Crop and Environmental Health; organized by the Society for Fertilizers and Environment during 25-26 February 2022.
- Dr. S. K. Nag was an External Screening and Evaluation Committee Member at ICAR-CRIJAF, Barrackpore for short listing of ideas received under MSME idea Hackathon 2.0.
- Dr. S. K. Nag was a Member of Judging Committee for evaluation of papers presented in the National Webinar on 'Managing Agro-chemicals for Crop and Environmental Health; organized by the Society for Fertilizers and Environment during 25-26 February 2022.
- Dr. S. K. Nag was an External Screening and Evaluation Committee Member at ICAR-CRIJAF, Barrackpore for short listing of ideas received under MSME idea Hackathon 2.0.
- Dr. U. K. Sarkar, HoD was appointed to act as external examiner for PhD viva-voce by Guru-Nanak Dev University, Amritsar, on 23 July 2022.

Linkages help to transmit knowledge and skills between the linked organizations. ICAR-CIFRI has established its linkages with several organizations for research and development, extension, education, outreach activities, seminars, workshops, publications, etc. Linkages are important in the spread and diffusion of knowledge, innovation, and developmental activities.

During 2022 the Institute maintained linkages with the following organizations

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
- World Fish Centre, Malaysia
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
- French Embassy

Foreign Universities

- Ghent University, Ghent, Belgium
- University of Manitoba, Canada
- University of Ottawa, Canada
- University of Waterloo, Canada
- Wageningen University, Netherlands
- Freie Universität, Berlin, Germany
- The University of Arizona, United States
- RMIT University, Australia
- Sylhet Agricultural University, Bangladesh

International Societies and Humanitarian organizations

- Aquatic Ecosystem Health & Management Society, Canada
- Rotary International
- International Collective in Support of Fish workers
- Wetlands International South Asia
- World Wide Fund for Nature, India

Linkages within India

Central Departments, Boards and Authorities

- Agrinnovate India Ltd., New Delhi
- AkashVani, Kolkata
- Brahmaputra Board, Ministry of Jal Shakti, Govt. of India
- Bureau of Indian Standards, New Delhi
- Central Water Commission, New Delhi
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Department of Biotechnology, New Delhi
- Farakka Barrage Authority, Murshidabad, West Bengal
- Indian Science Congress Association, Kolkata
- Ministry of Environment, Forest & Climate Change, Govt. of India, New Delhi
- Narmada Control Authority, Department of River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Govt. of India, Indore
- National Bank for Agriculture and Rural Development
- National Biodiversity Authority
- National Fisheries Development Board, Hyderabad
- National Mission for Clean Ganga, Department of River Development and Ganga Rejuvenation, Ministry of Jal Shakti, Govt. of India, New Delhi
- National Statistical Organization, National Accounts Division, Min. of Statistics and Programme Implementation, Govt. of India
- Zoological Survey of India, Kolkata
- Central Silk Board-CSRTI, Mysore and CTR & TI, Ranchi, Ministry of Textiles, Govt. of India Central Pollution Control Board

National Central Universities & Institutes

- Assam Agricultural University, Jorhat
- Benares Hindu University, Varanasi
- Bihar Animal Science University, Patna
- Centre for Development of Advanced Computing, Kolkata
- Central University of South Bihar, Patna
- Chaudhury Charan Singh National Institute of Agricultural Marketing, Jaipur

- College of Fisheries, Central Agricultural University, Lembucherra, Agartala
- Department of Zoology, University of Calcutta, Kolkata
- Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur
- G.B. Pant University of Agriculture & Technology, Pantnagar
- Indian Institute of Technology, Hyderabad
- Indian Institute of Technology, Jammu
- Indian Institute of Technology, Kharagpur
- Indian Statistical Institute, Kolkata
- Visva-Bharati University, Santiniketan
- Wildlife Institute of India, Chandrabani, Dehradun

ICAR Organizations

- Dhaanyaganga KVK, North 24 Parganas, Nadia, West Bengal
- Ashokenagar KVK, South 24 Parganas, West Bengal
- Gayeshpur KVK, Nadia, South 24 Parganas
- ICAR Research Complex for NEH Region, Umiam
- ICAR-Agricultural Technology Application Research Institute, Kolkata
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar
- ICAR-Central Institute of Fisheries Education, Mumbai
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar
- ICAR-Central Institute of Sub-tropical Horticulture, Regional Research Station Malda, West Bengal
- ICAR-Indian Institute of Soil and Water Conservation
- ICAR-Central Marine Fisheries Research Institute, Kochi
- ICAR-Central Research Institute of Jute & Allied Fibre, Barrackpore
- ICAR-Directorate of Coldwater Fisheries, Bhimtal
- ICAR-Indian Agricultural Statistics Research Institute, New Delhi
- ICAR-National Academy of Agricultural Research Management, Hyderabad
- ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
- ICAR-National Bureau of Fish Genetic Resources, Lucknow
- Krishi Vigyan Kendra, DRPCAU, Piprakothi, East Champaran, Bihar
- CHIS-Krishi Vigyan Kendra, Malda, West Bengal
- Rathindra Krishi Vigyan Kendra, Visva-Bharati, Sriniketan, Birbhum, West Bengal

State Departments, Boards and Authorities

- Assam Fisheries Development Corporation Ltd.
- Assam Rural Infrastructure and Agricultural Services Society (ARIAS)
- Chilika Development Authority, Bhubaneswar
- Department of Fisheries & Aquatic Resources, Nagaland
- Department of Fisheries, Govt. of Gujarat
- Department of Fisheries, Govt. of Manipur
- Department of Fisheries, Govt. of Tripura
- Department of Fisheries, Govt. of Uttarakhand
- Department of Forest, Govt of Gujarat, Ukai
- Department of Environment, Forest and Climate Change, Government of Bihar, Patna
- Department of Forest, Govt. of Odisha
- Department of Forest, Govt. of West Bengal
- Department of Forest, Govt. of Madhya Pradesh
- Directorate of Fisheries, Govt. of Andhra Pradesh
- Directorate of Fisheries, Govt. of Arunachal Pradesh
- Directorate of Fisheries, Govt. of Assam
- Directorate of Fisheries, Govt. of Bihar
- Directorate of Fisheries, Govt. of Chhattisgarh
- 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 Madhya Pradesh
- Directorate of Fisheries, Govt. of Maharashtra
- Directorate of Fisheries, Govt. of Meghalaya
- Directorate of Fisheries, Govt. of Odisha
- Directorate of Fisheries, Govt. of Telangana
- Directorate of Fisheries, Govt. of Tripura
- Directorate of Fisheries, Govt. of Uttar Pradesh
- Directorate of Fisheries, Govt. of West Bengal
- East Kolkata Wetland Management Authority, Department of Environment, Govt. of West Bengal
- Gujarat Maritime Board, Bharuch
- Narmada Control Authority, Gujarat
- Narmada Control Authority, Indore
- Narmada Water Resources, Water Supply and Kalpasar Department, Gandhinagar
- Sardar Sarovar Narmada Nigam Limited
- Sundarban Development Board, West Bengal
- Swami Vivekananda State Police Academy, Barrackpore
- West Bengal Biodiversity Board

- Rural Livelihood Mission, West Bengal
- ATMA, Bhagalpur
- Krishi Vigyan Kendra, BAU, Sabour

State Colleges/Universities

- Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia
- Bihar Agricultural University, Sabour
- College of Fisheries, Kishanganj, Bihar
- Fakir Mohan University, Balasore
- Munger University, Bihar
- University of Kalyani, Kalyani
- West Bengal University of Animal and Fishery Sciences (WBUAFS), West Bengal
- Manipur University, Imphal
- Utkal University, Bhubaneswar
- Vidyasagar University, Midnapore
- College of Fisheries, Gumla, Jharkhand
- Vidyasagar College for Women, Kolkata
- College of Fisheries, Raha, Assam
- Hooghly Mahsin College
- B. K. C. College, West Bengal
- D. M. College, Imphal
- Dr. Rajendra Prasad Central Agricultural University, Dholi, Bihar
- College of Fisheries, Udgir, Maharashtra
- Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Tamil Nadu

Central Public Sector Units

- National Hydroelectric Power Corporation (NHPC) Limited
- North Eastern Electric Power Corporation (NEEPCO) Limited
- Satluj Jal Vidyut Nigam (SJVN) Limited
- National Thermal Power Corporation Ltd., Farakka
- National Thermal Power Corporation Ltd., Gaderwara

Other Organizations/ NGOs

- Assam Agribusiness and Rural Transformation Project (APART)
- BANO charitable trust, Odisha
- Glaucus Agrochem Pvt. Ltd., Kolkata
- MR Aquatech, Bhubanaswar
- NIRMAN, Odisha
- RKMVERI, Belur
- Odisha Environment Society
- Pradan
- Ram Krishna Mission Ashram, Sargachi, Murshidabad
- Ram Krishna Mission Ashram, Ranchi
- Ramakrishna Mission, Bhadrak
- Ramakrishnayan Society of Moyna, West Bengal
- Ri-Bhoi Farmers' Union, Meghalaya
- SKSVYCS, NGO, Sundarbans,
- Sundarban Dreams

ICAR-CIFRI in Media : 2022

THE TIMES OF INDIA

Tips from experts to increase fish production, boost income

वर्तमान पत्रिका

राज्य में मछली उत्पादन बढ़ाने का लक्ष्य

सन्मार्ग

10K fish fingerlings released in Ganga under ranching plan

दबंग दुनिया

युगशङ्ख

वर्तमान

मत्स्य प्रजातियों और डॉल्फिन के संरक्षण के लिए विशेष पहल की जरूरत

One-day workshop for colorful fish farming organised in Sundarban

दबंग दुनिया

नदीय पारिस्थितिकी एवं मात्स्यिकी में मानवजनित हस्तक्षेप के प्रभाव पर चर्चा

दैनिक जागरण

METRO

ICAR CIFRI conducts ranching programme at Manipur

दुरन्त बार्ता

मत्स्य आदान वितरण और जन जागरूकता कार्यक्रम

ICAR-CIFRI knowledge initiative

THE TIMES OF INDIA

ICAR-CIFRI worm waste fish feed

বর্তমান

বর্তমান

মৎস্য চাষিদের প্রশিক্ষণ কর্মসূচি

The Annual Training Plan (ATP) of all categories of employees of the Institute for the year 2022-2023 was prepared based on the training need assessment and submitted through TMIS. There was 69% realization of trainings planned during the year. Category wise, as per the target 93% scientists attended training, but due to non availability of suitable training for the administrative and technical staff, the target could not be achieved for them. As per the plan, all six SSS grade employees attended the exposure visit. Two training programme *viz.*, "Ecosystem Modelling: Towards Management of Inland Fisheries" and "Advanced methodoligical approach on benthos in the inland open waters" were also organised at the institute by the HRD unit.

Annual Physical and Financial Targets and Achievements (April - December 2022)

A. Physical Targets and Achievements

Sl. No.	Category	Total No. of Employees	No. of trainings planned for each category during 2022-23 as per ATP	Total No. of employees undergone training during April 2022 to December 2022
1	Scientist	77	15	14
2	Technical	43	7	4
3	Administrative & Finance	32	7	0
4	SSS	22	6	6
	Total	174	35	24

B. Financial Targets and Achievements (April - December 2021)

BE 2022-23 for HRD (₹ in lakh)	Actual Expenditure (up to 31 December 2022) (₹ in lakh)	% Utilization of allotted budget
2.04	1.03	50.5

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
1.	Review Meeting of Officers and Staff of ICAR Hqrs., Institutes of ICAR, ASRB and DARE	All Staff of ICAR-CIFRI	04 January, 2022	ICAR, New Delhi; Virtual mode
2.	Reorienting the strategies towards sustainable aquaculture and fisheries	Thankam Theresa Paul	6-7 January, 2022	KUFOS, Kerala
3.	Meeting of Research and Extension Council of West Bengal University of Fisheries and Animal Sciences	U. K. Sarkar, A. K. Das	08 January, 2022	ICAR-CIFRI
4.	Webinar on Microbial Biotechnology for Novel Food and Food Ingredients	Soma Das Sarkar	11 January, 2022	The agriculture and food systems institute, Washington DC and Biotech consortium of India Ltd., New Delhi; Virtual mode
5.	23rd Meeting of the Expert Appraisal Committee for "River Valley Projects"	B. K Das, Director	28 January, 2022	2022 Virtual mode
6.	Empowered Committee Meeting of the NASF project 'Captive Breeding of Hilsa, Tenualosailisha: Phase II'	S. Samanta, R. K. Manna, A.K. Sahoo	01 February, 2022	ICAR
7.	Meeting with CGIAR Centers chaired by Secretary DARE & DG ICAR to discuss ongoing activities of CG Centres with India focus as well as future plans	B.K Das, Director	7 February, 2022	Virtual mode
8.	FAO and ICAR-CIFRI Workshop on "Inland fisheries of India and the creation of capacity in the collection and analysis of inland fisheries statistics"	B.K Das Malay Naskar Arun Pandit Aparna Roy Deepa Sudheesan,	08 February, 2022	ICAR-CIFRI, Barrackpore; virtual mode
9.	Awareness cum training programme on 'Disease and Health Management for Better Production of Fish", organized by College of Fishery Science, Jabalpur	B.K Das, Director	09 February 2022	Virtual mode
10.	Techno Commercial Assessment and Expert Committee Meeting of ICAR-CIFRI technologies	B. K. Das, Ganesh Chandra, Preetha Pannikar, Hemant choudhury, D. K. Meena, Mishal P, Asit Bera, Preetha Panikkar	11 February, 2022	Agri Innovate, New Delhi
11.	Meeting for cluster development of Brahmani river basin and Site visit to Barkot, Odisha	B.K Das, Director	12 February, 2022	Odisha
12.	EAS Workshop on Combating Marine Pollution with a focus on Marine Plastic Debris	B.K Das, Director	14-15 February, 2022	Virtual mode

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
13.	Geo-Spatial Analysis using QGIS & R	Vaisakh G	14-19 February, 2022	NAARM, Hyderabad; virtual mode
14.	National webinar on 'National Surveillance Programme for Aquatic Animal Diseases: A Step towards Establishing Disease Governance System in India'	P. Das, B.K. Behera	15 February, 2022	Department of Fisheries, Government of India
15.	Launch Meeting of 'UK-India Aquaculture Innovation Club'	U. K. Sarkar Mishal P.	18 February, 2022	Virtual mode
16.	Seminar on "The Role of Science in the Development of Indian Agriculture: Challenges and the Future" by Prof. R. Ramakumar, Professor and Former Dean, School of Development Studies, Tata Institute of Social Sciences, Mumbai	Arun Pandit	28 February, 2022	Virtual mode
17.	Screening committee meeting of project proposals to Technology Development Board	Preetha Panikkar	11 March, 2022	Department of Science and Technology, New Delhi
18.	76th Foundation Day of ICAR-CIFRI	All staff members of the institute	17 March,2022	ICAR-CIFRI, Barrackpore
19.	Platinum Jubilee Lecture Series #5 by Prof. Saroj Sanyal, Former VC, BCKV West Bengal on 'Arsenic Contamination of Groundwater: Build-up In Soft-Corp-Human Continuum System & Mitigation'	All staff members of the institute	17 March, 2022	ICAR-CIFRI, Barrackpore
20.	Executive committee meeting of Indian science Congress Association	B.K Das, Director	21 March, 2022	Kolkata
21.	1st meeting of Biodiversity Sectional Committee for registration at BIS portal	B.K Das, Director	22 March, 2022	Virtual mode
22.	1st Indian fisheries Outlook 2022 On "Priming Indian Fisheries in Attaining Sustainable Development Goals"	All staff members of ICAR-CIFRI	22-24 March, 2022	Professional Fisheries Graduates Forum (PFGF) and ICAR-CIFRI, at ICAR-CIFRI, Barrackpore
23.	International symposium on water sustainability, Challenges, Technology and opportunities organized by UNESCO Chair on Experiential Learning for Sustainable Innovation and Development, Amrita School for Sustainable Development (AST), India.	Anjana Ekka	22-24 March, 2022	virtual mode

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
24.	Satellite Symposiums on Hilsa dialogue: a Bay of Bengal perspective	Scientists of REF Division	23 March, 2022	ICAR-CIFRI, Barrackpore
25.	3rd International Aquaculture conference on marine biology	Vikash Kumar, Suvra Roy	24-25 March, 2022	Virtual mode
26.	Industry-Institute Inter-facia meet on policy imperatives, research needs and manpower requirements of the aquaculture sector in India	B. K. Das, Ganesh Chandra	23 March, 2022	ICAR-CIFRI, Barrackpore
27.	Annual General Meeting of ICAR society	B.K Das, Director	26 March, 2022	virtual mode
28.	International Conference on "Recent Trends in Science, Technology, Management & Humanities"	A. K. Yadav	29 March, 2022.	Jagannath University, Haryana
29.	Implementation and training of SPARROW in ICAR	S. Manoharan, P. V. Shajil	19 April, 2022	ICAR, New Delhi; virtual mode
30.	"Utilisation and Diversification of Silkworm Pupae Products for Human & Animal Consumption and Composting"	B.K Das, Director	26 April, 2022	CTRTI, Ranchi
31.	Advisory committee meeting of NASF Project on 'Captive breeding of hilsa, *Tenualosa ilisha*: Phase II'	S. Samanta, R. K. Manna, A.K. Sahoo	26-27 April, 2022	ICAR-CIFRI, Barrackpore
32.	Sustainable Health Science for future Generations from 28-29 April 2022 in ISCA Kolkata Chapter at Kalyani, West Bengal. Delivered a speech on "Fish in Human Nutrition"	B.K Das, Director	28 April ,2022	University of Kalyani, Kalyani
33.	National Rural Livelihood Mission (WB chapter) meeting on survey schedule finalization on 'Integrated Farming Cluster'	Arun Pandit Aparna Roy	28 April, 2022	ICAR-CIFRI Headquarter
34.	12th Indian Fisheries & Aquaculture Forum	Raju Baitha, Vijaykumar M. E	05-07 May, 2022	Tamil Nadu Dr. J Jayalalithaa Fisheries University (TNJFU) & Asian Fisheries Society Indian Branch (AFSIB), at Chennai, Tamil Nadu
35.	Meeting with the Team Leader, COFAD on Inland fisheries development in Assam, Manipur, Tripura, Odisha, Chhattisgarh and Andhra Pradesh under proposed Indo-German Financial Cooperation programme	B. K. Das, Ganesh Chandra	07 May, 2022	ICAR-CIFRI, Barrackpore

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
36.	Statutory Meeting of the Executive Committee of the Indian Science Congress Association	B.K.Das, Director	07 May, 2022	Kolkata
37.	National Symposium on Self-Reliant Coastal Agriculture	Sajina A. M., Suman Kumari	11-13, May 2022	ICAR-CCARI, Goa
38.	Webinar on Enhancing Competitiveness by Investing in Technology, Innovation and Research	Ganesh Chandra	12 May, 2022	Organized by CII, virtual mode
39.	Project evaluation committee meeting of Technology Development Board, Department of Science and Technology, New Delhi	Preetha Panikkar	19-20 May, 2022	Mudhol, Karnataka
40.	PM Garib Kalyan Sammelan	B.K Das, Director & all Scientific and technical staff of HQ	23 May, 2022	Kolkata
41.	National Symposium on 'Indian Agriculture after Independence'	Arun Pandit	24 May, 2022	Virtual mode
42.	Final Meeting for finalization of the FAO-CIFRI document on inland fisheries statistics	B. K. Das and Arun Pandit	24 May, 2022	ICAR-CIFRI Barrackpore
43.	SMD Meeting related to technology	B. K. Das, Director	30 May, 2022	Virtual mode
44.	2nd International Conference on River Corridor Research and Management	Niti Sharma	30 May-1June, 2022	IIT, Guwahati and IIT, Jammu.
45.	Hon'ble PM's interaction with farmers and other stakeholders	All scientists of ICAR-CIFRI, Barrckpore	31 May, 2022	Virtual mode at Indoor stadium, Eastern railway, Behala, Kolkata
46.	13th Asian Fisheries and Aquaculture Forum-2022	Aparna Roy Dibakar Bhakta	31 May-2June, 2022	Tainan City 701, Taiwan; Virtual mode
47.	Lecture #59 under Azadi Ka Amrit Mahotsav, "India's Pride in Green Revolution and way forward" by Prof. G.S. Khush	Arun Pandit	01 June, 2022	Virtual mode
48.	Ecosystem Approach towards sustainable aquatic bio-diversity conservation and management	B. K. Das, Director	06 June, 2022	Virtual mode
49.	6th International Conference on "Current Issues in Agricultural, Biological & Applied Sciences for Sustainable Development (CIABASSD-2022)"	T. Nirupada Chanu	11-13 June, 2022	Kalimpong Science Centre, Darjeeling
50.	World fish W3 meeting	B. K. Das A. K. Das Arun Pandit Aparna Roy	21 June, 2022	ICAR-CIFRI Barrackpore
51.	Vision 2047 for preparing strategic roadmap in fisheries	B. K. Das, Director	21 June, 2022	Virtual mode

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
52.	Meeting on Challenges and Opportunities in Food Systems across the Eastern Gangetic Plains	B. K. Das, Director	22-23 June, 2022	Virtual mode
53.	Techno Commercial Assessment and Expert Committee Meeting	B. K. Das, U. K. Sarkar, Ganesh Chandra, B. K. Behera, A. K. Sahoo, H. S. Swain	30 June, 2022	Agri Innovate, New Delhi
54.	Lecture #65 under Azadi Ka Amrit Mahotsav, 'Farmers' Rights – a cornerstone for food security and the management of seed diversity' by Ms. Svanhild-Isabelle Batta Torheim	Arun Pandit	30 June 2022	Virtual mode
55.	Techno Commercial Assessment and Expert Committee Meeting of ICAR-CIFE	Ganesh Chandra	06 July, 2022	ICAR-CIFE and Agri innovate India
56.	Meeting with delegation of French embassy for collaboration with ICAR-CIFRI	Didier Raboisson, Attaché de cooperation scientifique et universitaire North East Zone Mr Baptiste Fondin, Chargé de mission, Director, HoDs, In-charges of ITMU, PME and E & T Cell	11 July 2022	ICAR-CIFRI, Barrackpore
57.	Town Official Language Implementation Committee (C.O.)-I Halff-Yearly Meeting	A. K. Yadav	13 July, 2022	O/o the Principal Chief Commissioner of Income Tax, NE Region, Guwahati
58.	Meeting with the Principal Secretary, Department of Science & Technology and Biotechnology, Govt. of West Bengal	S. Samanta	14 July, 2022	Vigyan Chetana Bhawan, Salt Lake
59.	Workshop on Conservation of Fish Biodiversity and PPVFRA	Ganesh Chandra	25 July 2022	ZTMC, ICAR-CIFT; Virtual mode
60.	National Webinar on "Current status of river ecosystem and future strategy for conservation" on the occasion of World Nature Conservation Day	S. Samanta	28 July, 2022	Dr. M.G.R. Fisheries College and Research Institute, Ponneri, Tamil Nadu
61.	Webinar by SPINCO BIOTECH with IARI New Delhi on Pesticide analysis with food using mass spectrometer	Soma Das Sarkar	29 July, 2022	SPINCO BIOTECH with IARI New Delhi; Virtual mode
62.	Ecosystem Modelling: Towards Management of Inland Fisheries	Vaisakh G,Dibakar Bhakta, Sangeetha M.Nair	27 July to 02 August, 2022	ICAR-CIFRI, Barrackpore

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
63.	स्वाधीनता के 75 वर्षों में भारत में विज्ञान और प्रौद्योगिकी का विकास' विषय पर हिन्दी संगोष्ठी	All staff of ICAR CIFRI	29-30 July 2022	ICAR-CIFRI, Barrackpore; virtual mode
64.	Techno Commercial Assessment and National IP Awareness Mission	Ganesh Chandra, Shreya Bhattacharya	01-05 August, 2022	Intellectual Property Office, India with NAHEP
65.	"2nd Biotic Congress 2022" and "International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research"	Pronob Das, A. K. Yadav	08-09 August, 2022	Nowgong College, Nagaon, Assam
66.	Seminar by Dr T Mohapatra, former DG, ICAR on 'Science for the Society: Agricultural Imperatives'	Arun Pandit	12 August, 2022	Virtual mode
67.	Workshop on 'Fish production enhancement through cage culture in reservoirs of WB'	S. Samanta, Arun Pandit	17 August, 2022	ICAR-CIFRI, Barrackpore
68.	Meeting on Research Collaboration for River Ecology Studies with IIT Guwahati. Research Team of Dr. Subashisa Dutta, Water Resource Engineering Department	B. K. Das, Director and all scientists	24 August, 2022	ICAR-CIFRI
69.	Webinar on Emerging Pollutants in River Ganga	B. K. Das, S. Samanta, S. K. Nag and D. J. Sarkar	25 August, 2022	Central Pollution Control Board, Delhi
70.	Brainstorming Session on Agricultural Water Management in West Bengal: Issues and Strategies, Organized by National Academy of Agricultural Sciences, and ICAR-Central Research Institute for Jute and Allied Fibres on August 27, 2022. Gave a presentation on "Managing water in wetlands: Problems and prospects"	B. K. Das, Director	27 August, 2022	ICAR-CRIJAF, Barrackpore
71.	Special Meeting of the Executive Committee Indian Science Congress Association	B. K. Das, Director	29 August, 2022	Kolkata
72.	Conference on Connecting Wetland Narratives to Action Plan: A Stakeholders Dialogue. Organised jointly by SCOPE, DISHA and Jadavpur University	S. Samanta	30-31 August, 2022	Jadavpur University, Kolkata

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
73.	Sir Patha Dasgupta lecture on 'Economies of Biodiversity' organized by The British High Commission and Ministry of Earth Sciences, Government of India	Arun Pandit	31 August, 2022	Virtual mode
74.	3rd meeting of Fisheries Development Committee organized by the Tungabhadra Board, TB Dam	Preetha Panikkar	03September, 2022	TB Dam
75.	Meeting of Research and Extension Council of West Bengal University of Fisheries and Animal Sciences	U. K. Sarkar	14 September, 2022	WBUAFS
76.	National Conference on "Sustainable Aquaculture for Atmanirbhar Bharat" (in Hindi)	B. K. Das, Director	23-24 September, 2022	ICAR-CIFA, Bhubaneswar
77.	National Conference (Hindi) on "Sustainable Aquaculture for Atmanirbhar Bharat"	Raju Baitha	23-24 September, 2022	ICAR-CIFA, Bhubaneswar; virtual mode
78.	Meeting of the Executive Committee of the Indian Science Congress Association	B. K. Das, Director	08October, 2022	RTM University, Nagpur
79.	Workshop on preparation of restoration plans for the Ashtamudi and Vembanad Lakes	Deepa Sudheesan	12 October, 2022	Kerala State Pollution Control Board, Regional Office, Ernakulam
80.	Meeting of ICAR Regional Committee-II comprising the States of West Bengal, Odisha, Telangana, Andhra Pradesh and the Union Territory of Andaman & Nicobar Islands	B. K. Das, Director	14 October, 2022	ICAR-National Rice Research Institute, Cuttack, Odisha
81.	Hon'ble PM Kissan programme	All scientists of ICAR-CIFRI	17 October, 2022	Virtual mode
82.	CAPAM-FAO Workshop on Fisheries Stock Assessment Good Practices	Deepa Sudheesan, S. Borah, Sajina A. M., Suman Kumari, C. Johnson, P. K. Parida, S. K. Koushlesh	24-28 October, 2022	FAO, Rome; virtual mode
83.	Meeting with Nextyn Micro-Consulting Agritech (Inland Fisheries)	B. K. Das, Director	27 October, 2022	ICAR-CIFRI, Barrackpore
84.	National Symposium on "Vanya Sericulture: Opportunities Galore"	B. K. Das, Director & A. K. Das	28-29 October, 2022	Central Tasar Research & Training Institute (CTRTI), Ranchi, Jharkhand
85.	Meeting with World Fish	B. K. Das, Director	02 November, 2022	Virtual mode

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
86.	ICAR Regional Committee-IV Meeting under the chairmanship of Dr. Himanshu Pathak, Secretary DARE and DG, ICAR, New Delhi	B. K. Das, Director, Arun Pandit D. N. Jha	07 November, 2022	ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh
87.	Presentation on 'Activities and aspirations of ICAR' by DDG (Crop Sc.), DDG (Ag Engg), DDG (An. Sc.), DDG (Ag Edn), DDG (NRM), DDG (Hort), DDG (Hort) and DDG (Fy. Sc)	All Scientists	13-17 November, 22-25 November, 02-05 December, 2022	Virtual mode
88.	National Symposium on "Fisheries and Aquaculture for Livelihood and Nutritional Security" in association with Coldwater Fisheries Society of India (CFSI)	B. K. Das, Director & A. K. Das	18-19 November, 2022	ICAR-Directorate of Coldwater Fisheries Research (DCFR), Bhimtal, Uttrakhand
89.	8th Global Conference on Gender In Aquaculture & Fisheries (GAF -8)	Aparna Roy Thankam Theresa Paul	21-23 November, 2022	ICAR-CIFT,Kochi and SOFTI, Kerala
90.	23rd Odisha Bigyan 'O' Paribesh Congress as Guest of Honour.	B. K. Das, Director	26-27 November, 2022	Orissa Environmental Society and Sambalpur University, Burla
91.	Midterm review meeting of ICAR Regional Committee 8	Arun Pandit	30 November, 2022	ICAR-CIFRI, Barrackpore
92.	Webinar on Used Water Management for India - Challenges & Opportunities	Mitesh Ramteke	06 December, 2022	ICAR-CIFRI, Barrackpore; Virtual mode
93.	ITMC meeting of ICAR-NBFGR	Ganesh Chandra	08 December, 2022	ICAR-NBFGR
94.	Mid-term meeting of ICAR Regional Committee 2	Arun Pandit	12 December, 2022	Virtual mode
95.	Presentation by Dr. J. K. Jena, Deputy Director General (Fisheries Sc.), ICAR	All staff members of ICAR-CIFRI	13 December, 2022	ICAR, New Delhi; virtual mode
96.	International Conference on "Responsible Aquaculture and Sustainable fisheries Interact (RASHI 2022)"	B. K. Das, Director & most of the scientists	13-16 December, 2022	Central Agricultural University, Lembucherra, Tripura, virtual and offline mode

Sl. No.	Name of the programme	Name of the Official(s)	Date	Organizer & Venue
97.	Meeting with Shri Heikham Dingo Singh, Honourable Minister of Fisheries, Social Welfare, Skill, Labour, Employment and Entrepreneurship, Government of Manipur and Shri Heisnam Balkrishna Singh, Director, Department of Fisheries, Govt. of Manipur for reservoir fisheries production enhancement especially the cage culture experiments conducted in Dumbur reservoir	B. K. Das, Director	14 December, 2022	Tripura
98.	ITMC meeting of ICAR-CRIJAF	Ganesh Chandra	16 December, 2022	ICAR-CRIJAF, Barrackpore
99.	Town Official Language Implementation Committee (C.O.)-I Halff-Yearly Meeting	A. K. Yadav	20 December, 2022	O/o the Principal Chief Commissioner of Income Tax, NE Region, Guwahati
100.	National Training of Trainers (TOT) Workshop (Inland Fisheries) on The SSF Guidelines organized by ICSF Chennai	B. K. Das, Director, Ganesh Chandra & Arun Pandit	22-24 December, 2022	ICSF, Seva Kendra, Kolkata, W. B

Shri Bankim Chandra Hazra, Hon'ble Minister for Sundarban Affairs, Govt. of West Bengal (Right)

Dr. J. K. Jena, Deputy Director General (Fishery Science), ICAR, New Delhi

Brig. Rangrej Sett and **Col. Sajan Joshi**, Base Hospital, Barrackpore, Kolkata

Shri Asok Kumar G, Adt. Secretary & DG, National Mission for Clean Ganga, Ministry of Jal Shakti, Govt. of India (Right)

Dr. Vijay Laxmi Saxena, General President, Indian Science Congress Association, Kolkata (Extreme Left)

Dr. Ashok K. Saxena, Former General President, Indian Science Congress Association, Kolkata

ICAR-CIFRI, Barrackpore

Sr. No.	Visitor	Date of visit
1.	**Dr. (Smt). Poonam Malakondiah**, IAS, Special Chief Secretary (Animal Husbandry, Dairy and Fisheries) Govt. of Andhra Pradesh	08 January 2022
2.	**Shri. Kanna Babu**, IAS, Commissioner of Fisheries, Fisheries Department, Govt. of Andhra Pradesh	08 January 2022
3.	**Brig. Rangrej Sett** and **Col. Sajan Joshi**, Base Hospital, Barrackpore, Kolkata	01 February 2022
4.	**Mr. Jones Justin**, IFS, Deputy Field Director, Sundarban Tiger Reserve	26 February 2022
5.	**Mr. Santhosha, G. R.**, IFS, Additional Secretary, Panchayat & Rural Development Department, Kolkata	26 February 2022
6.	**Shri Sanmit Neogi**, DGM Credit, West Bengal State Electricity Board Limited	26 February 2022
7.	**Dr. Sharad Kumar Jain**, RAC member	08 March 2022
8.	**Dr. B. P. Mohanty**, ADG (Inland Fishery), ICAR, New Delhi	08 March 2022
9.	**Prof. Bhaskaran Manimaran**, Former Vice Chancellor of Tamil Nadu Dr. J Jaylalithaa Fisheries University, Nagapattinam	09 March 2022
10.	**Swami Mahadevanand** Maharaj Ji, Assistant Secretary, Bharat Sevashram Sangha	17 March 2022
11.	**Shri Rajiv Kumar**, GM, Metal and Steel Factory, Ministry of Defence, Govt. of India	17 March 2022
12.	**Prof. A. P. Sharma**, Former Registrar, GBPUAT, Pantnagar	17 March 2022
13.	**Prof. S. K. Sanyal**, Former Vice Chancellor, Bidhan Chandra Krishi Viswavidyalaya, Kalyani	17 March 2022
14.	**Dr. Gauranga Kar**, Director, ICAR-CRIJAF	17 March 2022
15.	**Shri Bankim Chandra Hazra**, Hon'ble Minister for Sundarban Affairs & Development, Govt. of West Bengal	22 March 2022
16.	**Dr. Riji John**, Vice Chancellor, Kerala University of Fisheries and Ocean Studies (KUFOS)	22 March 2022
17.	**Swami Suparnanada** Maharaj Ji, Honorary Secretary, Ramakrishna Mission Institute of Culture, Kolkata	22 March 2022
18.	**Dr. J. K. Jena**, Deputy Director General (Fishery Science), ICAR	22 March 2022
19.	**Prof. P. C. Thomas**, Former Director, College of Fisheries, OUAT	22 March 2022
20.	**Dr. A. Eknath**, Former Director General, NACA	22 March 2022
21.	**Dr. Dileep Kumar**, Former Director, ICAR-CIFE, Mumbai	22 March 2022
22.	**Dr. M. Sinha**, Former Director, ICAR-CIFRI, Barrackpore	22 March 2022
23.	**Dr. Gopalakrishna**, Director, ICAR-CIFE, Mumbai	22 March 2022
24.	**Dr. V. V. Sugunan**, Former ADG (Inland Fisheries), ICAR	22 March 2022
25.	**Dr. W. S. Lakra**, Former Director, ICAR-CIFE, Mumbai	22 March 2022
26.	**Dr. K. Sathyanarayana**, Director, Central Silk Board-Central Tasar Research Training Institute, Ranchi	26 April 2022
27.	**Shri Asok Kumar G**, Additional Secretary & Director General, National Mission for Clean Ganga, Ministry of Jal Shakti, Govt. of India	14 May 2022
28.	**Dr Didier Raboisson**, Attaché de cooperation scientifique et universitaire North East Zone; **Mr. Baptiste Fondin**, Chargé de mission, North East Zone; **Dr Meenakshi Singh**, Chargée de mission de cooperation scientifique North East Zone & Scientific Coordinator French Institute in India, French Embassy in India, New Delhi and **Mr. Amitava Das**, In charge of University and Scientific cooperation	11 July 2022
29.	**Dr. Vijay Laxmi Saxena**, General President, Indian Science Congress Association, Kolkata	29 July 2022
30.	**Dr. Ashok K. Saxena**, Former General President, Indian Science Congress Association, Kolkata	29 July 2022
31.	**Dr. B. J. Sreenivasa**, Director (Technical) & Director, CSGRC, Central S ilk Board, Ministry of Textiles, Bengaluru	06 August 2022
32.	**Shri Navin Kumar Prajapati**, Sr. Consultant & Centre-in-Charge (Kolkata), Central Translation Bureau, Rajbhasha Bibhag, Ministry of Home Affairs, Govt. of India	14 September 2022

CIFRI, Prayagraj

Sr. No.	Visitor	Date of visit
1.	**Dr. P. K. Sahoo**, Principal Scientist, ICAR-IARI, New Delhi	08 February 2022
2.	**Dr. A. R. Rao**, ADG (PIM), ICAR , New Delhi	08 September 2022
3.	**Dr. S. D. Gupta**, Former Principal Scientist, ICAR-CIFA	12 November 2022

ICAR-CIFRI, Bengaluru and Kochi

Sr. No.	Visitor	Date of visit
1.	**Dr. Pravin Puthra**, Assistant Director General (Marine Fisheries), ICAR, New Delhi	28 February 2022
2.	**Dr. Saroj Kumar Swain**, Director (Acting), ICAR - Central Institute of Freshwater Aquaculture	30 May 2022
3.	**Dr. Parveen Kumar**, Director, ICAR-Central Coastal Agricultural Research Institute, Goa	17 September 2022

Dr. (Smt). Poonam Malakondiah
IAS, Special Chief Secretary (Animal Husbandry, Dairy and Fisheries) Govt. of Andhra Pradesh

Shri. Kanna Babu, IAS, Commissioner of Fisheries, Fisheries Department, Govt. of Andhra Pradesh (2nd from right)

Dr. A. Eknath, Former Director General, NACA

Mr. Santhosha, G. R., IFS, Additional Secretary, Panchayat & Rural Development Department, Kolkata

From Left Dr. Aparna Roy (ICAR-CIFRI), **Mr. Amitava Das**, In charge of University and Scientific cooperation, Dr. S. K. Nag (ICAR-CIFRI), Dr. Arun Pandit (ICAR-CIFRI), **Dr Didier Rabuisson**, Attaché de cooperation scientifique et universitaire North East Zone; Dr. B. K. Das (ICAR-CIFRI), **Mr. Baptiste Fondin**, Chargé de mission, North East Zone; **Dr Meenakshi Singh**, Chargée de mission de cooperation scientifique North East Zone & Scientific Coordinator French Institute in India, French Embassy in India, New Delhi, Dr. S. K. Manna (ICAR-CIFRI) and Mr. Ganesh Chandra (ICAR-CIFRI)

Dr. B. J. Sreenivasa, Director (Technical) & Director, CSGRC, Central Silk Board, Ministry of Textiles, Bengaluru (Right)

Shri Navin Kumar Prajapati, Sr. Consultant & Centre-in-Charge (Kolkata), Central Translation Bureau, Rajbhasha Bibhag, Ministry of Home Affairs, Govt. of India (4th from left)

Mr. Jones Justin, IFS, Deputy Field Director, Sundarban Tiger Reserve (Left)

Dr. K. Sathyanarayana, Director, Central Silk Board-Central Tasar Research Training Institute, Ranchi (Right)

Shri Sanmit Neogi, DGM Credit, West Bengal State Electricity Board Limited (Right)

STAFF POSITION AS ON 31 DECEMBER 2022

Category	Sanctioned Strength	Filled up	Vacant
R.M.P	1	1	-
Scientist	88	77	11
Technical	86	43	43
Administrative	66	32	34
Skilled Support Staff	65	23	42
TOTAL	306	176	130

RECRUITMENT – NIL

NEW JOINING – NIL

TRANSFER :

Inter-institutional transfer – 6

Sl. No.	Name of the staff	From	To
1	Shri Wakambam Anand Meetei, Scientist	ICAR-CIFRI, Barrackpore	NEH Research Station, Imphal, Monipur
2	Shri Ningthoujam Samarendra Singh, Scientist	ICAR-CIFRI, Regional Centre, Guwahati	ICAR-CISH, Lucknow
3	Shri Shravan Kumar Sharma, Scientist, ICAR-CIFT, Research Station, Vashi	ICAR-CIFRI, Regional Centre, Prayagraj	ICAR-CIFT, Research Station, Vashi
4	Dr. H. S. Swain, Scientist	ICAR-CIFRI, Barrackpore	ICAR-CIFA, Bhubaneswar
5	Dr. U. K. Sarkar, Principal Scientist	ICAR-CIFRI, Barrackpore	ICAR-NBFGR, Lucknow
6	Shri Sudipta Gupta, AO	ICAR-CIFRI, Barrackpore	ICAR-NINFET, Kolkata

Intra-institutional transfer –6

Sl. No.	Name of the staff	From	To
1	Dr. Ajoy Saha, Scientist	ICAR-CIFRI, Research Centre, Bangalore	ICAR-CIFRI, Barrackpore
2	Md. Quasim, Chief Technical Officer	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Regional Centre, Prayagraj
3	Shri Ravi Kumar Sonkar, Skilled Support Staff	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Regional Centre, Prayagraj
4	Shri Anita Gawate, Skilled Support Staff	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Research Centre, Vadodara
5	Shri Divakar R, Skilled Support Staff	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Research Centre, Bangalore
6	Shri Bijoy Kumar Roy, Assistant	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Regional Centre, Guwahati

PROMOTION

SCIENTIST – 31

Sl. No.	Name & Designation	Promoted to	With effect from
1.	Dr. Ajoy Saha, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	27. 04. 2020
2.	Dr. Dhruba Jyoti Sarkar, Scientist	**Senior Scientist** with RGP ₹8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	23. 01. 2021
3.	Shri Vikas Kumar, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021
4.	Ms. Suvra Roy, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2019
5.	Ms. Niti Sharma, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01.2 020
6.	Shri A. K. Yadav, Scientist	**Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	09. 11. 2019
7.	Ms. Chayna Jana, Scientist	**Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	15. 12. 2019
8.	Dr. Aparna Roy, Senior Scientist	**Senior Scientist** with RGP ₹ 9000/- (Rs.37400-67000/-) Revised Pay Level -13 A as VII CPC	23. 06. 2021
9.	Dr. Amiya Kumar Sahoo, Senior Scientist	**Senior Scientist** with RGP ₹ 9000/- (Rs.37400-67000/-) Revised Pay Level -13 A as VII CPC	10. 02. 2021
10.	Dr. Sona Yengkokpam, Senior Scientist	**Senior Scientist** with RGP ₹ 9000/- (Rs.37400-67000/-) Revised Pay Level -13 A as VII CPC	07. 01. 2020
11.	Dr. Dipesh Debnath, Senior Scientist	**Senior Scientist** with RGP ₹ 9000/- (Rs.37400-67000/-) Revised Pay Level -13 A as VII CPC	26. 02. 2020
12.	Ms. Jesna P. K., Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
13.	Shri Mitesh H. Ramteke, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021
14.	Dr. H. S. Swain, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021
15.	Shri Tasso Tayung, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021
16.	Dr. Absar Alam, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	14. 08. 2019
17.	Shri Roshith C. M, Scientist	**Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	15. 12. 2019
18.	Dr. Deepa Sudheesan, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	01. 09. 2019
19.	Dr. Sajna A. M, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	01. 09. 2019
20.	Dr. Soma Das Sarkar, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	01. 09. 2019
21.	Dr. D. K. Meena, Senior Scientist	**Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC (Designated as Senior Scientist w.e.f 05.11.2021)	15. 12. 2019
22.	Dr. S. C. Sukla Das, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	15. 09. 2021
23.	Dr. Pronob Das, Scientist	**Senior Scientist** with RGP ₹ 8000/- (Rs.15600-39100/-) Revised Pay Level -12 as VII CPC	15. 09. 2020
24.	Dr. Sibina Mol S., Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
25.	Dr. Vaisakh G, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
26.	Shri Jeetendra Kumar, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
27.	Dr. Simanku Borah, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
28.	Shri Wakambam A. Meetei, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
29.	Ms. T. N. Chanu, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2020
30.	Smt. P. R. Swain, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021
31.	Shri Pranab Gogoi, Scientist	**Scientist** with RGP ₹ 7000/- (Rs.15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2021

PROMOTION

Administrative – 4

Sl. No.	Name & Designation	Promoted to
1.	Shri Sudipta Gupta	Promoted to the post of Administrative Officer
2.	Shri Biswajit Ba rua	Promoted to the post of Administrative Officer
3.	Shri Santosh Sarkar	Promoted to the post of AAO
4.	Shri C. D. Parmar	Promoted to the post of AAO

Technical - 3

Sl. No.	Name & Designation	Promoted to
1.	Shri Subhendu Mandal	Promoted to Technical Officer (T-5)
2.	Shri Asim Kumar Jana	Promoted to Technical Officer (T-5)
3.	Md. Yousuf Ali Sk.	Promoted to Technical Officer (T-5)

Skilled Support Staff - 1

Sl. No.	Name & Designation	Promoted to
1.	Ms. Shibani Bhattacharya	Promoted to the post of LDC

SUPERANNUATION – 08

Sl. No.	Name	Designation	Date of Birth	Date of Retirement	Place of posting
1.	Dr. Kalpana Srivastava	ACTO	29. 01. 1962	31. 01. 2022	Prayagraj
2.	Mr. Gopal Chand	SSS	12. 01. 1962	31. 01. 2022	Prayagraj
3.	Mr. R. Nagarrajan	SSS	13. 05. 1962	31. 05. 2022	Bangalore
4.	Mr. M. Mari	Technician	08. 05. 1962	31. 05. 2022	Bangalore
5.	Mrs. G. Vinoda Laxmi	PS	03. 07. 1962	31. 07. 2022	Bangalore
6.	Mr. Subhendu Mondal	STA	27. 07. 1962	31. 07. 2022	Barrackpore
7.	Mr. Atanu Das	TO	26. 10. 1962	31. 10. 2022	Barrackpore
8.	Mr. Arunava Mitra	TO	16. 11. 1962	30. 11. 2022	Kolkata

OBITUARY

Sl. No.	Name of the Official	Designation	Date of demise
1.	Mr. Kishore Shaw	Assistant Administrative Officer	08.03.2022

Abbreviation	Expanded form
µg	Micro gram
µs	Micro Siemens
^{0}C	Degree Celsius
AFDC	Assam Fisheries Development Corporation
avg.	Average
Avl.	Available
BOD	Biochemical Oxygen Demand
C	Carbon
CaCO3	Calcium carbonate
CCC	Criterion continuous concentration
Cd, Cr, Cu, Pb, Zn, Fe	Cadmium, chromium, copper, lead, zinc, iron
CF	Cat Fishes
Chl-a	Chlorophyll a
Cm	Centimetre
CP	Crude Protein
CPUE	Catch per Unit Effort
DD	Data Deficient
DO	Dissolved Oxygen
DOM	Dissolved Organic Matter
EC	Electrical Conductivity
EN	Endangered
ESBN	Estuarine Set Bag Net
FAD	Fish aggregating device
FCE	Feed Conversion Efficiency
FCR	Feed Conversion Ratio
FRL	Full Reservoir Level
g/gm	gram
GPP	Gross Primary Productivity
ha	Hectare
hr	Hour
IMC	Indian Major Carps
IUCN	International Union for Conservation of Nature
kg	Kilogram
km	Kilometre
L	Litre
LC	Least Concern
m	Metre
mg	Milligram
mgC	Milligram carbon
Mm	Millimetre
Mn	Manganese
MON	Monsoon
MP	Madhya Pradesh
mS	Specific conductivity
MT	Metric Tonnes
N	Nitrogen
NE	Not Evaluated
nos.	Numbers
NP	National Park

Abbreviation	Expanded form
NT	Near Threatened
NTU	Nephelometric Turbidity Unit
OC	Organic carbon
P	Phosphorous
P2 O5	Phosphorus pentoxide
PCA	Principal Component Analysis
PER	Protein Efficiency Ratio
PFCS	Primary Fishermen Cooperative Society
POM	Post Monsoon
Ppt	Parts per thousand
PRM	Pre monsoon
R^2	Coefficient of determination
RA	Relative abundance
Rs.	Indian Rupees
SCSP	Scheduled Caste Sub Plan
SD	Standard Deviation
T	Ton
TDS	Total dissolved Solids
TSI	Trophic State Index
U	Unit
u/L	Unit/litre
UP	Uttar Pradesh
VU	Vulnerable
WBNF	Winter Bagnet Fishery
WMBN	Winter migratory bag net
Yr	Year

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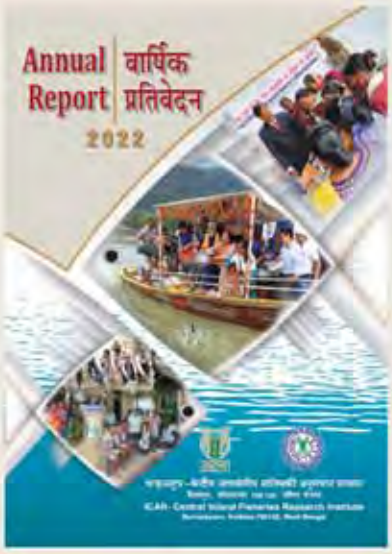

भाकृअनुप
ICAR

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