वार्षिक प्रतिवेदन

Annual Report

2023



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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Cover Page: A fisherman and his daughter fishing in the Ganga River at Balagarh, Hooghly, West Bengal

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Preface

Indian fisheries together with aquaculture are important segments of food basket which provide food and nutritional security to a large section of the population. With diverse inland captured fisheries resources like rivers, estuaries, reservoirs, wetlands, canals, the country has been achieving high growth rate in fish production in the last 4-5 decades. The sector also contributes handsomely to the agricultural exports and engages around 23 million people in different activities along the value chain. India has set a target of 220 lakh tons fish of production in the post-COVID era. The 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 would provide significant contribution to the targeted production.

During the last 77 years of existence, the institute has generated a vast knowledge base through interdisciplinary research for ensuring sustainability in the inland fisheries sector. The habitat features, diversity of aquatic organism, magnitude and rate of change of hydrologic conditions, ecosystem health, biological productivity, production sustainability, climatic variability and impact on ecosystem, socio-economic and livelihood of fishers are among the areas of research in ICAR-CIFRI. The significant harm to ecosystem functions and alterations to trophic relationships arising from the rampant destruction of non-targeted species are a major concern, as they diminish sustainable yields in multispecies open-water fisheries to a large extent. 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.

The institute has conducted research on Ganga and Yamuna rivers; Hooghly-Matlah, Rushikulya, Mandovi-Zuari, Netravathi-Gurupur and Vembanad estuarine systems with different objectives in the year. The impact of dam in River Rangit in Sikkim was studied. The fish landings and catch structure in the rivers Mahanadi, Krishna, Tapti, Barak and Kosi were estimated. Two sygnathid species, *Hippocampus trimaculatus* and *Hippichthys spicifer*, and the Indian frogfish, *Antennarius indicus*, were identified for the first time from the Hooghly-Matlah estuarine system. Two cyprinids, *Chagunius nicholsi* and *Opsarius dogarsinghi* were recorded for the first time from the Torsa River in the Jaldapara National Park. The Hirakud, Panam, Idukki, Sunei, Kalo, Gayathri, Kodar, Poondi, Serlui-B, Kanva, Sathanur and Banasurasagar reservoirs were studied for ecology and fisheries. Fisheries enhancement activities were carried out in the floodplain wetlands of Assam, West Bengal and Bihar. New net pen design was developed to suit deep water bodies like reservoirs. A new initiative was taken to develop next generation inland open water cage culture with special reference to system and species diversification. Ecopath model of Idukki reservoir has been developed for sustainable fisheries management. Recommendations for sustainable fisheries management of Serlui-B reservoir have been formulated. Attempt was made for development of novel formulations for fish health management. A bigdata analytics framework has been used to generate a database of Asian fish species' occurrence at the country level, comparison of taxonomic diversity and threatened status among 48 countries of Asia. Nanostructured material was prepared by impregnating metal oxides into cellulosic material to curb phosphate pollution in inland aquatic ecosystems. AMR study in West Bengal showed that 75% of *S. aureus* isolates were resistant to Penicillin, 28 % of the *E. coli* isolates showed resistance to Amoxicillin-Clavulanic Acid.

Domestication of *Nandus nandus* was achieved in indoor aquarium setup. Captive breeding of dwarf chameleon fish, *Badis blosyrus* was achieved for the first time. The institute bred and ranched around 29 lakh Indian major carp seeds for ecosystem restoration and fisheries conservation in the river Ganga. It also carried out 102 awareness camps under the NMCG in various states. The institute established “Environmental & Aquatic Animal Health Monitoring Laboratory" at Sambalpur,

Odisha to study the Hirakud reservoir. An IoT based DO management system has been developed which continuously measures the DO level in the waterbody as well as operate the aerator automatically in case of low DO level to manage the stress condition. A drone based vertical water sampler has been developed to collect water samples from inaccessible areas of inland open waterbodies. In partnership with the West Bengal Government, the institute is demonstrating cage culture technology in the Kangsabati reservoir. A project on East Kolkata Wetland management is ongoing for multiple value assessment of the fish, agriculture, horticulture and floriculture production, fish disease status, indigenous fish culture potential and impact of invasive fish species. Scampi (*Macrobrachium rosenbergii*) fisheries enhancement technologies in under-utilized reservoirs of Jharkhand was also initiated.

Like in previous years, significant attention was paid to the northeastern region. Following the institute's intervention in 10 *beels* of Assam, there was 21% increase in fish production. Cage culture trials were carried out at Takmu pat of Manipur, Serlui-B reservoir of Mizoram and Umiam reservoir of Meghalaya. Under STC and SCSP programmes, the Institute has taken up several initiatives including 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 around 5000 fishers and fish farmers. *Mahila Matsayajibi Sammelan* was organized at Sundarban in the august presence of the DG, ICAR which was attended by around 5000 fishers including 3000 women fishers.

The Institute organized/co-organized several seminars, conferences and workshops. National seminar on "Ecology vs. Economic Development with Special Reference to the Ganga Basin", interactive workshop on 'Management of Open Water Fisheries of Sikkim', workshop on "Livelihood development addressing SDGs through inland open water fisheries, workshop on "Impact of Climate Change in Inland Fisheries and Development of Adaptive Strategies, stakeholders' consultation-cum-consultative workshop on 'Fish conservation and ranching in the Ganga', stakeholders consultation cum consultative workshop on 'Hilsa fisheries improvement for sustainable fisheries and conservation in the Ganga under the NMCG project" were some of them.

In HRD front, the Institute conducted 53 trainings to 1363 fishers, officials, and students. Eleven awareness programmes were organized covering more than 1470 participants. Institute technologies /products/publication were showcased in 19 exhibitions in different parts of the country. Six hundred fifty nine students were exposed to the institute facilities and research during the year.

The scientists brought many awards and recognitions for the Institute. Prof G. K. Manna Memorial Award by the Indian Science Congress Association, Best Researcher Award, Lifetime Achievement Award, Young Researcher Award, Best Senior Scientist Award, Best Ichthyologist Award, Excellence in Research Award, Young Scientist Award, Dr. V. G. Jhingran Gold were some of the awards. Besides, eight scientists got the Best oral presentation awards in different fora.

During the year under report, applications of one patent, two trademarks and 11 copyrights have been filed. Besides, two design registrations, one trademark and two copyrights were granted. 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 would like to acknowledge the profound support 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, Assistant Director General (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 Editorial team in the preparation of this document are commendable.

Dated : 1 January, 2024
Barrackpore

B. K. Das
(Director)

प्रस्तावना

भारत की जलीय कृषि और मछली उत्पादन का खाद्य सुरक्षा में एक महत्वपूर्ण भूमिका है जो एक बड़े जनसंख्या को भोजन और पोषण सुरक्षा प्रदान करते हैं। नदियों, मुहाना, जलाशयों, आर्द्रभूमि, नहरों जैसे विविध अन्तर्स्थलीय मत्स्य संसाधनों के विकास दर के कारण पिछले 4–5 दशकों में मछली उत्पादन में वृद्धि देखी जा रही है। यदि कृषि निर्यात को देखा जाए तो मत्स्य पालन क्षेत्र में लगभग 23 मिलियन लोगों की आजीविका निर्भर करता है। भारत में, कोविड महामारी के बाद लगभग 220 लाख टन मछली उत्पादन का लक्ष्य रखा गया है, अर्थात अन्तर्स्थलीय खुले जल संसाधन अर्थात 45,000 किमी नदियाँ, 0.3 मिलियन हेक्टेयर मुहाना, 0.19 मिलियन हेक्टेयर बैकवाटर और लैगून, 3. 524 मिलियन हेक्टेयर जलाशय, 0.354 मिलियन हेक्टेयर बाढ़कृत मैदानी आर्द्रभूमि और 0.72 मिलियन हेक्टेयर उच्चभूमि झील से लक्षित उत्पादन में महत्वपूर्ण योगदान दे सकते हैं।

पिछले 77 वर्षों के दौरान संस्थान ने अन्तर्स्थलीय मत्स्य पालन क्षेत्र में स्थिरता सुनिश्चित करने के लिए अंतःविषय अनुसंधान के माध्यम से एक विशाल आंकडा कोष तैयार किया है। इसमें मत्स्य आवास स्थलों की विशेषताएं, जलीय जीवों की विविधता, हाइड्रोलॉजिकल स्थिति का स्तर और इसके परिवर्तन का दर, पारिस्थितिकी तंत्र स्वास्थ्य, जैविक उत्पादकता, उत्पादन स्थिरता, जलवायु परिवर्तनशीलता और पारिस्थितिकी तंत्र पर प्रभाव, मछुआरों की सामाजिक–आर्थिक और आजीविका पर फोकस किया गया है। पारिस्थितिक तंत्र को महत्वपूर्ण नुकसान और अनपेक्षित और गैर–लक्षित प्रजातियों के बड़े पैमाने पर विनाश से उत्पन्न होने वाले ट्रॉफिक संबंधों में परिवर्तन एक गंभीर चिंता का विषय है, क्योंकि वे खुला पानी में बहु–प्रजाति के मत्स्य पालन के टिकाऊ उत्पादन को बड़े पैमाने पर कम कर देते हैं। समसामयिक आवश्यकता के अनुरूप, संस्थान ने अन्तर्स्थलीय खुले जल मत्स्य पालन में अनुसंधान के दृष्टिकोण और प्राथमिकता निर्धारित करने के लिए प्राकृतिक संसाधन प्रबंधन के अनुसंधान एवं विकास हेतु कार्य कर रहा है। संस्थान पर्यावरण और उत्पादन के बीच गहरे संबंध की पहचान के साथ पारिस्थितिकी तंत्र–आधारित सतत मत्स्य पालन की ओर प्रयासरत है।

संस्थान ने गंगा और यमुना नदियों के विस्तार क्षेत्रों पर शोध कार्य किया है – हुगली – मातलाह, रुशिकुल्या, मांडोवी – जुआरी, नेत्रवती – गुरुपुर और वेम्बनाड ज्वारनदमुख तंत्र। सिक्किम में रंगीत नदी पर बांध के प्रभाव का अध्ययन किया गया। महानदी, कृष्णा, ताप्ती, बराक और कोसी नदियों में मछली की लैंडिंग और पकड़ संरचना का अनुमान लगाया गया था। हुगली – मातलाह ज्वारनदमुख तंत्र से पहली बार दो *सिग्नैथिड* प्रजातियां, *हिप्पोकैम्पस ट्राइमेकुलैटस* और *हिप्पिकथिस स्पिसिफ़र* और *इंडियन फ्रॉगफिश, एंटेनारियस इंडिकस* की पहचान की गई थी । जलदापारा राष्ट्रीय उद्यान में टोरसा नदी से पहली बार दो *साइप्रिनिड चागुनियसनिचोल्सी* और *ओप्सारियस डोगरसिंघी* को रिकॉर्ड किया गया था। पारिस्थितिकी और मत्स्य पालन के लिए हीराकुड, पानम, इडुक्की, सुनेई, कालो, गायत्री, कोडार, पूंडी, सेरलुई–बी, कण्वा, सथानुर और बाणासुरसागर जलाशयों का अध्ययन किया गया। असम, पश्चिम बंगाल, बिहार के बाढ़कृत आर्द्रभूमि में मत्स्य पालन संवर्धन हेतु कार्य किया गया । जलाशयों जैसे गहरे जल निकायों के अनुरूप नया नेट पेन डिज़ाइन विकसित किया गया था। प्रणाली और प्रजाति विविधीकरण के लिए अन्तर्स्थलीय खुले जल में पिंजरे में पालन तकनीक को विकसित करने के लिए एक नई पहल की गई । सतत मत्स्य पालन प्रबंधन के लिए इडुक्की जलाशय का इकोपैथ मॉडल विकसित किया गया है। सेरलुई–बी जलाशय के टिकाऊ मत्स्य पालन प्रबंधन के लिए दिशा–निर्देश के साथ मछली स्वास्थ्य प्रबंधन के लिए नवीन सूत्र का विकास किया गया । राष्ट्रीय स्तर पर एशियाई मछली प्रजातियों के वर्गीकरण विविधता की तुलना और एशिया के 48 देशों के बीच लुप्तप्राय/संकटग्रस्त मछली प्रजातियों पर डेटाबेस तैयार करने के लिए एक बिगडेटा एनालिटिक्स फ्रेमवर्क का उपयोग किया गया है। अन्तर्स्थलीय जलीय पारिस्थितिक तंत्र में फॉस्फेट प्रदूषण को रोकने के लिए सेल्युलोसिक सामग्री में धातु ऑक्साइड को संसेचित करके नैनोसंरचित सामग्री तैयार की गई है। पश्चिम बंगाल में एएमआर अध्ययन से पता चला कि 75% से अधिक एस. ऑरियस के आइसोलेट पेनिसिलिन के प्रति प्रतिरोधी, 28% ई. कोलाई के आइसोलेट एमोक्सिसिलिन–क्लैवुलैनिक के प्रति तथा एरोमोनस एसपी के 33.33% आइसोलेट एमोक्सिसिलिन–क्लैवुलैनिक एसिड के प्रति और इसके 30.70% आइसोलेट सेफलोथिन के प्रति प्रतिरोधी प्रतिरोधी पाए गए।

जलमग्न मैक्रोफाइट वृक्षारोपण और चारा अनुपूरण के साथ इनडोर एक्वेरियम संरचना में गंगेटिक लीफ फिश, नेंदस नेंदस का एक्वेरियम में पालन किया गया। ड्वॉर्फ कैमलियन मछली, *बैडिस ब्लोसाइरस* का घेरे में प्रथम बार प्रजनन किया गया। संस्थान ने गंगा नदी में पारिस्थितिकी तंत्र की बहाली और मत्स्य संरक्षण के लिए लगभग 29 लाख इंडियन मेजर कार्प बीजों का प्रजनन और पालन किया। विभिन्न राज्यों में नमामि गंगे परियोजना के तहत 102 जागरूकता कार्यक्रम भी

आयोजित किए गए। संस्थान ने हीराकुंड जलाशय का अध्ययन करने के लिए ओडिशा के संबलपुर में "पर्यावरण और जलीय पशु स्वास्थ्य निगरानी प्रयोगशाला" की स्थापना की। एक आई ओ टी (IoT) आधारित घुलित ऑक्सीजन प्रबंधन प्रणाली विकसित की गई है जो जलाशय में तनाव की स्थिति को प्रबंधित करने के लिए घुलित ऑक्सीजन स्तर को लगातार मापने के साथ जलवाहक को स्वचालित रूप से संचालित करती है। अन्तर्स्थलीय खुले जल निकायों के दुर्गम क्षेत्रों से पानी के नमूने एकत्र करने के लिए एक ड्रोन आधारित ऊर्ध्वाधर जल नमूना तकनीक विकसित किया गया है। पश्चिम बंगाल सरकार की साझेदारी में संस्थान कांगसबती जलाशय में पिंजरे में मछली पालन कर रहा है। ईस्ट कोलकता वेटलैंड में परियोजना के अंतर्गत मछली, कृषि, बागवानी और पुष्पोत्पादन, मछली रोग की स्थिति, स्वदेशी मछली पालन क्षमता और परभक्षी मछली प्रजातियों के प्रभाव का मूल्यांकन किया जा रहा है । झारखंड के जलाशयों में स्कैमपी प्रजाति, *मैक्रोब्रेकियम रोजेनबर्गी* की उत्पादन वृद्धि की दिशा में प्रयास किया गया

पिछले वर्षों की तरह, इस वर्ष भी पूर्वोत्तर क्षेत्र पर महत्वपूर्ण कार्य किया गया। असम के 10 बीलों में संस्थान के प्रयासों के कारण मछली उत्पादन में 21% की वृद्धि दर्ज की गई। मणिपुर के ताकमु पाट, मिजोरम के सेरलुई–बी और मेघालय के उमियाम जलाशय में पिंजरा पालन परीक्षण किए गए। अनुसूचित जाति उप–योजना और आदिवासी योजना के तहत संस्थान ने आर्द्रभूमि और जलाशयों में पेन पालन और पालन आधारित मात्स्यिकी तकनीक, सजावटी मछली पालन, घर के पिछवाड़े आँगन के तालाबों से उत्पादन वृद्धि, क्षमता निर्माण और जन जागरूकता सृजन सहित कई पहल किया हैं जिससे लगभग 5000 मछुआरों और मछली किसानों को लाभ हुआ है। सचिव, डेयर तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद की गरिमामयी उपस्थिति में सुंदरबन में महिला मत्स्यजीबी सम्मेलन का आयोजन किया गया जिसमें 3000 महिला मछुआरों सहित लगभग 5000 मछुआरों ने भाग लिया।

संस्थान ने कई संगोष्ठियों, सम्मेलनों और कार्यशालाओं का आयोजन/सह–संगठन किया। "गंगा बेसिन के विशेष संदर्भ में पारिस्थितिकी बनाम आर्थिक विकास" पर राष्ट्रीय संगोष्ठी; 'सिक्किम के खुला जल निकायों में मत्स्य पालन प्रबंधन' पर इंटरैक्टिव कार्यशाला; अन्तर्स्थलीय खुले जल मत्स्य पालन के माध्यम से सतत विकास लक्ष्यों को संबोधित करते हुए आजीविका विकास" पर कार्यशाला; "अन्तर्स्थलीय मत्स्य पालन में जलवायु परिवर्तन का प्रभाव और अनुकूली रणनीतियों का विकास" पर कार्यशाला; गंगा में मछली संरक्षण और रैंचिंग पर हितधारकों की परामर्शी कार्यशाला; नमामि गंगे परियोजना के तहत गंगा में टिकाऊ मत्स्य पालन और संरक्षण के लिए 'हिल्सा मत्स्य पालन सुधार' पर हितधारकों की परामर्शी कार्यशाला।

मानव संसाधन विकास की दिशा में संस्थान में 1363 मछुआरों, अधिकारियों और छात्रों के लिए 53 प्रशिक्षण और 1470 से अधिक प्रतिभागियों के लिए 11 जागरूकता कार्यक्रम आयोजित किए गए। संस्थान की प्रौद्योगिकियों/उत्पादों/प्रकाशन को देश के विभिन्न राज्यों में 19 प्रदर्शनियों में प्रदर्शित किया गया। रिपोर्ट अवधि के दौरान छह सौ उनतालीस छात्रों को संस्थान की सुविधाओं और अनुसंधान से अवगत कराया गया।

संस्थान के वैज्ञानिकों को कई पुरस्कार और प्रशस्ति पत्र प्रदान किए गए– भारतीय विज्ञान कांग्रेस एसोसिएशन के 108 सत्र में प्रोफेसर जी के मन्ना मेमोरियल अवार्ड, सर्वश्रेष्ठ शोधकर्ता पुरस्कार, लाइफटाइम अचीवमेंट अवार्ड, यंग रिसर्चर अवार्ड, बेस्ट 'सीनियर साइंटिस्ट अवार्ड, बेस्ट इचथियोलॉजिस्ट अवार्ड, एक्सीलेंस इन रिसर्च अवार्ड, यंग साइंटिस्ट अवार्ड, डॉ. वीजी झिंगरन गोल्ड मेडल। इसके अलावा, आठ वैज्ञानिकों को विभिन्न मंचों पर सर्वश्रेष्ठ लेख प्रस्तुति के लिए पुरस्कार मिला।

रिपोर्ट वर्ष के दौरान, एक पेटेंट, दो ट्रेडमार्क और 11 कॉपीराइट के लिए आवेदन दायर किए गए हैं। इसके अलावा, दो डिज़ाइन पंजीकरण, एक ट्रेडमार्क और दो कॉपीराइट प्रदान किए गए। मुझे विश्वास है कि शोधकर्ताओं के निरंतर प्रयासों से मौजूदा प्रौद्योगिकियों को व्यापक रूप से अपनाने, नई प्रौद्योगिकियों के विकास और टिकाऊ उत्पादन वृद्धि और पारिस्थितिकी तंत्र स्वास्थ्य संरक्षण के लिए प्रोटोकॉल को बढ़ावा मिलेगा जो अन्तर्स्थलीय खुले जल मत्स्य पालन क्षेत्र को एक नई ऊंचाई पर ले जाएगा।

मैं डॉ. हिमांशु पाठक, सचिव, डेयर और महानिदेशक, भारतीय कृषि अनुसंधान परिषद से प्राप्त मार्गदर्शन के लिए हृदय से आभार व्यक्त करता हूँ। मैं डॉ. जे के जेना, उप–महानिदेशक (मत्स्य विज्ञान) का आभारी हूं। मैं डॉ. बी पी मोहंती, सहायक महानिदेशक (अन्तर्स्थलीय मत्स्य पालन); डॉ. सुभदीप घोष, सहायक महानिदेशक (समुद्री मत्स्य पालन) के साथ–साथ संस्थान के वैज्ञानिकों और अन्य संस्थान कर्मियों को उनके निरंतर समर्थन के लिए धन्यवाद देता हूँ। संस्थान के विकास और संस्थान के अनुसंधान गतिविधियों को सुव्यवस्थित करने के लिए आरएसी, आईएमसी, क्यूआरटी, आईआरसी के दिशानिर्देशों और सुझावों को को भी विनम्रतापूर्वक स्वीकार करता हूँ। प्रस्तुत प्रलेख को तैयार करने में संपादकीय टीम के प्रयास सराहनीय हैं।

दिनांक : 1 जनवरी, 2024
बैरकपुर

बि. के. दास
(निदेशक)

From the Director's Desk



As our nation is marching towards Viksit Bharat and strides closer to the Amrit Kal era, wherein self-sufficiency and self-reliance in terms of nutritional security and achieving Sustainable Development Goals (SDGs) are paramount, the inland fisheries sector emerges as a significant contributor towards these objectives.

Fish production in India has experienced remarkable growth, from 7.5 lakh tonnes in 1950-51 to the current production of 162 lakh tonnes. Due to the implementation of science-based fisheries practices, the inland capture fisheries have undergone a significant transformation and now contributes around 20 lakh tonnes (12.5% of the total fish production in the country) production. As a result of the comprehensive approach adopted under the PMMSY, vast opportunities and potential for enhancing production through the optimal utilization of fisheries, infusion of technology, and capacity building existed. In 2023, the institute successfully commercialized CageGrow Feed technology. Applications have been submitted for one patent, with six more in the pipeline. Two trademarks have been granted, and another was filed. Furthermore, seven copyrights have been granted and eight copyrights have been filed. Notably, our scientists have been honoured with prestigious awards including the Prof. G. K. Manna Memorial Award at the 108th Session of The Indian Science Congress, Recognition Award from the Zoological Society of India, Young Researcher Award, Best Senior Scientist Award, Young Scientist Award, and numerous other prestigious accolades.

For conservation of native fish stock and to enhance fish production, we continued river ranching programmes in which we released 28.88 lakh fingerlings of Indian Major Carps and Mahseer into the river Ganga. A total of 93 thousand Hilsa brood fish were also released in upstream of Farakka barrage. ICAR-CIFRI conducted a comprehensive assessment of the annual fish catch and fishing effort in five major rivers across India: Ganga, Mahanadi, Krishna, Tapti, and Barak. The estimated annual fish catch from these rivers were 56,387 tonnes for Ganga, 15,134 tonnes for Mahanadi, 18,902 tonnes for Krishna, 6,946 tonnes for Tapti, and 1,593 tonnes for Barak.

A fish disease surveillance and health management program was conducted in West Bengal, India in which more than 150 fish, shrimp and ornamental fish farms have been surveyed and an awareness program was conducted. A microbial consortium as feed probiotics is developed for improving growth, promoting nutrient digestion, enhancing host immunity, and modulating the balance of intestinal microbiota. The mitochondrial genome of *Mystus cavasius*, *M. gulio* and *Gudusia chapra* were characterized to understand the genetic stock of these small indigenous fish species across major river systems of India including rivers Ganga, Krishna, Cauvery, Brahmaputra and Mahanadi.

Antimicrobial resistance (AMR) of *Staphylococcus aureus, E.coli* and *Aeromonas* sp. in fish samples collected from North 24 Parganas, Burdwan, Howrah, Hoogly, Murshidabad and Malda districts of West Bengal showed that more than 75% of *S. aureus* isolates were resistant to Penicillin, 28% of *E. coli* isolates were resistant against Amoxicillin-Clavulanic Acid and 33.33% of *Aeromonas* sp. resistant to Amoxicilin-Clavulanic Acid and 30.70% isolates were resistant to Cephalothin.

The institute implemented the SCSP and STC programmes, with a focus on empowering rural women through various fisheries technologies such as ornamental fish culture, backyard pond fishculture, culture-based fisheries (CBF), and pen culture. The programme, which was implemented in a participatory manner in rural and difficult areas such as Sunderban, benefited over 3000 people through fisheries input distribution, technology demonstrations, capacity

building, sensitization, interactive workshop and technical assistance.

Successful captive breeding was achieved for two species of indigenous freshwater ornamental fishes, *viz.*, *Badis blosyrus* and *Nandus nandus*, in an indoor glass aquarium tank. Several growth trials have been conducted successfully in cages with high-value indigenous species such as *Ompok bimaculatus, Heteropneustes fossilis, Labeo rohita* (Jayanti), *L. bata, L. gonius, Systomus sarana, Osteobrama belangeri*, and *Etroplus suratensis*. The institute has also developed model cages and HDPE pens, along with cost-effective floating pelleted feed formulations based on Black Soldier Fly (BSF) and Silk Worm Pupae (SWP). These feeds offer improved feed conversion ratios, making them suitable for cage and pond farming of fishes.

Under climate change research vulnerability assessment of coastal wetlands, impact of extreme events on ecosystem services provided by coastal wetlands, impact of high pre-monsoon flood in floodplain wetland fisheries, ecological assessment of wetland using GIS tools in changing climate, resilience of Vembanad fishery, demonstration of climate-resilient CBF involving *E. suratensis*, and assessment of carbon sequestration and greenhouse gas emission from wetlands were attempted.

Detection of contaminants in the ecosystem is one of the major concerns faced by the quality regulatory agencies. Hence, a field portable colourimetric sensing device (IMAGinE) was developed in collaboration with CDAC-Kolkata for the detection of Cr (VI) and As (V) using peroxidase mimic properties of nanoparticles with 87% accuracy. The sensing mechanism can detect as low as 25 ppb of Cr (VI) and 5 ppb of As (V). Further, a biosensing device (Aqua Suraksha) was developed to evaluate OP pesticides as EDC in aquatic ecosystems.

The institute has organized capacity-building programmes in specialized areas for developing and strengthening the skills, instincts, and abilities of the 967 stakeholders. Apart from tailored programmes for the farmers, some innovative training programmes were also imparted to the students. The institute has also organized workshops, interfaces and interactive meetings with officials of Jharkhand and Chhattisgarh. An international Training-cum-Workshop on "Sustainable Fisheries and Dairy" was organized for 24 participants representing Cambodia, Lao PDR, Myanmar and Vietnam (CLMV). Keeping in view International Women's Day theme "Accelerating Equality & Empowerment" for the year 2023, ICAR-CIFRI had taken up "Mission 3000", *i.e.* to adopt 3000 women across the country under SCSP/TSP/NEH scheme for empowering them economically. In this regard, Mahila Matasyajibi Sammelan (Women Fishers Meet) was organized at Kultali, Sundarban, West Bengal and more than 5,000 fishers, including 2700 women, participated in that Women Fishers Meet.

Our team, comprising scientists, technical officers, and research scholars, has collectively published 113 research papers, with a total international Impact Factor of 396.04. In addition, we have published 18 popular articles and 5 books, 24 book chapters, 8 training manuals. I extend my appreciation to all staff members for their dedicated efforts in advancing the Institute to new heights. Furthermore, I express gratitude to the Heads of Divisions, Heads of Centres, and Administration and Finance for their valuable contributions for the timely completion of this document.



Dated : 01 January, 2024
Barrackpore

B. K. Das
(Director)

निदेशक की कलम से

देश में अमृतकाल से विकसित भारत की इस अभूतपूर्व यात्रा में पोषण सुरक्षा और सतत विकास लक्ष्यों (एसडीजी) को प्राप्त करने में आत्मनिर्भरता और संसाधनों की प्रचुरता को सर्वोपरि रखा गया है। इस संदर्भ में यह देखा गया है कि अन्तर्स्थलीय मत्स्य पालन क्षेत्र एक महत्वपूर्ण संसाधन एवं आजीविका विकास के रूप में उभर रहा है।

भारत में मछली उत्पादन में उल्लेखनीय वृद्धि हुई है। वर्ष 1950–51 में मछली उत्पादन 7.5 लाख टन था और वर्तमान उत्पादन 162 लाख टन आँका गया है। उत्पादन में इस बढ़त का श्रेय विज्ञान–आधारित मत्स्य पालन पद्धतियों का सटीक कार्यान्वयन को जाता है। अन्तर्स्थलीय मात्स्यिकी से होने वाला उत्पादन पालन लगभग 20 लाख टन है जो देश में कुल मछली उत्पादन का 12.5% आँका गया है। परिणामस्वरूप, प्रधानमंत्री मत्स्य संपदा योजना (पीएमएमएसवाई) के तहत प्रयासों के कारण मत्स्य पालन के इष्टतम उपयोग, प्रौद्योगिकी का उपयोग और क्षमता निर्माण के माध्यम से उत्पादन वृद्धि के विशाल अवसर और संभावनाओं को देखा गया है। वर्ष 2023 में संस्थान की उपलब्धियों में प्रमुख हैं – केजग्रो फ़ीड तकनीक का सफलतापूर्वक व्यावसायीकरण; एक पेटेंट के लिए आवेदन के साथ छह अन्य पर भी कार्य किया जा रहा है; दो ट्रेडमार्क प्राप्त किए गए और अन्य कई दायर किए गए हैं। इसके अलावा, सात कॉपीराइट प्राप्त किए गए और आठ कॉपीराइट के लिए आवेदन किए गए हैं। विशेष तौर पर संस्थान के वैज्ञानिकों को कई प्रतिष्ठित पुरस्कारों से सम्मानित किया गया है, जिनमें प्रमुख हैं– भारतीय विज्ञान कॉंग्रेस संस्था के 108वें सत्र में प्रोफेसर जी. के. के मन्ना मेमोरियल पुरस्कार; जूलॉजिकल सोसाइटी ऑफ इंडिया, गया से मान्यता पुरस्कार; युवा शोधकर्ता पुरस्कार, सर्वश्रेष्ठ 'वरिष्ठ वैज्ञानिक पुरस्कार', युवा वैज्ञानिक पुरस्कार तथा कई अन्य सम्मान।

स्वदेशी मछली प्रजातियों के स्टॉक संरक्षण और मछली उत्पादन वृद्धि के लिए विभिन्न राज्यों में नदियों में रैंचिंग कार्यक्रम किया गया जिसके अंतर्गत इंडियन मेजर कार्प और महासीर मछलियों की 28.88 लाख अंगुलिकाओं को गंगा नदी में छोड़ा गया है। फरक्का बांध के ऊपरी भाग में हिल्सा की कुल 93 हजार ब्रूड मछलियों को भी छोड़ा गया है। सिफरी ने देश की पांच प्रमुख नदियों–गंगा, महानदी, कृष्णा, ताप्ती और बराक में वार्षिक मछली पकड़ और मछली पकड़ प्रयास का व्यापक तौर पर मूल्यांकन किया है। इन नदियों से अनुमानित वार्षिक मछली पकड़ गंगा नदी से 56,387 टन, महानदी से 15,134 टन, कृष्णा नदी से 18,902 टन, ताप्ती नदी से 6,946 टन और बराक नदी से 1,593 टन आँका गया है।

पश्चिम बंगाल में मछलियों में होने वाले बीमारियों और संक्रमण की निगरानी और स्वास्थ्य प्रबंधन के लिए कार्यक्रम संचालित किया गया जिसके अंतर्गत 150 से अधिक मछली, झींगा और सजावटी मछली फार्मों का सर्वेक्षण के साथ एक जागरूकता कार्यक्रम आयोजित किया गया। संस्थान में फ़ीड प्रोबायोटिक्स के रूप में एक माइक्रोबियल कंसोर्टियम विकसित किया गया है जिसका उद्देश्य मछलियों के विकास में सुधार, पोषक तत्वों के पाचन में सुविधा, संक्रमण–प्रवृत्त मछलियों की प्रतिरक्षा क्षमता में वृद्धि करना और उनकी आंतों के माइक्रोबायोटा के संतुलन को नियंत्रित करना है। *मिस्टस कैवसियस, एम. गुलियो* और *गुडुसिया चपरा* के माइटोकॉन्ड्रियल जीनोम को गंगा, कृष्णा, कावेरी, ब्रह्मपुत्र और महानदी नदियों सहित भारत की प्रमुख नदीतंत्रों में इन छोटी स्वदेशी मछली प्रजातियों के आनुवंशिक स्टॉक का सर्वेक्षण और अध्ययन किया गया है।

पश्चिम बंगाल के उत्तर 24 परगना, बर्दवान, हावड़ा, हुगली, मुर्शिदाबाद और मालदा जिलों से एकत्र किए गए *स्टैफिलोकोकस ऑरियस, ई. कोलाई* और *एरोमोनास* एसपी के रोगाणुरोधी प्रतिरोध (एएमआर) मछली के नमूनों के अध्ययन में 75% से अधिक *एस. ऑरियस* के आइसोलेट पेनिसिलिन के प्रति प्रतिरोधी, 28 : *ई. कोलाई* के आइसोलेट एमोक्सिसिलिन – क्लैवुलैनिक के प्रति तथा *एरोमोनस* एसपी के 33.33% आइसोलेट एमोक्सिसिलिन–क्लैवुलैनिक एसिड के प्रति और इसके 30.70% आइसोलेट सेफलोथिन के प्रति प्रतिरोधी प्रतिरोधी पाए गए।

संस्थान ने अनुसूचित जाति उप–योजना (एससीएसपी) और आदिवासी योजना के तहत विभिन्न कार्यक्रमों को आयोजित किया है। इसके अंतर्गत मत्स्य पालन प्रौद्योगिकियों जैसे सजावटी मछली पालन, घर के आँगन में स्थित तालाब मछली पालन, पालन आधारित मात्स्यिकी (सीबीएफ), और पेन में मछली पालन के माध्यम से ग्रामीण महिलाओं के आर्थिक सशक्तिकरण पर ध्यान केंद्रित किया गया है। इन कार्यक्रमों को सुंदरबन जैसे ग्रामीण और सुदूर क्षेत्रों में सामुदायिक भागेदारिता से लागू किया गया था। इस प्रकार के मत्स्य पालन इनपुट वितरण, प्रौद्योगिकी प्रदर्शन, क्षमता निर्माण, संवेदीकरण, इंटरैक्टिव कार्यशाला और तकनीकी सहायता के माध्यम से 3000 से अधिक ग्रामीणों को लाभान्वित किया है ।

एक इनडोर ग्लास एक्वेरियम टैंक में स्वदेशी मीठाजल सजावटी मछलियों की दो प्रजातियों, *बैडिस ब्लोसिरस* और *नेंदस नेंदस* का घेरे में सफल प्रजनन किया गया। इनके अलावा, पिंजरों में *ओमपोक बिमाकुलैटस, हेटेरोपनेस्टेस फॉसिलिस, लेबियो रोहिता* (जयंती),

एल. बाटा, एल. गोनियस, सिस्टोमस सराना, ओस्टियोब्रामा बेलांगेरी और *एट्रोप्लस सुरैटेंसिस* जैसी उच्च मूल्य वाली स्वदेशी प्रजातियों का सफलतापूर्वक विकास परीक्षण किए गए हैं। संस्थान ने ब्लैक सोल्जर फ्लाई (बीएसएफ) और सिल्क वर्म प्यूपा (एसडब्ल्यूपी) पर आधारित लागत प्रभावी फ्लोटिंग पेलेटेड फ़ीड फॉर्मूलेशन के साथ–साथ मॉडल पिंजरा और एचडीपीई पेन भी विकसित किया है। इन फ़ीड का फ़ीड रूपांतरण अनुपात बेहतर होता है, जिससे पिंजरे और तालाब में मछलियों का विकास अच्छा होता है।

जलवायु परिवर्तन अध्ययन के तहत तटीय आर्द्रभूमि की संवेदनशीलता का आंकलन, तटीय आर्द्रभूमि की पारिस्थितिकी तंत्र सेवाओं पर प्राकृतिक आपदाओं का प्रभाव, बाढ़कृत मैदानी आर्द्रभूमि के मत्स्य पालन पर मानसून पूर्व आने वाली उच्च बाढ़ का प्रभाव, जलवायु परिवर्तन में जीआईएस उपकरणों द्वारा आर्द्रभूमि का पारिस्थितिक मूल्यांकन, वेम्बनाड झील में जलवायु उन्मुख मत्स्य पालन पद्धति, घेरे में *ई. सुरैटेंसिस* का जलवायु उन्मुख पालन का प्रदर्शन और आर्द्रभूमि से कार्बन पृथक्करण और ग्रीनहाउस गैस उत्सर्जन का आंकलन पर कार्य किया गया।

गुणवत्ता नियामक एजेंसियों के लिए पारिस्थितिकी तंत्र में प्रदूषकों का पता लगाना एक गंभीर चुनौती है। इसलिए, 87% सटीकता के साथ नैनोकणों के पेरोक्सीडेज सदृश गुणों द्वारा सीआर (VI) और As (V) का पता लगाने के लिए प्रगत संगणक विकास केंद्र (CDAC), कोलकाता के सहयोग से एक फील्ड पोर्टेबल कोलोरिमेट्रिक सेंसिंग डिवाइस (IMAGinE) विकसित किया गया है। यह सेंसिंग तंत्र कम से कम 25 पीपीबी सीआर(VI) और 5 पीपीबी एएस(वी) का पता लगा सकता है। इसके अलावा, जलीय पारिस्थितिक तंत्र में ईडीसी के रूप में ओपी कीटनाशकों का मूल्यांकन करने के लिए एक बायोसेंसिंग डिवाइस (एक्वा सुरक्षा) विकसित किया गया।

संस्थान ने 967 हितधारकों के कौशल, प्रवृत्ति और क्षमताओं को विकसित और सशक्त करने के लिए विशेष क्षेत्रों में क्षमता निर्माण कार्यक्रम आयोजित किया है। किसान–अनुकूलित कार्यक्रमों के अलावा, छात्रों को भी नवीन विषयों पर प्रशिक्षण दिया गया। संस्थान ने झारखंड और छत्तीसगढ़ के मत्स्य विभाग के अधिकारियों के साथ की कार्यशालाएं, इंटरफेस और पारस्परिक संवाद (इंटरैक्टिव) बैठकों का आयोजन किया। इसी क्रम में कंबोडिया, लाओ पीडीआर, म्यांमार और वियतनाम (CLMV) से 24 प्रतिभागियों के लिए "स्थायी और सतत मत्स्य पालन और डेयरी" पर एक अंतरराष्ट्रीय प्रशिक्षण–सह–कार्यशाला आयोजित की गई। वर्ष 2023 के लिए अंतर्राष्ट्रीय महिला दिवस की विषय "समानता और सशक्तिकरण में गतिवृद्धि" को ध्यान में रखते हुए संस्थान ने "मिशन 3000" के अंतर्गत देश भर में 3000 महिलाओं को आर्थिक रूप से सशक्त बनाने के लिए अनुसूचित जाति उप–योजना/आदिवासी विकास/पूर्वोत्तर क्षेत्र विकास (SCSP/TSP/NEH) योजनाओं के तहत महिलाओं को आदान वितरण और कौशल विकास किया। इस संबंध में, पश्चिम बंगाल के सुंदरबन के कुलतली में महिला मत्स्यजीबी सम्मेलन आयोजित किया गया जिसमें 5,000 से अधिक मछुआरों (2700 महिलाओं सहित) ने भाग लिया।

संस्थान में वैज्ञानिक, तकनीकी अधिकारी और शोध छात्रों ने संयुक्त तौर पर कुल 113 शोध पत्र (ईम्पैक्ट फैक्टर – 396.04) प्रकाशित किया है। इसके अलावा, संस्थान ने इस वर्ष 18 प्रचलित लेख, 5 पुस्तकें, 24 बुक चैप्टर, 8 प्रशिक्षण मैनुअल प्रकाशित किया है। मैं संस्थान को सफलता की नई ऊंचाइयों तक ले जाने में संस्थान कर्मियों के समर्पित प्रयासों के लिए उन्हे धन्यवाद देता हूँ। इसके अलावा, मैं इस प्रस्तुत रिपोर्ट को समय पर पूरा करने में बहुमूल्य योगदान के लिए समस्त प्रभागों के प्रमुख, केंद्र प्रमुख तथा प्रशासनिक और वित्त विभाग के प्रति आभार व्यक्त करता हूं।

दिनांक : 1 जनवरी, 2024
बैरकपुर

बि. के. दास
(निदेशक)

Executive Summary

The institute's research work was carried out through 23 institute funded and network projects, 19 externally funded research projects and 4 consultancy projects in the year 2023. In addition, the Institute executed developmental activities like NEH, SCSP and STC programmes in several parts of the country for livelihood improvement of the downtrodden fishers targeting different SDGs. Special care has been taken for effective technology dissemination, input distribution to the needy fish farmers/fishers and knowledge and skill upgradation of the different stakeholders, etc. Salient achievements of the Institute in the year 2023 are summarized below:

Awards

The Director of the institute was awarded the Prof. G. K. Manna Memorial Award at the 108th session of The Indian Science Congress. He also bagged the Best Researcher Award for the new science inventions and Congress Zoology Medal by the Zoological Society of India. Besides, he also received the Lifetime Achievement Award by the International Academy of Science and Research.

Many scientists served as experts in different external bodies/committees. They also chaired several technical sessions in conferences. Many of them served as research guides for PhD and MFSc research scholars. Many scientists evaluated the PhD and MSc/MFSc research thesis of several universities. Some scientists acted as Member of the Institute Management Committee of other ICAR institutes. One scientist received the Netaji Subhas ICAR International Fellowship 2022-23. Eight scientists received the Best oral presentation awards in different fora like, VIROCON 2023, 'Young Researcher Award' by the Indian Society of Analytical Scientists, Delhi Chapter (ISAS-DC), best 'Senior Scientist Award' at the National Seminar on "Ecology Vs. Economic Development with Special Reference to the Ganga Basin (NEED-2023), 'Best Ichthyologist Award 2023' by the Council of International Academy of Science and Research, 'Excellence in Research Award 2023' and 'Young Scientist Award 2023' by Kalash Research and Welfare Society, 'Young Scientist Award' at the International Conference on 'Aquatic Resources and Sustainable Management', 'Dr. V. G. Jhingran Gold Medal' at the National Conference on "Transforming Rural Poverty to Prosperity through Sustainable Fisheries (TRPSF-2023). The Institute sports contingent won 3 gold and 2 silver medals in the ICAR Zonal Sports Tournament (Eastern Zone)-2022 and 2023 held at ICAR-IVRI, Izatnagar and the ICAR-National Rice Research Institute, Cuttack, respectively.

Technology Management

- During the year under report, applications for one patent, two trademarks and 11 copyrights have been filed. Besides, two design registrations, one trademark and two copyrights were granted. The institute signed technology license agreement of 'CIFRI cage grow feed' with M/s. Glaucus Agrochem Pvt. Ltd.

Research on Riverine and Estuarine Fisheries

- Two sygnathid species, *Hippocampus trimaculatus* and *Hippichthys spicifer*, and the Indian frogfish, *Antennarius indicus*, were identified for the first time from the Hooghly-Matlah estuarine system.
- *Polynemus paradiseus* and *Setipinna phasa* were overfished in the Hooghly-Matlah estuary, with estimated exploitation rates (E) of 0.66 and 0.55 for *P. paradiseus* and *S. phasa*, respectively.
- An aquatic hydroid forest has been found on long-submerged ropes, nets, bamboo, wooden logs, and metallic jetty walls in the lower part of the Hooghly-Matlah estuary. At least 20 species of aquatic organisms have been recorded from this recently discovered euryhaline hydroid forest; among those *Melarhaphe neritoides* (gastropoda) and *Synidotea laticauda* (isopoda) are new records in Indian waters.
- Current exploitation rate of *Planiliza subviridis* in Rushikulya estuary was below biological reference point indicating that the stock was underexploited.
- The polyhaline zone of the Mandovi-Zuari estuary mainly yielded marine stragglers and marine migrants as the major catch. The major species contributed to the fishery in the oligohaline zone of the estuary were *Etroplus suratensis, Lates calcarifer, Lutjanus argentimaculatus, Chanos chanos, Caranx ignobilis, Sillago sihama,*

Systomus sarana, Glossogobius giuris and *Channa striatus*.

- Average trophic state estimates of the Vembanad lake indicated a shift from 49.53 (meso-trophic) to 66.7 (hyper-eutrophic) during the study period. The trophic state estimates along the salinity gradient indicated an increase in TSI of high salinity zone from 48.37 (meso-trophic) to 56.75 (hyper-eutrophic).
- Impact of dam on the river ecology and fisheries were accessed during lean season representing low flows in river Ranjit. The ecology downstream of dam is not suitable for the fish habitat. Though, reproductive analysis of the migratory fish *Schizothorax* sp. showed no changes between the upstream and downstream of the dam.
- The fishing crafts operated in river Kosi were motorized or non-motorized wooden boats (plank built). Fishing gears comprised of gill net, cast net, drag net, dip net, hook and line and indigenous traps.
- Two cyprinids *Chagunius nicholsi* and *Opsarius dogarsinghi* were recorded for the first time from the Torsa River in the Jaldapara National Park, extending their distribution range beyond northeastern India.
- *Eustrongylides ignotus* (Jagerskiold, 1909), a nematode known for causing the parasitic disease 'Eustrongylidosis' in fish and birds, has been detected in four different indigenous fish species *Channa marulius*, *Clupisoma garua*, *Ompok bimaculatus* and *Rita rita* from Ken River in Panna National Park.
- Eight exotic fish species were recorded from the river Yamuna, with species such as *Cyprinus carpio, Oreochromis niloticus* and *Clarias gariepinus* being recorded at every sampling centres except Barkot. Exotics contributed more than 65% of the fish catch along the stretch from Delhi to Chilla Ghat.
- Leaf litter decomposition of major mangrove species from Indian indicates that *Avicennia* spp. (86.63-115.5 days) showed higher decomposition rate with shorter half-life as compare to *Rhizophora mucronata* (Half-life: 115.5-173.25 days) and *Ceriops tagal* (Half-life: 231 days).
- Sediment organic carbon (SOC) distribution indicates that the Indian Sundarban mangroves act as a natural C sink, but can be a significant source of greenhouse gases, if the mangrove vegetation is not protected.
- Small-bodied copepods showed dominance over the large-bodied copepods in the Sundarban estuarine system. The dominance of herbivory zooplankton (57%) in the mangrove dominated sites indicated maximum utilization of trophic energy of the strata.

Reservoir and Wetland Fisheries

- Catch per unit effort (CPUE) in Hirakud reservoir ranged from 1.5 – 28.4 kg/day/fisher for gill net fishing fleet, while it was 90-200 kg/day for drag nets. Carps contributed around 38% of the fish catches while catfishes contributed to the tune of 27% of the fish catch from Hirakud reservoir.
- The presence of threatened fishes like *Clarius magur* (EN), *Ompok bimaculatus* (NT), *Ompok pabda* (NT) and *Wallago attu* (VU), and also otters in and around the wetlands under the Dudhwa National Park, which are some national priority animals for conservation gives recognizance to the importance of these freshwater habitats to ensure the continued presence of these aquatic animals.
- Ecopath model of Idukki reservoir (Kerala) has been developed for sustainable fisheries management.
- Studies carried out in three medium reservoirs, *viz*., Kodar (Chhattisgarh), Poondi (Tamil Nadu) and Serlui-B (Mizoram), indicated towards the need for strengthening of CBF management of medium reservoirs with proper stocking of IMC and commercially important indigenous species fingerlings in ideal stocking density as per the carrying capacity of reservoir.
- Recommendations for sustainable fisheries management of Serlui-B reservoir have been formulated.
- Studies on refinement of culture-based fisheries for small reservoirs indicated that stocked fish dominated the fish catch contributing 75 to 90% of the total fish catch in Sunei, Kalo, and Gayathri reservoirs where regular stocking practices were implemented indicating the significance of regular stocking efforts.
- The possible impact of a further increase in the biomass of important fish groups on the ecological attributes of Gayathri reservoir (Karnataka) was evaluated by the use of Ecopath model with Ecosim (EwE). The primary production/respiration value was 6.12 in Gayathri reservoir and the system overhead value was 61.93%, which indicated that the ecosystem is in the developmental phase and is not fully resilient to perturbations.
- Eight floodplain wetlands of Assam spread across six districts, *viz*., Morigaon (Dandua and 46-Morakolong beels), Nagaon (Lakhanbandha and Rupahi beels), Cachar (Algapuranua beel), Karimganj (Sone beel), Bongaigaon (Tamranga beel), and Dhubri (Dhir beel) were studied for generating data on their fisheries and ecology.
- Irregular stocking in wetlands of Murshidabad (West Bengal) was recorded due to various issues such as hike in lease value, resulting in

drastic decline of major carp production forcing the fishers to thrive on SIFs and other indigenous fish.

- High accumulation of sediment organic carbon (2.1-3.2%) was recorded in wetlands of Murshidabad; restoration of river connectivity for hydrological flushing is needed.
- Institutional mechanisms have been identified to be a key component of sustainable fisheries in wetlands of Bihar. Bhusra Wetland nearly went defunct due to lack of proper ownership, almost entirely choked by floating macrophytes; in contrast, Manika and Simra Maun saw improved fisheries with newly leased owners.
- The average monthly family income of fishermen dependent on wetlands was highest at Man Sagar (Rs. 9818) in Madhya Pradesh, followed by the Kitaman (Rs. 9525) and Ramgarh (Rs. 8312) tals of Uttar Pradesh. The lowest recorded monthly family income was at Lokpal Sagar (Rs. 3043) in Madhya Pradesh.
- Exploratory surveys conducted in Sathanur (Thiruvanamali district, Tamil Nadu) and Kanva (Ramanagara district, Karnataka) reservoirs reported that the average net primary productivity of Sathanur reservoir was 144 $mgC/m^3/hr$ with a production potential of 2190 kg/ha/yr; whereas, the net primary productivity of Kanva reservoir was 48 $mgC/m^3/hr$ with an estimated production potential of 730 kg/ha/yr.

Open-water Aquaculture Production and Management

- New net pen design was developed to suit deep water bodies like reservoirs, which is capable of countering the issues of dwindling water levels and wave action during prolonged culture periods. The design was successfully tested at Maithon reservoir, Jharkhand, and later the pen infrastructure was shifted to Kansabati reservoir, West Bengal for feasibility studies.
- The fishermen reported notable increase in weight (200-250 g) for the stocked fingerlings of *Labeo catla* and *L. rohita* fed with CIFRI-CAGEGROW floating pellets during 80 days of rearing in these newly designed pens.
- Three isonitrogenous feeds (CP 32 %), *i.e.*, two formulated (soybean as protein source and casein as main protein sources) and one commercial feed was tested in *Pangasianodon hypothalamus* reared in 500 L circular tanks.
- Leaching experiment and indoor feeding trial was conducted for the efficacy testing of formulated feeds (soybean based, brewer waste based and casein based) and was compared with commercial feed along with nutrient leaching and retention in *Oreochromis niloticus* and *P. hypophthalmus* fish flesh.
- Insulin-like Growth Factors (IGFs) expression in cage-reared butter catfish (*Ompok bimaculatus*) was studied across stocking densities, emphasizing the significance of liver-derived igf-1 as a biomarker for growth in response to culture density.
- Collection and rearing of *Sperata aor* advanced fingerlings from the River Ganga were carried out, involving techniques to ensure the well-being of the collected fishes, recording length and weight, and providing suitable conditions in hatchery tanks for adaptation and growth.

Fishery Resource Assessment and Informatics

- Emerging contaminants such as Triclosan, Triclocarban, BPA, and Phthalates were detected in few fishes collected from different sites along the upper and middle stretches of the river Cauvery. Sediment enzyme activity of the sites revealed higher carbon cycling (glucosidase), phosphorous mineralizing (phosphatase) and general microbial activity in reservoir sites of Mettur and KRS, than the river course at Kudige and Shivanasamudra indicating possible impact of dams and barrages on a river stretch.
- Investigation on metal contamination in fishes of Loktak Lake revealed that fishes within the FAD (fish aggregating device) contained less metals and thus safe for consumption than the fishes from outside the FAD.
- Residues of few metabolites of DDT like DDE and DDD were recorded in waters of three freshwater wetlands (Chaltia, Bishnupur and Katiganga beels) in the Murshidabad district of West Bengal, albeit at a very low concentration. Accumulation of residues of synthetic pyrethroids was noticed in sediments of these wetlands.
- A bigdata analytics framework has been used to generate a database of Asian fish species' occurrence at the country level, comparison of taxonomic diversity and threatened status among 48 countries of Asia.
- An innovative Bayesian GLMM hierarchical modelling has been applied to decouple the phytoplankton cell damage risk from inland waterway navigation and other potential factors in the Bhagirathi-Hooghly river.

Aquatic Environmental Biotechnology

- Metagenomics profile of a polluted water body has been assessed and found that the sewage site has the highest concentration of microorganisms including virus and bacteria. The wetland microbiome has 50% of the genes involved in metabolism, 20% genes in cellular processes & signalling, and 18% of the genes in information storage & processing.

- The bio-remediation capabilities of bacterial isolates were characterized and microbial consortiums were developed for the potential removal of ammonium from contaminated water bodies.
- Stock characterization of two small indigenous bagrid catfishes, *Mystus gulio* and *Mystus cavasius* was carried out. The complete mitochondrial genome sequences *M. cavasius* and *M. gulio* have been submitted in GenBank with an accession number OP893799 and OP856487 respectively.
- Nanostructured material was prepared by impregnating metal oxides into cellulosic material to curb phosphate pollution in inland aquatic ecosystems. The material could adsorb 4805 µg PO_4/g with an incubation time of 20 hr at 10 ppm initial PO_4 concentration.
- *In vitro* cytotoxic effect of phosphate remediating nanomaterial was assessed in Zebrafish (*Danio rerio*) gill cell line. The 20-50 ppm concentration of the material was found not markedly cytotoxic to cells.
- Tilapia mortality investigation in East Kolkata Wetlands revealed TiLV and TiPV infections, along with the presence of *Aeromonas hydrophila* and *A. veronii* infections in the affected fishes.
- A comparative bioconversion of *Salvinia molesta* - a floating aquatic weed had shown a higher yield of stable vermicompost manure (38.94%) than the garden wastes (25%). It offers an eco-friendly viable solution to the aquatic weed management in the drinking water unit proving the concept of "*waste to wealth*".
- A feed composition with herbal extracts, as well as immuno-stimulant minerals and elements was developed for fish feed supplement. Trials have yielded exceptional results in terms of overall fish survival over the winter months.

Fisheries Socio-Economics

- Seven SDGs, *viz*., SDGs 1: End poverty, 2: Zero hunger, 5: Gender equity and women empowerment, 8: Economic Growth, 12: Sutainable Consumption and Production, 13: Climate Action, and 14: Life below Water were addressed through the project on 'Sustainable Development of Inland Fisheries through Sustainable Development Goals (SDGs)'.
- The average number of income-generating activities per household ranged from 3.92 to 4.4 in the floodplain wetlands of the Lower Ganga Basin.
- The average years of school education received by the fishermen were 3.17 years, 3.55 years, and 1.47 years, respectively, in the lower, middle, and upper stretches of the river Ganga. The monthly income from fish catch increased from Rs. 2500 in 2001 to Rs. 4345 in 2021.
- The food-energy-water nexus in the Cauvery River Basin was investigated by studying the trade-off between agriculture, hydropower, and fish species richness in the Kabini watershed, using hydro-economic modelling to understand the future viability of dams.
- The study highlighted the need for balanced decision-making, considering the benefits of electricity generation and agriculture against ecological consequences, and emphasising sustainable development for energy, biodiversity, and economic goals.

Network Projects

- Fish samples were collected from the North 24 Parganas, Burdwan, Howrah, Hooghly, Murshidabad, and Malda districts of West Bengal for investigation on the AMR against *Staphylococcus aureus*, *E. coli*, and *Aeromonas* sp.
- AST showed that more than 75% of *S. aureus* isolates were resistant to Penicillin. 28 % of the *E. coli* isolates showed resistance to Amoxicillin-Clavulanic Acid. In case of *Aeromonas* isolates, 33.33 % were resistant to Amoxicillin-Clavulanic Acid, and 30.7 % showed resistance to Cephalothin.
- The ICAR-CIFRI conducted World AMR Awareness Week (WAAW) for fish farmers, students and general public, during 18 – 23 November 2023.
- Domestication of Gangetic leaf fish, *Nandus nandus* was achieved in indoor aquarium setup with submerged macrophyte plantation and feed supplementation.
- Successful rearing of artificially bred peacock eel, *Macrognathus aral* juvenile was achieved in glass aquarium using supplementary feeding.
- Captive breeding of dwarf chameleon fish, *Badis blosyrus* was achieved for the first time.

Externally Funded Projects

- The ICAR-CIFRI had undertaken a tremendous effort to implement the "National Ranching Programme" across several Indian states. In order to conserve and restore the populations of Indian Major Carps (IMC) and Mahseer in the river Ganga, the institute has conducted 19 distinct ranching operations in 2023, releasing 28.88 lakh fingerlings.
- The FiSAT program was employed for stock assessment of four important small indigenous species (SIF) from the River Ganga: *Johnius coitor*, *Cabdio morar*, *Salmostoma bacaila*, and *Gudusia chapra*. The results indicated that the species *C. morar* was heavily exploited. On the lower stretch of the River Ganga, all of the fish stocks are optimally

exploited (E_{opt}), except for the species *Cabdio morar*.

- Artificial breeding of Hilsa (*Tenualosa Ilisha*) was carried out in Godakhali and Farakka regions of river Ganga with the goal of enhancing the Hilsa population in the river. The fertilization rate of 72% to 80% was achieved, and the hatching rate was recorded at 57% to 60%.
- Assessed the possibility of imaging hilsa gonad through ultrasonography with the partner Institute ICAR-CIFE. The GSI and the stage of ovary and testis have been determined with the fishes grown at Kolaghat.
- The institute carried out 102 awareness initiatives under the NMCG in various states, including West Bengal, Uttarakhand, Uttar Pradesh, Bihar, and Jharkhand.
- Culture of *Etroplus suratensis* recorded an average weight gain of 30 g/month, indicating that the culture can be successfully taken up by small-scale farmers associated with Vembanad wetland.
- GHG emission study was conducted in two different types of floodplain wetlands: open and closed. The low emission from open wetlands elucidates the importance of maintaining the link channel with the parent river.
- Ecological services provided by the 17 coastal wetlands of three districts of West Bengal, *viz*., North 24 Parganas, South 24 Parganas, and Purba Medinipur were studied, and the score was developed in the context of climate change and resultant extreme events.
- The microbiome diversity of Ganga River sediment was evaluated from the urban Kolkata sites using metatranscriptome analysis. The analysis revealed a total of 18,381 unigenes; among these 9473 genes were down-regulated and 8823 genes were up-regulated and 393 DEGs in the obtained samples.
- Microbial metagenomic study showed that the antibiotic florfenicol induces significant increase in bacteria diversity of gut of *Pangasianodon hypophthalmus*, which, however, partially recovered within 10 days of drug withdrawal.
- Pharmacokinetics study of antibiotic enrofloxacin following bolus oral administration showed long mean residence time and half-life of the drug in blood which corroborated with prolong withdrawal period of the drug in *P. hypophthalmus*.
- A prototype device for colorimetric detection of Cr (VI) in natural water was developed with a modification of using EDTA.
- The institute established "Environmental & Aquatic Animal Health Monitoring Laboratory" at Sambalpur, Odisha to study the Hirakud reservoir.
- Monoculture of *Systomus sarana* in pens at Chamta and Sindrani wetlands demonstrated potential of pen culture integration for successful production and conservation of this valuable small-indigenous-fish species.
- Comparative LC-MS/MS based proteomic studies after chronic exposure to sub-lethal dose of LC_{50} of Bisphenol-A (BPA), Diethyl phthalate (DEP), Triclosan (TCS) and Cypermethrin (CYP) to Catla (*L. catla*) revealed dynamic changes in protein level in response to low dose of toxic exposure.
- An IoT based DO management system has been developed which continuously measures the DO level in the waterbody as well as operate the aerator automatically in case of low DO level to manage the stress condition.
- A drone based vertical water sampler has been developed to collect water samples from inaccessible areas of inland open waterbodies like difficult terrains, highly polluted sites etc., using a remote-controlled water sampler.
- In partnership with the West Bengal government's Directorate of Fisheries, the institute launched a major developmental project to disseminate cage culture technology, strengthen the capacity of the officials of the Directorate of Fisheries, the resource user communities and cooperatives. The project was undertaken in co-management mode with fishermen group. A battery of 32 cages were installed at the Kangsabati reservoir and stocked with *Pangasius* seed with a target to produce 80 tons of fish in 8-9 months of duration.
- A project on East Kolkata Wetland management, funded by the Department of Environment, Government of West Bengal, is ongoing for multiple value assessment of the fish, agriculture, horticulture and floriculture production, fish disease status, indigenous fish culture potential and impact of invasive fish species with emphasis on possible management.
- MoU was signed between the ICAR-CIFRI, Barrackpore and Department of Fisheries, Jharkhand for improving livelihood of tribal communities through Scampi (*Macrobrachium rosenbergii*) fisheries enhancement technologies in under-utilized reservoirs of Jharkhand.
- A project was conceived to assess the impact of water intake due to NTPC Gadarwara STPP on ecology of Narmada river.

NEH Programme

- Impact of fish stock enhancement on fish yield after direct intervention by ICAR-CIFRI was carried out in 10 floodplain wetlands of Central and Lower

Brahmaputra valley, Assam. Average fish yield of the beels increased from 493.57 kg/ha during 2019-20 to 599.96 kg/ha during 2021-22 following ICAR-CIFRI's intervention.

- Polyculture of *Amblypharyngodon mola* (mola), *Ctenopharyngodon idella* and *Labeo rohita* was carried out in pens at Takmupat in Bishnupur district of Manipur. The fish yield from the pens was estimated at 3680 kg/ ha/ yr.
- Cage culture trials of *Osteobrama belangeri* (pengba), *C. idella* and *L. bata* was also carried out at Takmu pat. The fishes were released into the lake for stock enhancement after four months of culture.
- Status and prospect of cage culture in Serlui-B reservoir of Mizoram was studied. The ICAR-CIFRI assisted Mizoram State Fisheries Department in developing human resource in cage culture through on- and off-campus training programmes.
- A total of 38 fish species has been documented from the Umiam reservoir, Meghalaya. The exotic common carp (*Cyrprinus carpio*) had established in the reservoir and dominated the fish catches, with indigenous chocolate mahseer (*Neolissocheilus hexagonolepis*) occurring in low numbers.
- Cage culture trials were carried out at Umiam reservoir, where the *C. carpio* and *Barbonumus gonionotus* performed well in terms of growth and survival. The sale of cage reared fishes directly benefitted 25 fisher women families.
- The ecology and fisheries of Bor beel of Namsai district, Arunachal Pradesh has been documented. Fish yield from the beel ranged from 35-155 kg/ha/year across seasons. The beel was observed to be moderately eutrophic based on TSI values.

SCSP and STC Programmes

- The SCSP and STC programmes were 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 the remote and vulnerable regions of West Bengal, Odisha, Jharkhand, Chhattisgarh, Meghalaya, Karnataka and Tamil Nadu. The necessary inputs were distributed for aquaculture, fisheries, ornamental fish culture and pen culture. A workshop was conducted on livelihood development addressing SDGs through inland open waters. A stakeholders consultation was also conducted. Mahila Matsayajibi Sammelan was organized at Sundarban in the august presence of the DG, ICAR which was attended by around 5000 fishers including 2700 women fishers.

HRD and Other Activities

- The Institute organized 53 trainings for fishers/fish farmers, students and state government officials imparting knowledge and skills to 1363 stakeholders. Eleven awareness programmes were organized covering more than 1470 participants. Institute technologies/products/publication were showcased in 19 exhibitions in different parts of the country. A total of 659 students were exposed to the institute facilities and research during the year.
- The Institute organized/co-organized several seminars, conferences and workshops. National seminar on "Ecology vs. Economic Development with Special Reference to the Ganga Basin (NEED-2023)", Institute-industry interface meeting on waste-to-wealth products, "Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference", interactive workshop on "Management of Open Water Fisheries of Sikkim", workshop on "Livelihood development addressing SDGs through inland open water fisheries", workshop under the NICRA project "Impact of Climate Change in Inland Fisheries and Development of Adaptive Strategies, stakeholders" consultation-cum-consultative workshop on "Fish conservation and ranching in the Ganga", stakeholders consultation cum consultative workshop on "Hilsa fisheries improvement for sustainable fisheries and conservation in the Ganga under the NMCG project" were some of them.
- The Institute scientists, technical officers, research scholars have published 113 research and review papers having total international IF of 396.04, 18 popular articles, 5 books, 24 book chapters, and 8 training manuals.

विशिष्ट सारांश

वर्ष 2023 में संस्थान के अनुसंधान कार्यों में 23 वित्त पोषित और नेटवर्क परियोजनाओं, 19 बाह्य वित्त पोषित परियोजनाओं और 4 परामर्शी परियोजनाओं का विशेष योगदान रहा है । इसके अलावा, संस्थान ने देश के कई भागों में पूर्वोत्तर क्षेत्र (एनईएच), अनुसूचित जाति उप–योजना (एससीएसपी) तथा आदिवासी विकास (एसटीसी) जैसी विकासात्मक गतिविधियों को क्रियान्वित किया जिसका लक्ष्य विभिन्न सतत विकास लक्ष्यों को प्राप्त करने के साथ निर्धन और साधनहीन मछुआरों की आजीविका में सुधार करना था। इस संदर्भ में प्रभावी प्रौद्योगिकी प्रसार, जरूरतमंद मछली किसानों/मछुआरों को आदान वितरण और विभिन्न हितधारकों के ज्ञान और कौशल विकास आदि का विशेष ध्यान रखा गया है। वर्ष 2023 में संस्थान की मुख्य उपलब्धियाँ को संक्षिप्त तौर पर नीचे दिया गया है।

पुरस्कार

संस्थान के निदेशक को भारतीय विज्ञान कांग्रेस के 108वें सत्र में प्रोफेसर जी के मन्ना मेमोरियल अवार्ड से सम्मानित किया गया। साथ ही, उन्हें नए विज्ञान आविष्कारों के लिए सर्वश्रेष्ठ शोधकर्ता पुरस्कार और जूलॉजिकल सोसाइटी ऑफ इंडिया द्वारा कांग्रेस जूलॉजी मेडल भी प्रदान किया गया। इसके अलावा उन्हें इंटरनेशनल एकेडमी ऑफ साइंस एंड रिसर्च द्वारा लाइफटाइम अचीवमेंट अवॉर्ड भी मिला है।

रिपोर्ट अवधि के दौरान, संस्थान के कई वैज्ञानिकों ने विभिन्न बाह्य संगठन/समितियों में विशेषज्ञ के रूप में कार्य किया और सम्मेलन के तकनीकी सत्रों की अध्यक्षता की। कई वैज्ञानिकों ने पीएचडी और एमएफएससी शोध छात्रों के लिए अनुसंधान मार्गदर्शक के रूप में कार्य किया तथा पीएच.डी. थीसिस और एमएससी / एमएफएससी रीसर्च थीसिस का मूल्यांकन किया। कुछ वैज्ञानिकों ने भारतीय कृषि अनुसंधान परिषद के अन्य संस्थानों की संस्थान प्रबंधन समिति के सदस्य के रूप में कार्य किया। संस्थान के एक वैज्ञानिक को नेताजी सुभाष आईसीएआर इंटरनेशनल फेलोशिप 2022–23 प्रदान किया गया है। साथ ही आठ वैज्ञानिकों को विभिन्न मंचों पर आलेख प्रस्तुति के लिए सर्वश्रेष्ठ पुरस्कार मिला है – विरोकॉन 2023; "जलीय संसाधन और सतत प्रबंधन" पर अंतर्राष्ट्रीय सम्मेलन; "गंगा बेसिन के विशेष संदर्भ में पारिस्थितिकी बनाम आर्थिक विकास" पर राष्ट्रीय संगोष्ठी (एनईईडी–2023); इंडियन सोसाइटी ऑफ एनालिटिकल साइंटिस्ट्स, दिल्ली चैप्टर (आईएसएएस–डीसी) का 'यंग रिसर्चर अवार्ड'; काउंसिल ऑफ इंटरनेशनल एकेडमी ऑफ साइंस एंड रिसर्च का 'बेस्ट इचथियोलॉजिस्ट अवार्ड 2023' और 'उत्कृष्ट अनुसंधान पुरस्कार 2023'; कलश रिसर्च एंड वेलफेयर सोसाइटी का 'यंग साइंटिस्ट अवार्ड 2023'; 'जलीय संसाधन और सतत प्रबंधन' पर अंतर्राष्ट्रीय सम्मेलन में 'युवा वैज्ञानिक पुरस्कार'; और 'सतत मत्स्य पालन के माध्यम से ग्रामीण गरीबी को समृद्धि में परिवर्तन' (टीआरपीएसएफ–2023) विषय पर राष्ट्रीय सम्मेलन में डॉ वी. जी. झिंगरन स्वर्ण पदक आदि। संस्थान कर्मियों ने क्रमशः भाकृअनुप–भारतीय पशु चिकित्सा अनुसंधान संस्थान (ICAR & IVRI), इज्जतनगर और भाकृअनुप –राष्ट्रीय चावल अनुसंधान संस्थान (ICAR & NRRI), कटक में आयोजित आईसीएआर जोनल स्पोर्ट्स टूर्नामेंट (पूर्वी क्षेत्र)–2022 और 2023 में 3 स्वर्ण, 2 रजत पदक जीता है ।

प्रौद्योगिकी प्रबंधन

- रिपोर्ट वर्ष के दौरान, एक पेटेंट, दो ट्रेडमार्क और 11 कॉपीराइट के आवेदन दायर किए गए हैं। इसके अलावा, दो डिज़ाइन का पंजीकरण, एक ट्रेडमार्क और दो कॉपीराइट प्राप्त हुआ। संस्थान ने मेसर्स ग्लोकसएग्रोकेम प्राइवेट लिमिटेड के साथ 'CIFRI केज ग्रो फीड' के प्रौद्योगिकी लाइसेंस समझौते पर हस्ताक्षर किया ।

नदी और ज्वारनदमुख प्रभाग

- हुगली–मातलाह ज्वारनदमुख तंत्र से पहली बार दो सिग्नाथिड प्रजातियाँ, *हिप्पोकैम्पस ट्राइमेकुलैटस* और *हिप्पिचथिस स्पिसिफ़र* तथा इंडियन फ्रॉगफिश, *एंटेनारियस इंडिकस* की पहचान की गई थी।

- हुगली–मातलाह मुहाने में *पॉलीनेमस पैराडाइज़स* और *सेटिपिन्ना फासा* प्रजाति की मछलियों का अत्यधिक दोहन हुआ है। दोनों प्रजातियों का अनुमानित दोहन दर क्रमशः 0.66 और 0.55 आँका गया है।

- हुगली– मातलाह मुहाना के निचले हिस्से में लंबे समय से जलमग्न रस्सियों, जालों, बांस, लकड़ी के लट्ठों और धातु से बने जेटी के कारण एक जलीय हाइड्रॉइड जंगलनुमा बन गया है। हाल ही पाए गए इस यूरीहैलाइन हाइड्रॉइड वन से जलीय जीवों की कम से कम 20 प्रजातियाँ दर्ज की गई हैं; जैसे *मेलार हाफेनरिटोइड्स* (गैस्ट्रोपोडा) और *सिनिडोटेले टिकौडा* (आइसोपोडा) देश के समुद्री क्षेत्र के नए रिकॉर्ड हैं।

- ऋषिकुल्या ज्वारनदमुख में *निलिज़ा सुबविरिडिस* की वर्तमान दोहन दर जैविक संदर्भ बिंदु से नीचे पाया गया जो यह दर्शाता है कि स्टॉक का कम दोहन किया गया है ।

- मांडोवी–जुआरी मुहाने के अतिलवणीय क्षेत्र में मुख्य रूप से समुद्री प्रवासी और समुद्री प्रवासी मछलियों की प्रचुरता पाई गई। इस मुहाना के अल्पलवणीय क्षेत्र में प्रमुख प्रजातियाँ पाई गई– *एट्रोप्लस सुरटेन्सिस, लेटेस कैलकैरिफ़र, लुजेनस आरजेंटिमाकुलैटस, चानोस चानोस, कैरानक्सि ग्नोबिलिस, सिलागो सिहामा, सिस्टोमस सराना, ग्लोसोगोबियस गिउरिस* और *चन्ना स्ट्रिएटस* ।

- वेम्बानाड झील की औसत पोषी स्थिति के अनुमान ने अध्ययन अवधि के दौरान 49.53 (मध्यम–पोषी) से 66.7 (पोषक तत्वों से भरपूर) में बदलाव का संकेत मिलता है । लवणीयता की प्रवणता के साथ पोषी स्थिति के अनुमान उच्च लवणता क्षेत्र के टीएसआई में 48.37 (मध्यम–पोषी) से 56.75 (पोषक तत्वों से भरपूर) तक वृद्धि को दर्शाता है ।

- रंगीत नदी में कम जल प्रवाह वाले मौसम के दौरान नदी पारिस्थितिकी और मत्स्य पालन पर बांध के प्रभाव का पता लगाया गया। बांध के निचले हिस्से की पारिस्थितिकी मत्स्य आवास के लिए उपयुक्त नहीं है। हालाँकि, प्रवासी मछली, *शाईज़ोथोरैक्स* एसपी के प्रजनन विश्लेषण में बांध के अपस्ट्रीम और डाउनस्ट्रीम के बीच कोई बदलाव नहीं दर्ज किया गया ।

- कोसी नदी में मछली पकड़ने की नौका (मोटर चालित या गैर–मोटर चालित लकड़ी की नाव) का प्रयोग किया जाता है। मछली पकड़ने के गियर में गिलनेट, कास्ट नेट, ड्रगनेट, डिप नेट, हुक और लाइन और स्वदेशी जाल दर्ज किए गए हैं।

- दो साइप्रिनिड प्रजातियाँ, *चागुनियस निचोल्सी* और *ओप्सारियस डोगरसिंघी* को पहली बार जलदापारा राष्ट्रीय उद्यान में टोरसा नदी से दर्ज किया गया था, जो अबतक केवल पूर्वोत्तर भारत में पाए जाते थे।

- पन्ना राष्ट्रीय उद्यान में केन नदी से चार अलग–अलग देशी मछली प्रजातियों *चन्ना मारुलियस, क्लुपिसोमा गारूआ, ओमपोक बिमाकुलैटस* और *रीता रीता* में *यूस्ट्रॉन्गिलिडिस इगनोटस* (जैगर्सकीओईड, 1909) का संक्रमण पाया गया है । यह परजीवी मछलियों और पक्षियों में पाया जाता है।

- यमुना नदी से आठ विदेशी मछली प्रजातियाँ दर्ज की गईं, जिनमें *साइप्रिनस कार्पियो, ओरियोक्रोमिस नाइलोटिकस* और *क्लारियास गैरीपिनस* जैसी प्रजातियाँ बरकोट को छोड़कर प्रत्येक नमूना केंद्रों पर दर्ज की गईं। दिल्ली से चिल्लाघाट तक मछली पकड़ने में विदेशी प्रजातियों की प्रचुरता 65% से अधिक दर्ज किया गया।

- भारत के प्रमुख मैंग्रोव क्षेत्र में *एविसेनिया* एसपीपी (86.63–115.5 दिन) के पत्तियों के कूड़े के अपघटन से संकेत मिलता है कि *राइजोफोरा मुक्रोनाटा* (115.5–173.25 दिन) और *सेरियोपस टैगल* (231 दिन) का अपघटन दर उच्च देखा गया है।

- तलछट कार्बनिक कार्बन (Sediment Organic Carbon) का वितरण यह दिखाता है कि भारतीय सुंदरबन के मैंग्रोव क्षेत्र प्राकृतिक तौर पर कार्बन सोखता के रूप में कार्य करते हैं। लेकिन यदि मैंग्रोव के जंगलों का संरक्षण नहीं किया जाए तो यह ग्रीनहाउस गैसों का एक बड़ा स्रोत बन सकता है।

- सुंदरबन मुहाना क्षेत्र में छोटे आकार के कोपेपोड की संख्या बड़े आकार वाले कोपपोड से अधिक पाई गई। मैंग्रोव बहुल स्थलों में शाकाहारी जन्तुप्लवक (57%) की प्रबलता पोषी ऊर्जा के अधिकतम उपयोग का संकेत देते है ।

जलाशय और आर्द्रभूमि प्रभाग

- हीराकुंड जलाशय में गिल नेट से मत्स्ययन प्रति इकाई प्रयास (सीपीयूई) 1.5 से 28.4 कि. ग्रा. /दिन/मछुआरा के बीच दर्ज किया गया, जबकि ड्रैग नेट के लिए यह 90–200 कि. ग्रा./दिन/मछुआरा था। पकड़ी गई मछलियों में कार्प की प्रचुरता लगभग 38% और कैटफ़िश की 27% पायी गई ।

- दुधवा राष्ट्रीय उद्यान के अंतर्गत आर्द्रभूमि में *क्लारियस मागुर* (लुप्तप्राय), *ओमपोक बिमाकुलैटस* (संकटग्रस्त), *ओमपोक पाबदा* (संकटग्रस्त) और *वालागो अट्टू* (असुरक्षित) जैसी संकटग्रस्त मछलियों की उपस्थिति और राष्ट्रीय प्राथमिकता वाले जन्तु जैसे ऊदबिलावों का संरक्षण आवश्यक है। इन जलीय जंतुओं की निरंतर उपस्थिति सुनिश्चित करने के लिए

इन मीठा जल मछलियों का संरक्षण हिय जाना चाहिए ।

- सतत और स्थायी मत्स्य पालन प्रबंधन के लिए केरल के इडुक्की जलाशय का इकोपैथ मॉडल विकसित किया गया है।

- देश के तीन माध्यम आकार वाले जलाशयों जैसे कोडर (छत्तीसगढ़), पूंडी (तमिलनाडु) और सेरलुई–बी (मिजोरम) के अध्ययनों से यह पता चला कि ऐसे मध्यम आकार के जलाशयों में घेरे में इंडियन मेजर कार्प और व्यावसायिक रूप से महत्वपूर्ण स्वदेशी मछलियों के सटीक भंडारण (जलाशय की वहन क्षमता के अनुसार मछलियों की अंगुलिकाओं का मानक स्टॉकिंग घनत्व) द्वारा ऐसे पालन प्रबंधन को मजबूत करने की आवश्यकता है।

- सेरलुई–बी जलाशय में स्थाई और सतत मत्स्य पालन प्रबंधन के लिए सुझाव दिया गया है।

- छोटे जलाशयों के लिए पालन आधारित मात्स्यिकी के अध्ययन से संकेत मिलता है कि सुनेई, कालो और गायत्री जलाशयों में कुल मछली पकड़ में 75 से 90% स्टॉक की गई मछलियों का वर्चस्व देखा गया जहां स्टॉकिंग पद्धति को नियमित तौर पर लागू किया गया था।

- कर्नाटक के गायत्री जलाशय में इकोसिम (EwE) के साथ इकोपैथ मॉडल द्वारा पारिस्थितिक गुणों पर महत्वपूर्ण मछली समूहों के बायोमास में अतिरिक्त वृद्धि के संभावित प्रभाव का मूल्यांकन किया गया था। गायत्री जलाशय में प्राथमिक उत्पादन/श्वसन मान 6.12 और सिस्टम ओवरहेड मान 61.93% देखा गया जो यह दर्शाता है कि पारिस्थितिकी तंत्र विकास चरण में है और किसी भी प्रकार के असामान्य परिस्थिति से प्रभावित हो सकता है।

- असम के छह जिलों में फैले आठ बाढ़कृत आर्द्रभूमि अर्थात् मोरीगांव (दंडुआ और 46–मोराकोलोंग बील), नागांव (लखनबंधा और रूपाहि बील), कछार (अल्गापुरनुआ बील), करीमगंज (सोन बील), बोंगाईगांव (तमरंग बील), और धुबरी (धीर बील) के मत्स्य पालन और पारिस्थितिकी संबंधी आंकड़ों को प्राप्त करने के लिए अध्ययन किया गया।

- पश्चिम बंगाल के मुर्शिदाबाद जिले की आर्द्रभूमि में होने वाले अनियमित भंडारण को दर्ज किया गया। अनियमित भंडारण का कारण था – पट्टे के मूल्य में वृद्धि के परिणामस्वरूप मेजर कार्प मछलियों के उत्पादन में भारी गिरावट आई जिससे मछुआरों को छोटी स्वदेशी मछलियों और अन्य स्वदेशी मछलियों पर निर्भर रहना पड़ा।

- मुर्शिदाबाद की आर्द्रभूमि में तलछट कार्बनिक कार्बन (2.1–3.2%) का उच्च संचय स्तर दर्ज किया गया। अतः हाइड्रोलॉजिकल फ्लशिंग के लिए नदी संपर्क का पुनरुत्थान की आवश्यकता है।

- बिहार की आर्द्रभूमि में सतत और स्थायी मत्स्य पालन के एक प्रमुख घटक के रूप में संस्थागत तंत्र की पहचान की गई है। भूसरा आर्द्रभूमि उचित स्वामित्व के अभाव में लगभग समाप्त हो गया क्योंकि यह पूरी तरह से तैरते हुए मैक्रोफाइट के कारण लगभग पूरी तरह से अवरुद्ध हो गया है। इसके विपरीत, मनिका और सिमरा मौन पट्टे पर दिए गए थे इसलिए इसके मछली पालन में सुधार देखा गया ।

- मध्य प्रदेश के आर्द्रभूमि पर निर्भर मछुआरों की औसत मासिक पारिवारिक का अध्ययन किया गया। इसमें यह देखा गया कि मान सागर के मछुआरों की औसत आय 9818 रुपये आँका गया जो सबसे अधिक थी। इसके बाद उत्तर प्रदेश के कितामन (9525 रुपये) और रामगढ़ (8312 रुपये) ताल थे। सबसे कम मासिक पारिवारिक आय मध्य प्रदेश के लोकपालसागर (3043 रुपये) में दर्ज की गई।

- सथानुर (तिरुवनमाली जिला, तमिलनाडु) और कण्वा (रामनगर जिला, कर्नाटक) जलाशयों में किए गए सर्वेक्षणों से पता चला है कि सथानुर जलाशय की औसत शुद्ध प्राथमिक उत्पादकता 144 $mgC/m^3/hr$ (उत्पादन क्षमता 2190 कि.ग्रा./हेक्टेयर/वर्ष) थी जबकि कनवा जलाशय की शुद्ध प्राथमिक उत्पादकता 48 $mgC/m^3/hr$ और अनुमानित उत्पादन क्षमता 730 कि.ग्रा./हेक्टेयर/वर्ष आंकी गई थी।

खुलाजल कृषि और उत्पादन प्रबंधन

- जलाशय जैसे गहरे जल निकायों के अनुरूप नया नेट पेन डिज़ाइन विकसित किया गया था, जो लंबे समय तक पालन अवधि के दौरान घटते जल स्तर और जल धार वेग संबंधी कारकों से मुकाबला करने में सक्षम है। इस डिजाइन का झारखंड के मैथन जलाशय में सफलतापूर्वक परीक्षण किया गया था और बाद में व्यवहार्यता अध्ययन के लिए पेन के ढांचे को कंसाबती जलाशय, पश्चिम बंगाल में स्थानांतरित कर दिया गया था।

- मछुआरों ने इन नए डिज़ाइन वाले पेन में *लेबियो कतला* और *एल. रोहिता* के अंगुलिकाओं को 80 दिनों तक पालन किया। इस दौरान उन्हें सिफरी केजग्रो फ्लोटिंग आहार खिलाया गया। पालित 80 दिनों के बाद स्टॉक की गई अंगुलिकाओं के वजन में उल्लेखनीय वृद्धि (200–250 ग्राम) देखी गई।

- तीन आइसोनिट्रोजेनस फ़ीड (सीपी 32%), अर्थात दो तैयार फ़ीड (प्रोटीन स्रोत के रूप में सोयाबीन और मुख्य प्रोटीन स्रोत के रूप में कैसिइन) और एक वाणिज्यिक फ़ीड का परीक्षण 500 लीटर के गोलाकार टैंकों में पालित *पंगासियनोडोन हाइपोथैलेमस* के साथ किया गया।

- तैयार किए गए फ़ीड (सोयाबीन युक्त, शराब कारखानों के अपशिष्ट युक्त और कैसिइन युक्त) की प्रभावकारिता परीक्षण के लिए लीचिंग प्रयोग और इनडोर फीडिंग परीक्षण किया गया। इस फ़ीड को की प्रभावकारिता की तुलना *ओरियोक्रोमिस नाईलोटिकस* और *पी. हाइपोथाल्मस* मछली के मांस में पोषक तत्वों की लीचिंग और धारण के संदर्भ में वाणिज्यिक फ़ीड के साथ की गई थी।

- इंसुलिन अनुरूप विकास कारक (IGFs) एक्सप्रेशन का अध्ययन पिंजरों में पालित *ओम्पक बीमाकूलेटस* के स्टॉकिंग घनत्व के संदर्भ में किया गया, जिसमें पालन घनत्व के प्रतिक्रिया में वृद्धि के लिए बायोमार्कर के रूप में यकृत–व्युत्पन्न आईजीएफ –1 के महत्व पर जोर दिया गया था।

- गंगा नदी से *स्पेराटा एओर* के उन्नत अंगुलिकाओं का संग्रहण और पालन किया गया, जिसमें एकत्रित मछलियों का स्वास्थ्य विकास को सुनिश्चित करने, उनकी लंबाई और वजन रिकॉर्ड करने और हैचरी टैंकों में उनके अनुकूलन और विकास के लिए उपयुक्त स्थिति प्रदान करने की तकनीक आदि सम्मिलित थी।

मत्स्य संसाधन मूल्यांकन और सूचना विज्ञान

- कावेरी नदी के ऊपरी और मध्य हिस्सों से एकत्र की गई कुछ मछलियों में ट्राइक्लोसन, ट्राइक्लोकार्बन, बीपीए और फ़ेथलेट्स जैसे उभरते संदूषक पाए गए। इन स्थलों की तलछट एंजाइम गतिविधि के अध्ययन में यह देखा गया कि कुडिगे और शिवानासमुद्र में नदी के प्रवाह की तुलना में मेट्टूर और केआरएस के जलाशय स्थलों में उच्च कार्बन साइक्लिंग (ग्लूकोसिडेज़), फॉस्फोरस खनिजकरण (फॉस्फेटस) और सामान्य माइक्रोबियल गतिविधि है जो नदी के विस्तार पर बांधों और बैराजों के संभावित प्रभाव का संकेत देता है।

- लोकतक झील की मछलियों में धातु संदूषण की जांच से पता चला कि एफएडी (मछली एकत्रीकरण उपकरण) के भीतर की मछलियों में धातु का स्तर कम था और इस प्रकार एफएडी के बाहर की मछलियों की तुलना में उपभोग के लिए सुरक्षित थीं।

- पश्चिम बंगाल के मुर्शिदाबाद जिले में तीन मीठे पानी के आर्द्रभूमि (चल्टिया, बिष्णुपुर और कटिगंगबील्स) के पानी में डीडीटी जैसे डीडीई और डीडीडी प्रकार के कुछ मेटाबोलाइट के अवशेष दर्ज किए गए, हालांकि इनकी सांद्रता बहुत कम थी । इन आर्द्रभूमि के तलछट में सिंथेटिक पाइरेथ्रोइड्स के अवशेषों का संचय देखा गया।

- राष्ट्रीय स्तर पर एशियाई मछली प्रजातियों के वर्गीकरण विविधता की तुलना और एशिया के 48 देशों के बीच लुप्तप्राय/संकटग्रस्त मछली प्रजातियों पर डेटाबेस तैयार करने के लिए एक बिगडेटा एनालिटिक्स फ्रेमवर्क का उपयोग किया गया है।

- भागीरथी – हुगली नदी में अन्तर्स्थलीय जलमार्ग नेविगेशन और अन्य संभावित कारकों से पादपप्लवकों के उत्तकीय क्षति के जोखिम को कम करने के लिए एक अभिनव बायेसियन हायररकियल पदानुक्रमित मॉडलिंग का उपयोग किया गया है।

जलीय पर्यावरण जैव प्रौद्योगिकी

- प्रदूषित जल निकाय के मेटाजेनोमिक्स प्रोफाइल के मूल्यांकन में अपरद स्थलों में वायरस और बैक्टीरिया सहित सूक्ष्मजीवों की उच्चतम सांद्रता पाई गई है । आर्द्रक्षेत्र माइक्रोबायोम में चयापचय में 50% जीन, सेलुलर प्रक्रियाओं और सिग्नलिंग में 20% जीन और सूचना भंडारण और प्रसंस्करण में 18% जीन शामिल होते हैं।

- बैक्टीरियल आइसोलेट्स की जैव–उपचार क्षमताओं की विशेषता सुनिश्चित की गई और दूषित जल निकायों से अमोनियम को संभावना को काम करने के लिए माइक्रोबियल कंसोर्टियम विकसित किए गए हैं ।

- छोटी स्वदेशी बैग्रिड कैटफ़िश, *मिस्टस गुलियो* और *मिस्टस कावासियस* का स्टॉक लक्षण वर्णन किया गया। *एम. कैवसियस* और *एम. गुलियो* का संपूर्ण माइटोकॉन्ड्रियल जीनोम अनुक्रम क्रमशः परिग्रहण संख्या OP893799 और OP856487 के साथ जीनबैंक में संरक्षित किए गए हैं।

- अन्तर्स्थलीय जलीय पारिस्थितिक तंत्र में फॉस्फेट प्रदूषण को रोकने के लिए सेल्युलोसिक तत्वों में धातु ऑक्साइड को संसेचित करके नैनोसंरचित सामग्री तैयार की गई थी। यह सामग्री 10 पीपीएम फॉस्फेट प्रति ग्राम सांद्रता पर 20 घंटे के ऊष्मायन समय के साथ 4805 माइक्रोग्राम फॉस्फेट प्रति ग्राम सांद्रता को सोख सकती है।

- जेब्रा फिश, *डैनियो रेरियो* के गिल उत्तकीय भाग में फॉस्फेट

रीमेडियेटिंग नैनोमटेरियल के इन–विट्रो साइटोटॉक्सिक प्रभाव का मूल्यांकन किया गया। पर 20–50 पीपीएम सांद्रता पर कोशिकाओं के लिए स्पष्ट रूप से साइटोटोक्सिक नहीं पाई गई।

- पूर्वी कोलकाता वेटलैंड में तिलापिया के मृत्यु दर जांच से प्रभावित मछलियों में *एयरोमोनास हाइड्रोफिला* और *ए. वेरोनी* संक्रमण की उपस्थिति के साथ–साथ ज्पस्ट और ज्पच्ट संक्रमण देखा गया ।

- *साल्विनिया मोलेस्टा* एक तैरता हुआ जलीय खरपतवार होता है। इसके जैव रूपांतरण के तुलनात्मक अध्ययन में यह देखा गया कि बागवानी क्षेत्र के कचरे (25%) की तुलना में स्थिर वर्मीकम्पोस्ट खाद (38.94%) अधिक उपजाऊ है। यह पेयजल इकाई में जलीय खरपतवार प्रबंधन के लिए एक पर्यावरण–अनुकूल व्यवहार्य समाधान प्रदान करता है जो " कचरे से कंचन " अवधारणा की पुष्टि करता है ।

- मछली आहार अनुपूरक के लिए हर्बल अर्क, के साथ इम्यूनोस्टिमुलेंट खनिज और तत्वों के साथ एक फ़ीड विकसित की गई । सर्दियों के महीनों में इस फ़ीड के परीक्षण में मछली के समग्र स्वास्थ्य के संदर्भ में असाधारण परिणाम प्राप्त हुए हैं।

मत्स्य पालन सामाजिक–अर्थशास्त्र

- सतत विकास लक्ष्यों में सात लक्ष्य अर्थात् एसडीजी 1: गरीबी उन्मूलन, 2: शून्य भूखमरी, 5: लैंगिक समानता और महिला सशक्तिकरण, 8: आर्थिक विकास, 12: सतत उपभोग और उत्पादन, 13: जलवायु संबंधी, और 14: जलीय जीवन को 'सतत विकास लक्ष्यों (एसडीजी) के माध्यम से अन्तर्स्थलीय मत्स्य पालन के सतत विकास' पर परियोजना के माध्यम से। संबोधित किया गया।

- निचले गंगा बेसिन के बाढ़कृत मैदानी आर्द्रभूमि में प्रति परिवार आय–सृजन गतिविधि की औसत संख्या 3.92 से 4.4 के बीच पाई गई ।

- गंगा नदी के निचले, मध्य और ऊपरी हिस्सों में मछुआरों द्वारा प्राप्त स्कूली शिक्षा के औसत वर्ष क्रमशः 3.17 वर्ष, 3.55 वर्ष और 1.47 वर्ष पाए गए । मछली पकड़ने से मासिक आय में 2500 रु. (वर्ष) से 4345 रु. (वर्ष 2021) की वृद्धि दर्ज की गई।

- कावेरी नदी बेसिन में बांधों की भावी व्यवहार्यता को समझने के लिए जल–आर्थिक मॉडलिंग द्वारा काबिनी जलक्षेत्र में कृषि, जल विद्युत और मछली प्रजातियों की समृद्धि के संदर्भ में खाद्य–ऊर्जा–पानी के बीच पारस्परिक संबंधों की जांच की गई।

- अध्ययन में पारिस्थितिकीय प्रभावों के परिपेक्ष्य में बिजली उत्पादन और कृषि के लाभों पर विचार करते हुए ऊर्जा, जैव विविधता और आर्थिक लक्ष्य की प्राप्ति के लिए सतत विकास पर जोर देते हुए एक प्रभावी निर्णय लेने पर प्रकाश डाला गया।

नेटवर्क परियोजनाएँ

- पश्चिम बंगाल के उत्तर 24 परगना, बर्दवान, हावड़ा, हुगली, मुर्शिदाबाद और मालदा जिलों से *स्टैफिलोकोकस ऑरियस, ई. कोली* और *एरोमोनस* एसपी के संदर्भ में एएमआर की जांच के लिए मछली के नमूने एकत्र किए गए थे।

- एएसटी के अध्ययन से पता चला कि पश्चिम बंगाल के उत्तर 24 परगना, बर्दवान, हावड़ा, हुगली, मुर्शिदाबाद और मालदा जिलों से एकत्र किए गए *स्टैफिलोकोकस ऑरियस, ई.कोलाई* और *एरोमोनास* एसपी के रोगाणुरोधी प्रतिरोध (एएमआर) मछली के नमूनों के अध्ययन में 75% से अधिक *एस. ऑरियस* के आइसोलेट पेनिसिलिन के प्रति प्रतिरोधी, 28% *ई. कोलाई* के आइसोलेट एमोक्सिसिलिन – क्लैवुलैनिक के प्रति तथा *एरोमोनस* एसपी के 33.33% आइसोलेट एमोक्सिसिलिन – क्लैवुलैनिक एसिड के प्रति और इसके 30.70% आइसोलेट सेफलोथिन के प्रति प्रतिरोधी प्रतिरोधी पाए गए।

- संस्थान ने दिनांक 18 से 23 नवंबर 2023 के दौरान मछली किसानों, छात्रों और आम जनता के लिए विश्व एएमआर जागरूकता सप्ताह (WAAW) आयोजित किया।

- जलमग्न मैक्रोफाइट वृक्षारोपण और चारा अनुपूरण के साथ इनडोर एक्वेरियम संरचना में गंगेटिक लीफ फिश, *नेंदस नेंदस* का एक्वेरियम में पालन किया गया।

- कृत्रिम रूप से पाले गए पीकॉक ईल, *मैक्रोनेथस अराल* के किशोर मछलियों का सफल पालन किया गया।

- ड्वॉर्फ कैमलियन मछली, *बैडिस ब्लोसाइरस* का घेरे में प्रथम बार प्रजनन किया गया।

बाह्य रूप से वित्तपोषित परियोजनाएँ

- संस्थान ने देश के कई राज्यों में "राष्ट्रीय रैंचिंग कार्यक्रम" को जोर–शोर से लागू करने के लिए प्रयास किया। गंगा नदी में इंडियन मेजर कार्प (आईएमसी) और महासीर की जनसंख्या को संरक्षित और पुनर्स्थापित करने के लिए संस्थान ने 2023 में 19 अलग–अलग रैंचिंग अभियान चलाया है, जिसमें 28.88 लाख अंगुलिकाओं को नदियों में छोड़ा गया है।

- FiSAT कार्यक्रम को गंगा नदी से चार महत्वपूर्ण छोटी स्वदेशी प्रजातियों (एसआईएफ) के स्टॉक मूल्यांकन के

लिए नियोजित किया गया था: *जॉनियस कोइटर, कैबडिओ मोरार, सालमोस्टोम बाकैला* और *गुडुसिया चापरा*। परिणामों से संकेत मिला कि *सी. मोरार* प्रजाति का अत्यधिक दोहन हुआ किया गया। गंगा नदी के निचले हिस्से में, *कैबडिओ मोरार* को छोड़कर सभी मछली स्टॉक का इष्टतम दोहन किया जाता है ।

- गंगा नदी में हिल्सा की संख्या बढ़ाने के लिए गोदाखाली और फरक्का में हिल्सा (*टेनुलोसा इलिशा*) का कृत्रिम प्रजनन किया गया था। इस अभियान में 72% से 80% की निषेचन दर हासिल की गई, और अंडे सेने की दर 57% से 60% दर्ज की गई।

- एनएएसएफ परियोजना के तहत भागीदार संस्थान आईसीएआर–सीआईएफई के साथ अल्ट्रासोनोग्राफी के माध्यम से हिल्सा गोनैड की इमेजिंग की संभावना का आंकलन किया। कोलाघाट में पालित मछलियों से जीएसआई तथा अंडाशय और वृषण का स्तर निर्धारित किया गया है।

- संस्थान ने पश्चिम बंगाल, उत्तराखंड, उत्तर प्रदेश, बिहार और झारखंड सहित विभिन्न राज्यों में नमामि गंगे परियोजना के तहत 102 जागरूकता कार्यक्रमों का आयोजन किया ।

- *एट्रोप्लस सुरटेन्सिस* पालन में प्रति माह औसतन 30 ग्राम वजन वृद्धि दर्ज की गई जो यह दर्शाता है कि इस पालन को वेम्बनाड आर्द्रक्षेत्र से जुड़े छोटे पैमाने के किसानों द्वारा सफलतापूर्वक अपनाया जा सकता है।

- दो अलग–अलग प्रकार के बाढ़ग्रस्त आर्द्रभूमि अर्थात खुला और बंद आर्द्रभूमि में जीएचजी उत्सर्जन का अध्ययन किया गया था। अध्ययन में यह पाया गया कि खुले आर्द्रभूमि से जीएचजी का कम उत्सर्जन मूल नदी के साथ लिंक चैनल के बीच के महत्व को स्पष्ट करता है।

- पश्चिम बंगाल के तीन जिलों, अर्थात् उत्तर 24 परगना, दक्षिण 24 परगना और पूर्व मेदिनीपुर के 17 तटीय आर्द्रभूमि की पारिस्थितिक सेवाओं का अध्ययन किया गया और जलवायु परिवर्तन और प्राकृतिक आपदाओं के संदर्भ में गणना प्रणाली को विकसित किया गया।

- कोलकाता के शहरी स्थलों में गंगा नदी तलछट की माइक्रोबायोम विविधता का मूल्यांकन मेटाट्रांसक्रिप्टोम विश्लेषण द्वारा किया गया। इस विश्लेषण से कुल 18,381 स्वदेशी मछली प्रजातियों के जीन का पता चला। इनमें से 9473 जीन को डाउन–रेगुलेट और 8823 जीन को अप–रेगुलेट किया गया। प्राप्त दोनों नमूनों में 393 डीईजी (क्म्ळ) पाए गए ।

- माइक्रोबियल मेटागेनोमिक के अध्ययन से पता चला है कि एंटीबायोटिक फ्लोरफेनिकॉल *पंगासियनोडोन हाइपोथाल्मस* की आंत में बैक्टीरिया की विविधता को और भी बढ़ा देता है, जो दवा बंद करने के 10 दिनों के भीतर आंशिक रूप से ठीक हो गया।

- एंटीबायोटिक एनरोफ्लोक्सासिन के फार्माकोकाइनेटिक्स अध्ययन में यह देखा गया कि *पी. हाइपोफथाल्मस* के मुख द्वारा इस दावा को देने से इसका प्रभाव इसके रक्त में लंबे समय तक रहता है।

- प्राकृतिक जल संसाधनों में सीआर (VI) के वर्णमिति का पता लगाने के लिए एक प्रोटोटाइप उपकरण को EDTA में संशोधन के साथ विकसित किया गया ।

- संस्थान ने हीराकुंड जलाशय का अध्ययन करने के लिए संबलपुर, ओडिशा में "पर्यावरण और जलीय जीव स्वास्थ्य निगरानी प्रयोगशाला" की स्थापना की।

- चामता और सिंद्रानी आर्द्रभूमि में पेन में *सिस्टोमस सराना* के एकल पालन से यह निष्कर्ष निकाला गया कि इस मूल्यवान छोटी–स्वदेशी–मछली के सफल उत्पादन और संरक्षण पेन पालन द्वारा किया जा सकता है ।

- *एल. कातला* की LC_{50} of Bisphenol-A (BPA), Diethyl phthalate (DEP), Triclosan (TCS) और Cypermethrin (CYP) से लंबे समय तक संपर्क के बाद तुलनात्मक एलसी–एमएस/एमएस आधारित प्रोटिओमिक अध्ययन किया गया जिससे विषाक्त तत्व की कम खुराक की प्रतिक्रिया में प्रोटीन स्तर में गतिशील परिवर्तन का पता चला।

- एक IoT आधारित DO प्रबंधन प्रणाली विकसित की गई है जो जलाशय में घुलित ऑक्सीजन स्तर को लगातार मापते हुए तनाव की स्थिति को प्रबंधित करने के लिए घुलित ऑक्सीजन के कम स्तर के संदर्भ में स्वचालित रूप से जलवाहक को संचालित करती है।

- दुर्गम क्षेत्रों में स्थित अन्तर्स्थलीय खुला जल निकायों और अत्यधिक प्रदूषित स्थलों आदि पानी के नमूने एकत्र करने के लिए एक ड्रोन आधारित रिमोट–नियंत्रित ऊर्ध्वाधर जल नमूना पानी मापक यंत्र विकसित किया गया है।

- पश्चिम बंगाल सरकार के मत्स्य पालन निदेशालय की साझेदारी में संस्थान ने पिंजरे में मछली पालन तकनीक का प्रसार करने तथा मत्स्य पालन निदेशालय के अधिकारियों, संसाधन उपयोगकर्ता समुदायों और सहकारी समितियों की क्षमता को मजबूत करने के लिए एक

विकासात्मक परियोजना शुरू की है। यह परियोजना मछुआरों के समूह के साथ सह–प्रबंधन मोड में शुरू की गई थी। इस क्रम में कांगसबाती जलाशय में 32 पिंजरों की एक बैटरी स्थापित की गई और 8–9 महीनों में 80 टन मछली पैदा करने के लक्ष्य के साथ *पंगास* मछली के बीज का भंडारण किया गया।

- पश्चिम बंगाल सरकार के पर्यावरण विभाग द्वारा ईस्ट कोलकता वेटलैंड में परियोजना के अंतर्गत मछली, कृषि, बागवानी और पुष्पोत्पादन, मछली रोग की स्थिति, स्वदेशी मछली पालन क्षमता और परभक्षी मछली प्रजातियों के प्रभाव का मूल्यांकन किया जा रहा है ।

- झारखंड के कम उपयोग वाले जलाशयों में स्कैम्पी (*मैक्रोब्रेकियम रोजेनबर्गी*) के उत्पादन वृद्धि प्रौद्योगिकियों के माध्यम से आदिवासी समुदायों की आजीविका में सुधार के लिए संस्थान और मत्स्य पालन विभाग, झारखंड सरकार के बीच समझौता ज्ञापन पर हस्ताक्षर किया गया ।

- नर्मदा नदी की पारिस्थितिकी पर एनटीपीसी गदरवारा एसटीपीपी के कारण पानी के प्रभाव का आकलन करने के लिए एक परियोजना बनाई गई है।

पूर्वोत्तर क्षेत्र (एनईएच) कार्यक्रम

- संस्थान के सहयोग से मध्य और निचली ब्रह्मपुत्र घाटी, असम के 10 बाढ़कृत आर्द्रभूमि में मछली स्टॉक मं वृद्धि का मछली की उपज पर प्रभाव पड़ा है। परिणामस्वरूप, बील की औसत मछली उपज 2019–20 के दौरान 493.57 कि.ग्रा./हेक्टेयर से बढ़कर 2021–22 के दौरान 599.96 कि.ग्रा./हेक्टेयर हो गया।

- मणिपुर के बिष्णुपुर जिले के ताकमु पाट में पेन में *एम्ब्लीफैरिंजोडोन मोला* (मोला), *टेनोफैरिंगोडोन आइडेला* और *लेबियो रोहिता* का बहुपालन किया गया। पेन से अनुमानित मछली उपज 3680 कि.ग्रा./हेक्टेयर/वर्ष थी।

- ताकमु पाट में पिंजरों में *ओस्टियोब्रामा बेलांगेरी* (पेंगबा) , *सी. आइडेला* और *एल. बाटा* को पाला गया। चार महीने के पालन के बाद मछलियों का स्टॉक बढ़ाने के लिए झील में छोड़ दिया गया।

- मिजोरम के सेरलुई–बी जलाशय में पिंजरे में मछली पालन की स्थिति और संभाव्यता का अध्ययन किया गया। संस्थान ने ऑन–कैंपस प्रशिक्षण कार्यक्रमों के माध्यम से पिंजरे में मछली में पालन हेतु मानव संसाधन विकसित करने में मिजोरम राज्य के मत्स्य पालन विभाग को सहयोग दिया है ।

- मेघालय के उमियाम जलाशय से कुल 38 मछली प्रजातियों का प्रलेखन किया गया है। विदेशी कॉमन कार्प प्रजाति, *साइप्रिनस कार्पियो* का जलाशय में अधिक प्रचुरता देखी गई और स्वदेशी प्रजाति, चॉकलेट महासीर (*नियोलिसोकिलस हेक्सागोनोलेपिस*) की संख्या कम पाई गई ।

- उमियाम जलाशय में पिंजरे में मछली पालन परीक्षण किए गए, जिसमें *सी. कार्पियो* और *बारबोनुमस गोनियोनोटस* ने विकास और अतिजीविता दर उत्तम पाई गई। पिंजरे में पालित की बिक्री से 25 मछुआरा महिला परिवारों को सीधा लाभ प्राप्त हुआ।

- अरुणाचल प्रदेश के नामसाई जिले के बोरबील की पारिस्थितिकी और मत्स्य पालन का प्रलेखन किया गया है। सभी मौसम में बील से मछली उत्पादन 35–155 कि.ग्रा./हेक्टेयर/वर्ष तक होती है। टीएसआई मान के आधार पर बील को मध्यम तौर पर यूट्रोफिक देखा गया।

अनुसूचित जाति उप–योजना (एससीएसपी) तथा आदिवासी विकास (एसटीसी) कार्यक्रम

- अनुसूचित जाति उप–योजना (एससीएसपी) तथा आदिवासी विकास (एसटीसी) कार्यक्रमों को पश्चिम बंगाल, ओडिशा, झारखंड, छत्तीसगढ़, मेघालय, कर्नाटक और तमिलनाडु के सुदूर और संवेदनशील क्षेत्र के आर्द्रभूमि और जलाशयों में पेन में मछली पालन और पालन आधारित मात्स्यिकी, सजावटी मछली पालन, घर के पीछे आँगन के तालाबों से उत्पादन में वृद्धि, क्षमता निर्माण और जन जागरूकता सृजन किया गया, जिससे 5000 से अधिक मछुआरों और मछली किसानों को लाभ हुआ। जलीय कृषि, मत्स्य पालन, सजावटी मछली पालन और पेन में मछली पालन के लिए आवश्यक इनपुट वितरित किए गए। अन्तर्स्थलीय खुले जल के माध्यम से सतत विकास लक्ष्यों को संबोधित करते हुए आजीविका विकास पर एक कार्यशाला आयोजित की गई। एक हितधारक परामर्शी कार्यक्रम भी आयोजित किया गया था। सचिव, डेयर तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद की गरिमामयी उपस्थिति में सुंदरबन में महिला मत्स्यजीबी सम्मेलन का आयोजन किया गया जिसमें 3000 महिला मछुआरों सहित लगभग 5000 मछुआरों ने भाग लिया।

मानव संसाधन विकास और अन्य गतिविधियाँ

- मानव संसाधन विकास की दिशा में संस्थान में 1363 मछुआरों, अधिकारियों और छात्रों के लिए 53 प्रशिक्षण और 1470 से अधिक

प्रतिभागियों के लिए 11 जागरूकता कार्यक्रम आयोजित किए गए। संस्थान की प्रौद्योगिकियों/उत्पादों/प्रकाशन को देश के विभिन्न राज्यों में 19 प्रदर्शनियों में प्रदर्शित किया गया। रिपोर्ट अवधि के दौरान छह सौ उनतालीस छात्रों को संस्थान की सुविधाओं और अनुसंधान से अवगत कराया गया।

- संस्थान ने कई संगोष्ठिओं, सम्मेलनों और कार्यशालाओं का आयोजन/सह–संगठन किया। "गंगा बेसिन के विशेष संदर्भ में पारिस्थितिकी बनाम आर्थिक विकास" पर राष्ट्रीय संगोष्ठी; 'सिक्किम के खुला जल निकायों में मत्स्य पालन प्रबंधन' पर इंटरैक्टिव कार्यशाला; अन्तर्स्थलीय खुले जल मत्स्य पालन के माध्यम से सतत विकास लक्ष्यों को संबोधित करते हुए आजीविका विकास" पर कार्यशाला; "अन्तर्स्थलीय मत्स्य पालन में जलवायु परिवर्तन का प्रभाव और अनुकूली रणनीतियों का विकास" पर कार्यशाला; गंगा में मछली संरक्षण और रैंचिंग पर हितधारकों की परामर्शी कार्यशाला; नमामि गंगे परियोजना के तहत गंगा में टिकाऊ मत्स्य पालन और संरक्षण के लिए 'हिल्सा मत्स्य पालन सुधार' पर हितधारकों की परामर्शी कार्यशाला।

- संस्थान के वैज्ञानिकों, तकनीकी अधिकारियों, अनुसंधान विद्वानों ने 113 शोध पत्र प्रकाशित किए हैं (अंतर्राष्ट्रीय इम्पैक्ट फैक्टर 396.04) जिनमें कुल 18 लोकप्रिय लेख, 5 किताबें, 24 पुस्तक अध्याय और 8 प्रशिक्षण मैनुअल हैं।



Vision, Mission, Mandate

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

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Introduction

History

The institute reaches the land mark of 77 years of its existence. The blue revolution in the country has been possible largely due to 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.

The institute was established as Central Inland Fisheries Research Station at Calcutta under the Ministry of Food and Agriculture, Government of India on 17 March 1947 following the recommendation of the sub-committee of Central Government on Agriculture, Forestry and Fisheries. The Station was 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, develop strategies to optimize fish production in sustainable manner and human resource development in the field of inland fisheries.

The priorities of the Government of India during the late sixties and seventies were on aquaculture research and development. The Planning Commission sanctioned five All-India Coordinated Research Projects, namely, Composite Fish Culture, Riverine Fish Seed Prospecting, Air-breathing Fish Culture, Ecology and Fisheries Management of Reservoirs and Brackishwater Fish Farming during 1971-1973. The Institute, besides several other technologies, developed induced breeding and composite fish culture technologies that ushered blue revolution in the country and laid down a solid foundation for development of freshwater aquaculture.
The institute shifted its focus on research on inland open water fisheries of rivers, reservoirs, floodplain wetlands, estuaries, lagoons and backwaters since late 1980s. 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 development of new technologies.

Organizational Structure

The Institute is ISO 9001: 2015 certified. 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 station at Kochi. The research activities are now taken up through five Research Divisions, *viz*.,

- Riverine and Estuarine Fisheries Division
- Reservoir and Wetland Fisheries Division
- Open Water Aquaculture Production and Management Division
- Fisheries Resources Assessment and Informatics Division
- Aquatic Environmental Biotechnology 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, 86 Technical Officers, 66 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, STC programme, SCSP programme, ICAR Regional Committee meetings, and HRD executing different functions of the Institute.

The overall research, administrative and financial management was the responsibility of the Director. He carried out his duties as per the guidelines and recommendations of the Institute Management Committee, Institute Research Committee, Research Advisory Committee and Quinquennial Review Team.



Barrackpore HQ



Bengaluru RRC



Guwahati RRC



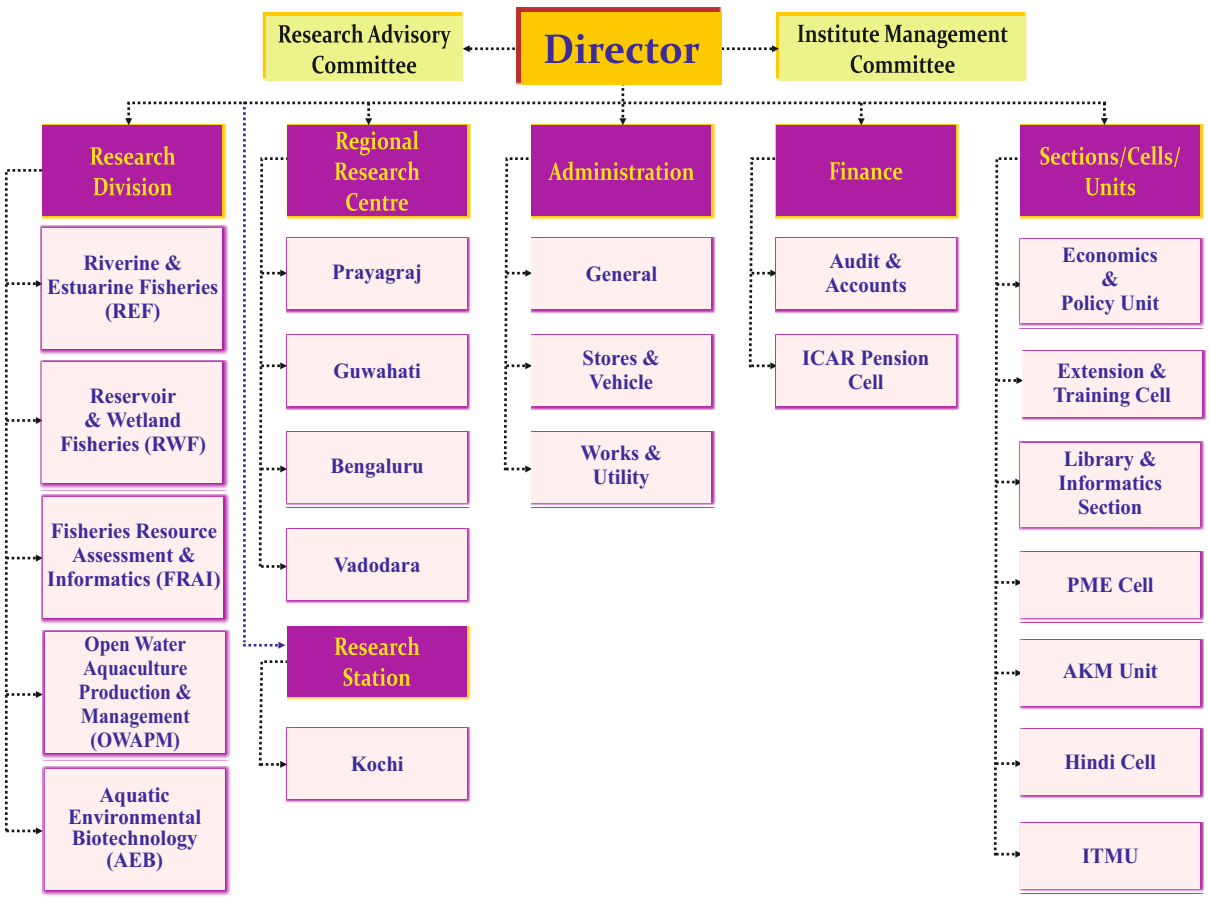
Kochi RS



Prayagraj RRC



Vadodara RRC



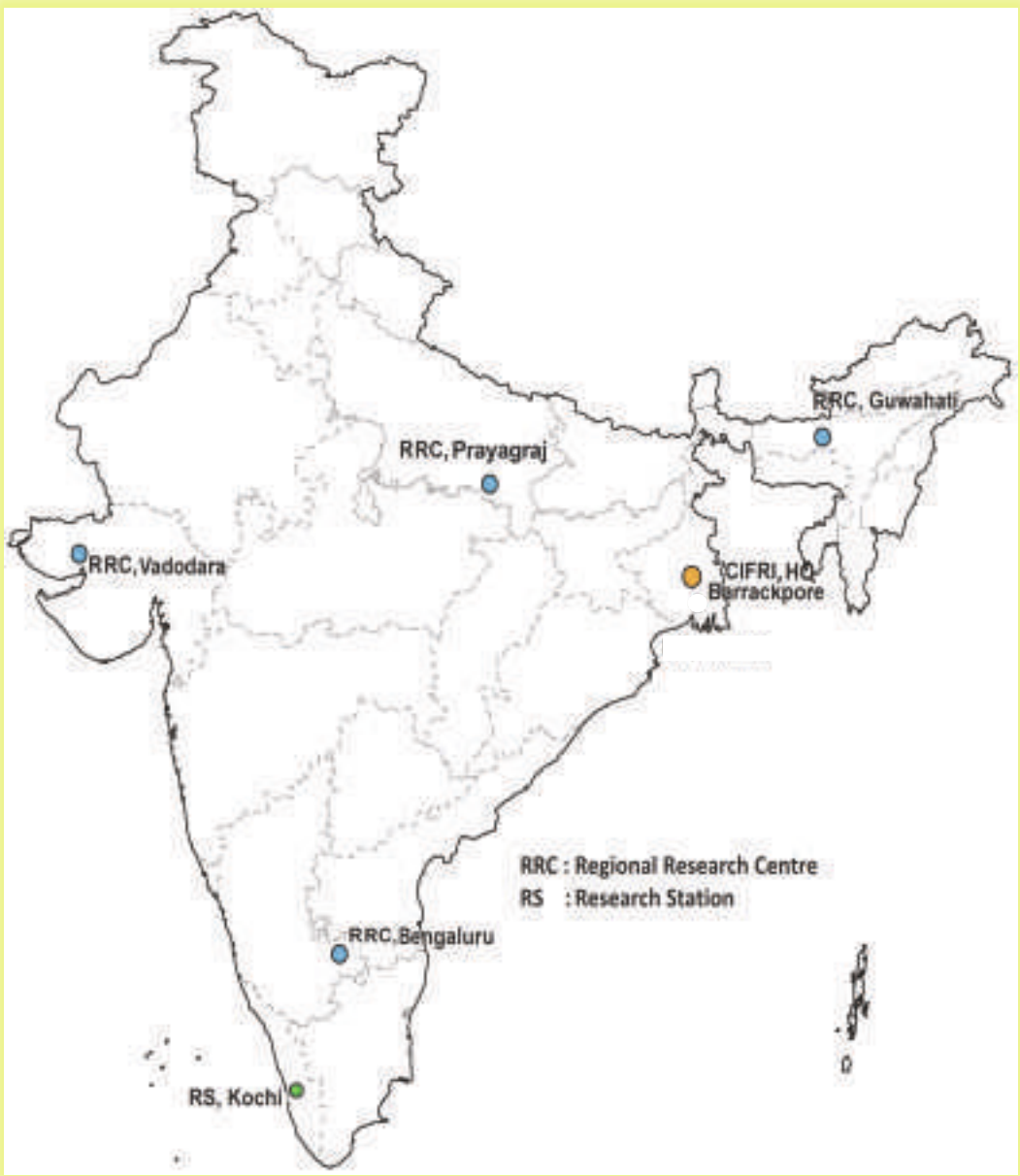
Organogram of ICAR-CIFRI



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Location of ICAR-CIFRI Headquarter, Regional Research Centres and Research Station

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Budget details for the year 2023-24 (upto 31.12.2023) (Rs. in lakh)

Head of accounts	Budget (RE)	Expenditure
Pay and allowance including OTA*	12250.00	11302.69
TA	52.00	33.73
Other charge including equipment, Library books, IT and HRD	1107.50	790.83
Works	160.50	160.50
Grand Total	**13570.00**	**12287.75**

The budget & expenditure under Institute for the financial year 2023-24 (upto 31.12.2023) (Rs. in lakh)

Budget Head	Institute	
	Budget	Expenditure
Revenue		
Estt. charges	3350.00	2669.72
OTA	0.00	0.00
TA	52.00	33.73
Other charges	638.00	475.44
Office building	10.00	4.53
Residential building	5.00	5.00
Minor works	5.00	3.31
Misc. expenses including HRD	20.00	15.84
TSP general	40.00	27.96
NEH general	46.00	33.08
Capital		
Equipment	101.00	69.98
Information Technology	35.00	10.21
Library books	2.50	2.50
Vessels / Vehicles	0.00	0.00
Furniture & fixture	11.00	8.40
Works	160.50	160.50
Minor works	0.00	0.00
TSP capital	25.00	14.90
NEH capital	45.00	23.84
SCSP capital	50.00	28.79
SCSP general	74.00	67.05
Total	**4670.00**	**3654.78**
Pension	8900.00	8632.97
Total	**13570.00**	**12287.75**
Loans & Advances	**102.50**	**76.05**



Other projects 2023-24 (upto 31.12.2023) (Rs. in lakh)

Budget Head	Budget	Receipts	Expenditure	Refund
NICRA	16.00	16.00	16.00	Nil
CABIN	20.00	14.00	7.11	
NASF Hilsa	35.14	34.12	18.40	
NASF Biosensor	7.11	7.11	3.39	
NASF Labour migration	1.87	1.11	0.31	
Fish Health	20.00	11.50	8.33	
ITMU	10.00	7.00	6.49	
NePPA	45.00	38.00	7.53	
Deposit Schemes (Externally funded)	1094.92	1094.92	366.96	
Consultancies	124.59	124.59	32.18	

Revenue receipts 2023-24 (upto 31.12.2023) (Rs. in lakh)

Head	ICAR	Institute	Target	Achievement
Income from sales / services	40.69		43.27	40.69
Fee / subscription	0.00			
Income from royalty, publication etc.	0.00			
Other income	12.84	35.40		
STD interest	0.00			
Sale of assets	0.00			
Recoveries on loans and advances	31.94			
CPWD / Grants Refund	0.00			
Total	85.47	35.40	43.27	40.69




On-Going
Projects

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On Going Projects

Institute Funded Research Projects

S. No.	Projects Code & Title	PI
1.	**Project 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
1.1	*Sub-project 1:* Temporal assessment of Hooghly-Matla estuarine fisheries resources for sustainable management	Dibakar Bhakta
1.2	*Sub-project 2:* Assessment of ecohydrological dynamics in relation to fish fauna and their recruitment towards development of sustainable management strategies in Rushikulya Estuary	S. K. Das
1.3	*Sub-project 3:* Temporal assessment of the Mandovi-Zuari estuarine fishery resources for sustainable Management	S. P. Kamble
1.4	*Sub-project 4:* Temporal assessment of Netravati-Gurupur estuarine fishery resources for sustainable management	Feroz Khan
1.5	*Sub-project 5:* Temporal assessment of Vembanand estuarine fisheries resources for sustainable management	T. T. Paul
2.	**Project REF/20-23/12:** Assessment of ecological impacts of dams and barrages in selected rivers with special references to fisheries	A. K. Sahoo
3.	**Project REF/20-23/13:** Estimation of fish landings and catch structure in the rivers Mahanadi, Krishna, Tapti, Barak and Kosi	B. K. Das (w.e.f. 01.04.22), Rosith C. M. (01.04.20-31.03.22)
4.	**Project REF/20-23/14:** Exploration and assessment of fisheries in protected inland water bodies	R. K. Manna
4.1	*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)	R. K. Manna
4.2	*Sub-project 2:* Assessment of fish diversity and identification of priority habitat in protected and less-explored wetlands and reservoirs of different eco-regions	Suman Kumari
5.	**Project REF/20-23/15:** Eco-variability and impact study of river Yamuna on river Ganga with special emphasis on fisheries	D. N. Jha
6.	**Project 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 (w.e.f. 01.04.22), S. Dam Roy (01.04.20-31.03.22)
7.	**Project: RWF/20-23/10:** Understanding spatio-temporal variations of reservoir ecosystem and developing improved fisheries management strategies for different eco-regions: A new perspective	A.K. Das (w.e.f. 20.10.22), U. K. Sarkar (upto 19.10.22)
7.1	*Sub-project:* Understanding spatio-temporal variations of large reservoir ecosystems (Hirakud, Panam& Idukki) and developing improved fisheries management strategies	A. K. Das
7.2	*Sub-project 2:* Development of ecosystem-based fisheries management strategies for medium reservoirs (Kodar, Upper Manair, Poondi, Seruli B) in different eco-regions	Sajina A. M. (w.e.f. 01.04.22), M. A. Hassan (01.04.20-31.03.22)
7.3	*Sub-project 3:* Refinement of culture-based fisheries for small reservoirs (Gayatri, Beko, Upper Khaguria & Sunei) in different eco-regions	Lianthuamluaia
7.4	*Sub-project 4:* Tropho-dynamic modelling of reservoirs for ecosystem-based fisheries management	P. Panikkar
8.	**Project: RWF/20-23/11:** Eco-orientation approach for fisheries enhancement of floodplain wetlands in diverse eco-regions of India	A. K. Das

S. No.	Projects Code & Title	PI
8.1	*Sub-project 1:* Eco-orientation approach for fisheries enhancement of floodplain wetlands in Northeastern India	Dipesh Debnath
8.2	*Sub-project 2:* Eco-orientation approach for fisheries enhancement of floodplain wetlands in West Bengal	A. K. Das
8.3	*Sub-project 3:* Eco-orientation approach for fisheries enhancement of floodplain wetlands in Bihar	A. Sinha
8.4	*Sub-project 4:* Eco-orientation approach for fisheries enhancement in floodplain wetlands in UP/MP	AbsarAlam
9.	**Project: 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.	**Project: RWF/22-25/13:** Development of environmentally sustainable feed for enclosure culture	D. K. Meena
11.	**Project: RWF/23-26/14:** Next generation inland open water cage culture in India with special reference to system and species diversification	B. K. Das
121.	**Project: RWF/23-26/15:** Exploration of ecosystem dynamics and fisheries of Kanva (Karnataka), Sathanur (Tamil Nadu) and Banasurasagar (Kerala) reservoirs for sustainability and conservation	Preetha Panikkar
13.	**Project: FREM/20-23/16:** Ecosystem health risks and food safety assessment in relation to chemical contaminants in inland aquatic environment	S. K. Nag
13.1	*Sub-project 1:* Monitoring of targeted pesticides and emerging contaminants in selected water bodies	S. K. Nag
13.2	*Sub-project 2:* Monitoring of heavy metals and Arsenic in selected inland water bodies	D. J. Sarkar
14.	**Project: FREM/20-23/17:** Evaluation and management of environmental health through omics technologies	Vikash Kumar (w.e.f. 31.12.22), B. K. Behera (upto 30.12.22)
14.1	*Sub-project 1:* Metagenomic profiling of floodplain wetlands for ecosystem health monitoring	Vikash Kumar (w.e.f. 31.12.22), B. K. Behera (upto 30.12.22)
14.2	*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.	P. Maurye
14.3	*Sub-project 3:* Stock characterization of two bagrid species (Mystuscavasius and M. gulio) for fisheries management	Suvra Roy (w.e.f. 21.12.22), P. K. Parida (upto 20.12.22)
15.	**Project: FREM/20-23/18:** Fisheries resource assessment and prediction in inland open water under AI and Big Data platform	M. Naskar
16.	**Project: FREM/21-24/19:** Development of ammonium and phosphate remediation techniques using nanostructured materials for refurbishment of polluted wetlands.	D. J. Sarkar
17.	**Project: FREM/23-26/20:** Aquatic environment health assessment and novel formulations development for fish health management	B. K. Das
18.	**Project: FSE/20-23/04:** Sustainable Inland Fisheries Development Pathways to Ensure Sustainable Development Goals	B. K. Das
19.	**Project: FSE/23-24/05:** Socio -economic profile of inland fisheries: A rapid assessment	Arun Pandit
20.	**Project: FSE/23-24/06:** Investigating the feasibility of the Food - Energy - Water nexus in the Cauvery River Basin	Anjana Ekka
21.	**Project: NEH/20-23/03:** Refinement of management strategies for openwater fisheries of Northeastern Region through location and ecosystem-based approaches	B. K. Bhattacharjya
21.1	*Sub-project 1:* Sustainableutilization of openwater fisheries in Assam and Nagaland through community participation	S. Borah
21.2	*Sub-project 2:* Enclosure culture in openwaters of Manipur incorporating locally important fish species for stock replenishment and table fish production	Sona Yengkokpam
21.3	*Sub project 3:* Refinementof cage culture and species enhancement in Dumbur reservoir of Tripura	Shyamal Chandra Sukla Das

S. No.	Projects Title	PI
21.4	*Sub-project 4:* Refinement of cage aquaculture technology in reservoirs of Mizoram	Dipesh Debnath
21.5	*Sub-project 5:* Sustainable utilization of reservoir fisheries of Meghalaya through community participation	Pronob Das
21.6	*Sub-project 6:* Refinementof enclosure culture technologies for stock enhancement and table fish production in openwaters of Arunachal Pradesh	Anil Kumar Yadav
22.	**Network Project:** Breeding of indigenous fish species of ornamental value from West Bengal and Assam	Suman Kumari (since 20.10.22 and Oct-May 2020-21), U. K. Sarkar (w.e.f. 01.06.21 - 19.10.22), A Sinha (till Sept 2020)
23.	**Network Project:** Anti-microbial resistance in fisheries and aquaculture	A. K. Sahoo

Externally Funded Research Projects

Sl. No.	Projects	PI
1.	Fish stock enhancement including Hilsa and livelihood improvement for sustainable fisheries and conservation in River Ganga	B. K. Das
2.	Impact of climate change in inland fisheries and development of adaptation strategic Research component of National Innovation in Climate resilient Agriculture	B. K. Das
3.	National Surveillance Programme for Aquatic Animal Diseases: Phase II	B. K. Das
4.	Microbiome meta transcriptomics assessment of Indian river basins for ecosystem health monitoring	B. K Behera
5.	All India Network Project on Fish Health	S. K. Manna
6.	Development of biosensors for detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies	D. J. Sarkar
7.	Captive breeding of Hilsa, *Tenualosa ilisha*: Phase II	S. Samanta
8.	Environmental and aquaculture animal health monitoring in Hirakund Reservoir under cage culture programme	B. K. Das
9.	ICAR-WorldFish Collaborative research Project (Window -3): Small scale fisheries in wetlands for livelihood and nutritional security	B. K. Das
10.	Assessment of endocrine disruption in fish reproduction	B. K. Das
11.	Empowering women of wetland dependent fisherfolk community of lower Gangetic plain through cost-effective technologies	Aparna Roy
12.	The changing dynamics of labour migration on employment, livelihoods and resource productivity patterns in Indian marine fisheries sector	Aparna Roy
13.	IoT based precision enclosure culture and fisheries management in inland open waters	B. K. Das
14.	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	B. K. Das
15.	Cage culture in Kangsabati reservoir	M. A. Hassan
16.	(A) Assessment of production of fish, fish disease and feasibility study of certification for fish produced in East Kolkata Wetland Subproject 1: Multiple value assessment (B) Assessment of agriculture (Paddy), horticulture, medicinal plants, floriculture and uses Subproject 2: Culture of indigenous fish species Subproject 3: Assessment of invasive fish species with special emphasis on *Pterygoplichthys* spp. for control/eradication in East Kolkata Wetland	B. K. Das
17.	Improving livelihood of tribal communities through Scampi fisheries enhancement technologies in under-utilized reservoir resources of Jharkhand	A. K. Das
18.	Addressing Skill Gap in the FPO Ecosystem in Eastern and North Eastern parts of India	Arun Pandit
19.	Study on impact of water intake due to Gadarwara STPP on Ecology of Narmada River	B. K. Das
20.	Project Title : Production Systems, Agribusiness and Institutions - Component I : Impact of Agricultural Technology'	Arun Pandit

Consultancy Projects

S. No.	Projects Title	PI
1.	Fish Survey of Goriganga for Sirkari Bhyol Rupsiabagar HE Power Project in Munsiyari, Pithoragarh, Uttarakhand	B. K. Das
2.	Assessment of Fisheries and Ecology in Kameng basin of Arunachal Pradesh in relation to proposed Hydropower projects at Gongri and Dinchang (Phase I & II)	B. K. Das
3.	Watershed development plan for micro-watershed within 10 km radius of the 1440 MW Malshejghat Bhorande Pumped storage project in Thane District (Maharashtra)	D. K Meena
4.	Watershed development plan for micro- watershed within 10 km radius of the 1200 MW Warsgaon Warangi Pumped storage project village Teckpole and Warangi, Tehsil Velhe and Mahad, District Pune & Raigad (Maharashtra)	D. K Meena



Riverine and Estuarine Fisheries



वार्षिक प्रतिवेदन

Annual Report

2023

Riverine and Estuaine Fisheries

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

Project Code: REF /20-23/11

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 (concluded in March 2023)

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

Duration: April 2020 to March 2024

Scientific Personnel: D. Bhakta (Sub-project Leader), S. Samanta, R. K. Manna, Sangeetha M. Nair, Arun Pandit (w.e.f. 01.04.22), Chayna Jana (w.e.f. 01.04.22), Prajna R. Behera (w.e.f. 01.04.23), Roshith C. M. (w.e.f. 04.08.23)

Summary

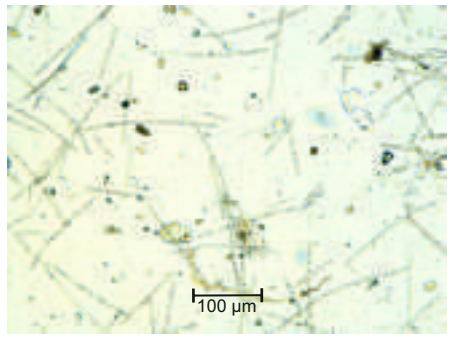
- A total of 132 phytoplankton species, representing 95 taxa, were identified in the Hooghly-Matllah estuary system, with Bacillariophyceae (43 species) being the dominant group.
- The post-monsoon had the highest maximum mean phytoplankton density (2.88 x 104 u/l), followed by the monsoon (2.419 × 104 u/l) and the pre-monsoon (1.574 × 104 u/l).
- Three Syngnathidae species, *Hippocampus trimaculatus*, *Hippichthys spicifer*, and *Microphis cuncalus* were identified in the Hooghly-Matlah estuary system at three different stations: Balagarh, Kakdwip, and Jatirampur (Gosaba).
- *Antennarius indicus* Schultz 1964, also known as the Indian frogfish, was identified for the first time from the winter migratory bagnet at Fraserganj fish landing site in the Hooghly-Matlah estuarine system.
- Stock assessments were done for *Polynemus paradiseus* and *Setipinna phasa*, and it was found that both species were overfished in the Hooghly-Matlah estuary, with estimated exploitation rates (E) of 0.66 and 0.55 for *P. paradiseus* and *S. phasa*, respectively.
- Ten different types of brackish and marine water fish have been identified at Tribeni, a freshwater zone situated 212 kilometers upstream from the sea in the Hooghly Estuary, immediately following the tidal bore.
- Since there is no evidence of saltwater intrusion in the Tribeni area, analysis of related environmental characteristics suggests that the displacement of those marine fish species for 85 to 179 kilometers from their usual distribution range, may be due to strong turbulence, flow, and waves associated with bore tide.
- In the lower part of the Hooghly-Matlah estuary, an aquatic hydroid forest has been found on long-submerged ropes, nets, bamboo, wooden logs, metallic jetty walls, etc. At least 20 species of aquatic organisms have been found in this recently found euryhaline hydroid forest. *Melarhaphe neritoides* (gastropoda) and *Synidoteala ticauda* (isopoda) are new records in Indian seas.

Plankton assemblage

A total of 132 species of phytoplankton belonging to 95 genera were recorded from the Hooghly-Matllah estuarine system. The phytoplankton community was dominated by Bacillariophyceae with 43 species, followed by Chlorophyceae (21 species), Mediophyceae (19 species), Cyanophyceae (11 species), Coscinodiscophyceae (11 species), Trebouxiphyceae (8 species), Dinophyceae (7 species), Zygnematophyceae (5 species), Euglenophyceae (3 species), and Ulvophyceae (2 species) among the eleven taxonomic groups identified. The species-rich family Bacillariophyceae accounted for 33.6% of the total phytoplankton population, followed by Mediophyceae (25.1%) and Coscinodiscophyceae (17.8%). Even though Chlorophyceae is the second-most species group, it only comprises 11.2% of the total population. The mean phytoplankton density was higher during post-monsoon (2.88 x 10^4 u/l), followed by monsoon (2.419 x 10^4 u/l) and pre-monsoon (1.574 x 10^4 u/l). The centric diatom, *Aulacoseira granulata* emerged as the dominant species, which was commonly available throughout the study period in all the stations except at Pathar Pratima. *A. granulata* contributed 14.6% of the total phytoplankton in the freshwater dominant zone. Meanwhile, genus *Coscinodiscus* was recorded at 6.12% in the Intermediate Zone. The highest contributions of *Cyclotella* sp. (15.6%) and *Coscinodiscus* sp. (7.47%) were observed in the upper and lower Sundarbans, respectively.

Macrobenthic faunal diversity

A total of 35 species of macrobenthic fauna belonging to twenty-one families comprising gastropods (24 species, 13 families) and bivalves (11 species, 8 families) were recorded during the study period. Gastropods contributed 80.14 % of the total macrobenthic population. The macrofaunal benthic diversity was maximum in Kuntighat where profusion of *Tarebia granifera* and *Tarebia lineate* was one of the remarkable observations in monsoon period. The macrobenthic faunal density was found higher during the monsoon (16748 no./m^2) followed by pre-monsoon and post-monsoon. *Novaculina gangetica, Barnea candida* and *Mactra luzonica* were found to be the dominant bivalves whereas the principal gastropods species such as *Neripteron violaceaum, Filopaludina bengalensis, Pugilina cochlidium, Tarebia granifera* and *Brotia costula* were recorded. The macrobenthic fauna was found at its maximum in Kuntighat (25795 no./m^2) and at its minimum in Sandeshkhali (435 no./m^2).



Aulacosiera granulata

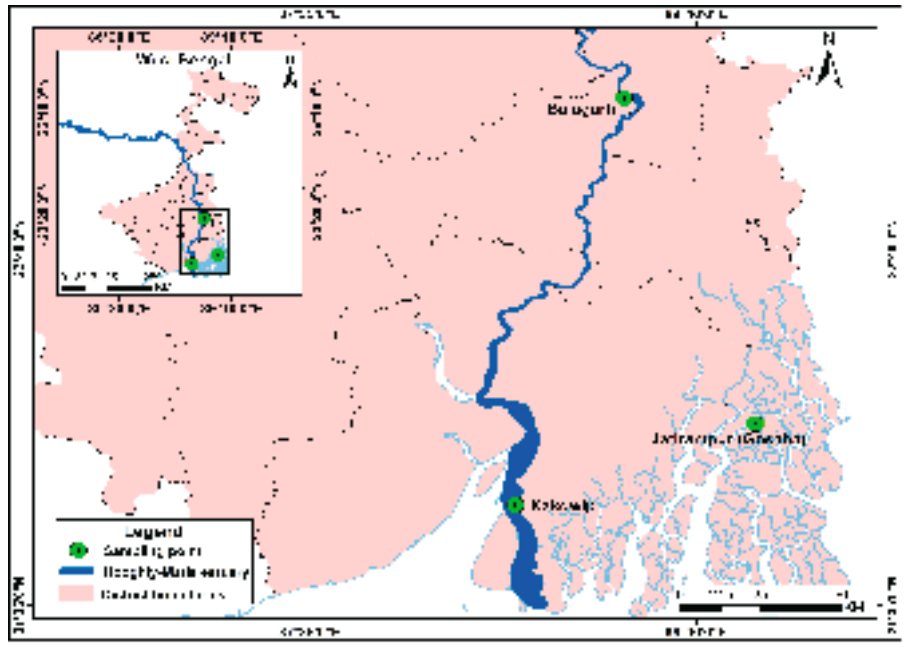


Coscinodiscus sp.

Two major phytoplankton species of Hooghly-Matlah estuary

Distribution of family Syngnathidae

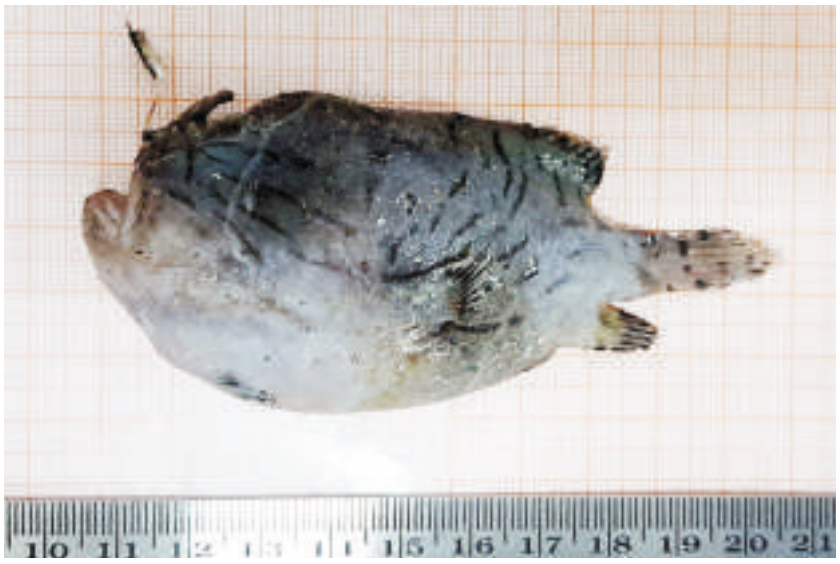
Sampling in the Hooghly-Matlah estuary system recorded three species of Sygnathids (Family – Syngnathidae) *viz. Microphis cuncalus, Hippichthys spicifer*, and *Hippocampus trimaculatus* at three stations (Balagarh, Kakdwip, and Jatirampur (Gosaba)) respectively. Kakdwip and Jatirampur had mangrove habitats, whereas Balagarh area had emergent macrophytes along the shorelines supporting Syngnathidae species. Seahorse is classified as vulnerable, while pipefish is classified as being least concern. Syngnathids are mostly employed in trade, and as their numbers are drastically



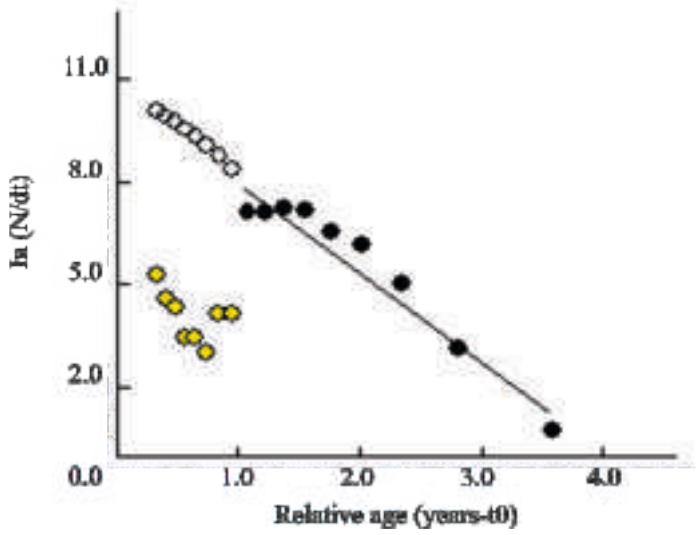
Map showing the collection sites of syngnathids from the Hooghly-Matlah estuarine system



A. *Microphis cuncalus,* B. *Hippichthys spicifer* recorded from the Hooghly-Matlah estuary



Indian frogfish (*A. indicus*) collected from Hooghly-Matlah estuary



Length converted catch curve for estimation of *Z* of *P. paradiseus* collected from Hooghly-Matlah estuarine system

dropping, many nations have outlawed the export of these animals. The syngnathid, *Microphis cuncalus*, was successfully barcoded, and sequence was submitted to GenBank (accession number OP090589.1). Even though many syngnathid species are exclusive to marine environments, a significant number of these species are supported by the Hooghly-Matlah estuary; as a result, appropriate conservation plans and management strategies may be put into place. The sampling station Balagarh was under freshwater regime (salinity 0.04±0.00 gm/l), Kakdwip recorded moderate salinity (10.83±0.16 gm/l), whereas, Gosaba had relatively higher salinity (31.50±0.50 gm/l) during collection of specimens.

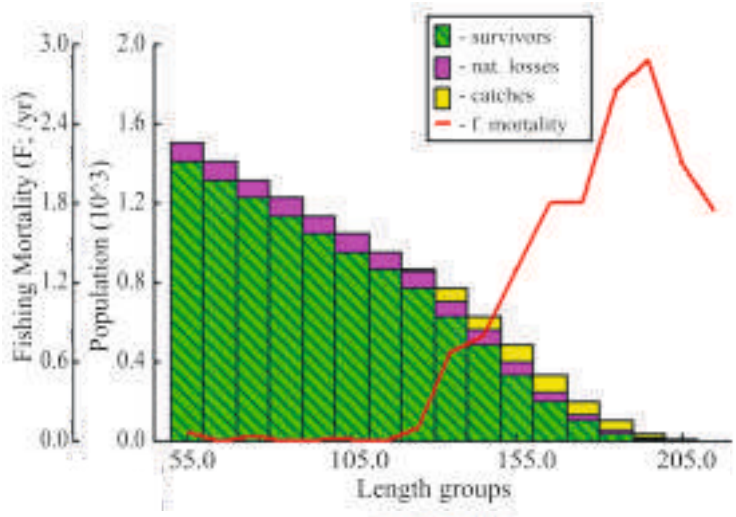
First report of Indian frogfish, *Antennarius indicus*

The Indian frogfish, *Antennarius indicus* (Schultz 1964), was recorded for the first time from the Hooghly-Matlah estuarine system. A single specimen (97.87 mm in length and 33.48 g in weight) of the species was collected from the winter bagnet fishery catch at Fraserganj. The prevailing estuarine salinity was 26.8 gm/l during collection of the sample.

Stock assessment of *Polynemus paradisus* and *Setipinna phasa*

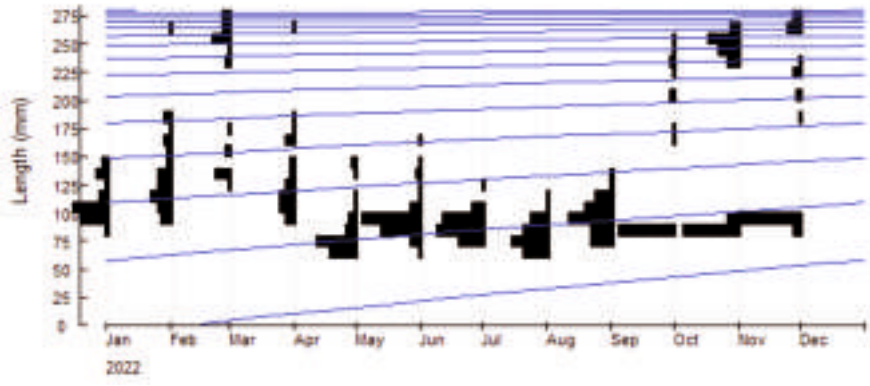
Two species, *Polynemus paradisus* and *Setipinna phasa* were taken into consideration for the stock assessment study, The majority of *P. paradiseus* commercial captures in the Hooghly-Matlah estuary were made up of length groups between 160-169 and 150-159 mm, based on length-frequency estimates. For the different growth parameters, the projected values were t_0 = -0.0038 years, K = 0.85 yr^{-1}, and $L\infty$= 225.95 mm. The mortality coefficients *Z, M,* and *F* were estimated to be 2.65, 0.91, and 1.74, respectively. An estimated value of exploitation rate (*E*) of 0.66 was obtained using the length-converted catch curve approach, which was marginally higher than the

optimal value of 0.50. The total stable stock biomass (SSB) in the Hooghly-Matlah estuary system was estimated by the length-structured virtual population analysis (VPA) of the FiSAT II to be 142.07 t. The recommended length at first catch (*Lc* = 129.80 mm TL) was kept throughout the capture periods, and as a result, the maximum sustainable yield (MSY) for *P. paradiseus* was estimated at 188.24 t.



Length-structured virtual population analysis of *P. paradiseus* collected from Hooghly-Matlah estuarine system

The Hooghly-Matlah estuary's commercial *S. phasa* catches were primarily composed of length groups ranging from 90-99 and 80-89 mm. Different growth parameters were estimated as: $L\infty$ = 288.75 mm, K = 0.41 yr^{-1}, and t_0 = -0.5233 years based on length-frequency data. The estimated values of the mortality coefficients *Z, M*, and *F* were 1.17, 0.53, and 0.64, respectively. The fish measured 97, 162, 204, 233, 252, 264, and 272 mm in length at end of the first, second, third, fourth, fifth, sixth, and seventh years. The estimated exploitation rate (*E*) of 0.55 was at higher than the optimum value of 0.50 determined by the length-converted catch curve approach.



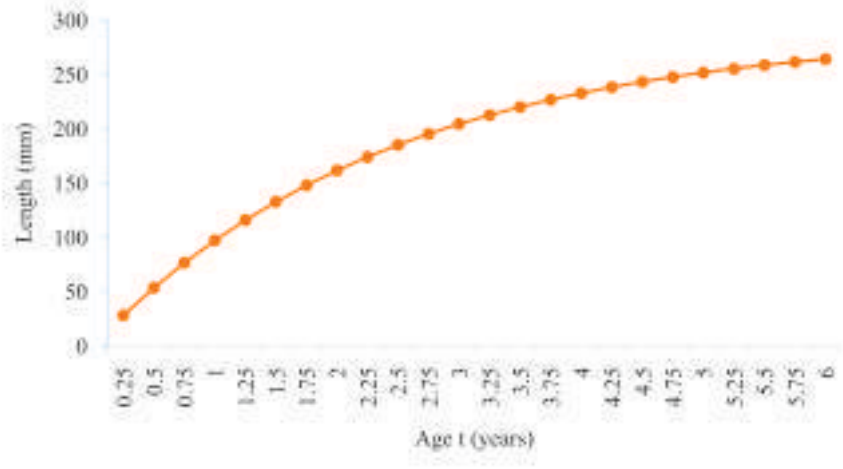
Growth curve of *S. phasa* collected from Hooghly-Matlah estuarine system by employing ELEFAN I ($L\infty$=288.75, and K = 0.46 yr^{-1})

Tidal bore induced upward shift of marine fish species distribution

A total of 9 different marine and brackish water fish species were recorded at Tribeni, a completely freshwater region located 212 km upstream from the sea mouth of Hooghly estuary, just after the tidal bore. The fish species include *Alepes djedaba*, *Eleotris fusca*, *Ilisha megaloptera*, *Lates calcarifer*, *Nuchequula blochii*, *Platycephalus indicus*, *Rhabdosargus sarba*, *Scatophagus argus,* and *Stolephorus indicus*. A 85–179 km shift of these marine fish species from their normal distribution range may be attributed to high turbulence, flow, and wave associated with bore tide, as there is

Table : Tidal bore induced upstream shift of marine fish species in Hooghly estuary

Fish species	Normal uppermost distribution area	Distance from sea (km)	Place of record under present study after tidal bore	Distance from sea (km)	Upward shift (km)
Alepes djedaba, Rhabdosargus sarba	Kakdwip	36	Tribeni	212	176
Ilisha megaloptera, *Nuchequula blochii*	Nischintapur	56	Tribeni	212	156
Lates calcarifer, *Scatophagus argus, Stolephorus indicus*	Roychak	95	Tribeni	212	107
Eleotris fusca, *Platycephalus indicus*	Godakhali	127	Tribeni	212	85

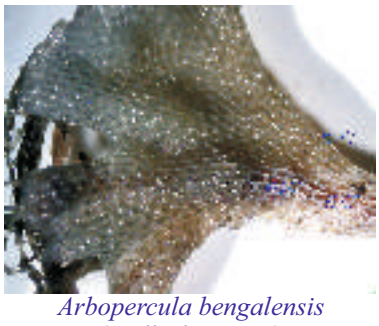


Average length attained by *S. phasa* at different ages from Hooghly-Matlah estuarine system

no sign of saltwater ingress in the Tribeni area revealed from associated environmental parameters. This shows that in addition to salinity, events such as bore tide should also be considered to explain fish species distribution in a tidal estuary. Analysis of fish samples revealed that all the marine fish in the catch were in juvenile stages, or small-sized fish. This may be because juvenile fish generally remain in nearshore areas and are unable to negotiate the thrust of the high flow and strong wave regime during tidal bore formation since the associated wave formation happens in shallower, near shore areas.



Newly discovered aquatic hydroid forest on submerged rope



Arbopercula bengalensis (Stoliczka, 1869)



Diadumene lineata (Verrill, 1869)



Neanthes glandicincta (Moore, 1903)



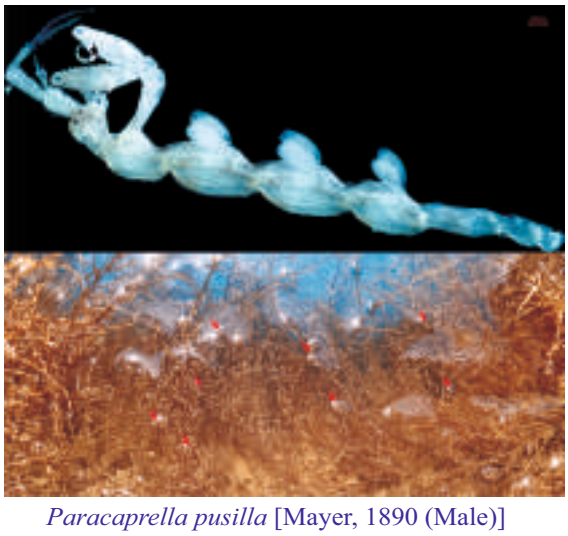
Synidotea laticauda (Benedict, 1897)



Aniptumnus neolaevis (Hari, Hershey & Mendoza 2022)



Ophiactis delagoa (Balinsky, 1957)



Paracaprella pusilla [Mayer, 1890 (Male)]



Ophiocara porocephalum (Valenciennes 1837)

Euryhaline hydroid (Cnidaria: Hydrozoa) forest and some of its associates in lower Hooghly-Matlah estuary

Euryhaline hydroid (Cnidaria: Hydrozoa) forest as breeding and nursery habitat of several marine organisms

Existence or development of aquatic hydroid forest has been discovered on long-time submerged ropes, nets, bamboo, wooden logs, metallic jetty walls, etc. in the lower part of the Hooghly-Matlah estuary. This newly discovered euryhaline hydroid forest was observed to harbour at least 19 species of marine organisms, utilizing the forest as shelter, breeding, and nursery grounds. Out of 19 species discovered, *Melarhaphe neritoides* (gastropoda) and *Synidotea laticauda* (isopoda) are new records in Indian waters, and *Psudovorticella marina*, *V. communis*, *V. similis*, *V. subsinuata* (ciliophora), *Diadumene lineata* (sea anemone), *Epitonium scalare* (gastropoda), *Modiolus auriculatus*, *Mesocibota bistrigata*, *Arcuatula senhousia* (bivalvia), and *Paracaprella pusilla* (skeleton shrimp) are additions to the biodiversity of the Indian Sundarbans. Reported estuarine species like *Arbopercula bengalensis* (Bryozoa), *Ophiactis delagoa* (Brittle star), *Optediceros breviculum* (Gastropoda), *Saccostrea cucullata* (Bivalvia), *Neanthes glandicincta* (Polychaeta), *Aniptumnus neolaevis* (Crab), and *Ophiocara porocephalum* (Pisces) are also observed to be inhabited in the forest. Identification of adhesive eggs and juveniles of invertebrates like Mollusca and Arthropoda revealed extensive use of hydroid forest by them as breeding grounds. Flow regime, substrate structure, and periphytic growth were observed as controlling factors, besides salinity for the establishment and growth of hydroid forests on submerged substrates.

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

Duration: April 2020 to March 2024

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

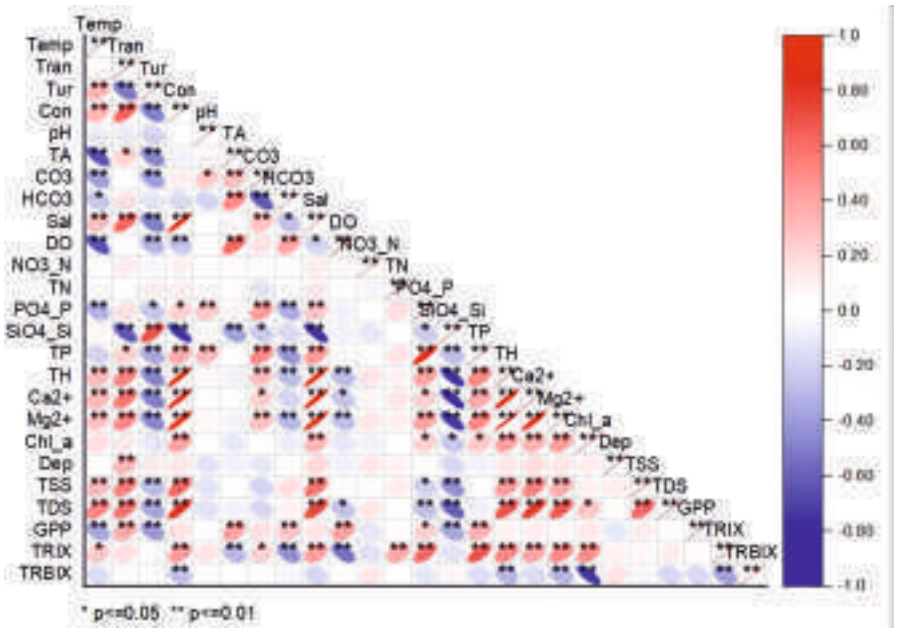
Summary

- Significant temporal and spatial variations in some of the water quality parameters were noticed in the estuary
- TN:TP was less than Redfield ratio indicating nitrogen limitation in the estuary
- Gross primary productivity was strong in middle part of estuary, whereas it dropped towards upper estuary
- Rushikulya is dominated by mullets as the main commercial catch
- The estuary had moderate degree of eutrophication with "good" water quality
- Fish catch drastically reduced in post-monsoon, especially in November
- Current exploitation rate of *Planiliza subviridis* in Rushikulya estuary was below biological reference point indicating that the stock was underexploited
- Significant seasonal variation of phytoplankton abundance was observed
- Four functional groups of benthos were recorded in the estuary and soil/sediment textural composition was found positively associated with the benthic functional groups

Water quality

In the Rushikulya estuary, 14 variables exhibited significant differences ($p<0.05$) between the seasons among the 23 water variables. The average yearly water temperature progressively declined as it approached the upper stretch of the estuary and reached the lowest (27.61±2.36 ºC) at Damodarpur (S6). Apart from station S6, there were no notable deviations in water temperature among the different stations. The estuary's mean annual water temperature was comparatively elevated in comparison to the open sea. The water in the estuary maintained an alkaline pH level. The average pH of the water ranged from 8.20±0.15 at S1 (estuarine mouth) to 8.5±0.15 at S6. Dissolved oxygen (DO) variation was not significant ($p>0.05$) across the sites. A high value of 7.16±0.1 mg l^{-1} was observed at S6 in November. Highest dissolved oxygen concentrations occurred in post-monsoon (7.35±0.75 mg/l) and pre-monsoon (7.34±0.78 mg/l), but significantly decreased during monsoon (5.94±0.56 mg/l). There was a significant change in the salinity values. The data exhibited a distinct seasonal pattern, ranging from 9.68±12.08‰ during the

monsoon season to 10.14±11.81‰ during the post-monsoon. The total alkalinity fell within the optimum range of 82–142 mg/l. The nephelometric turbidity measurement exhibited an upward trend as it approached the upper estuary or river stretch (S6), starting from its minimum at estuarine mouth (S1). Specific conductivity was less in the upper section and progressively rose towards the lower section. The mean specific conductivity reached its highest value at S1, measuring 25.25±18.05 mS/cm. A fluctuating seasonal pattern in nutrient parameters was identified across the seasons. The concentrations of NO_3–N and SiO_4–Si were highest during the monsoon, whereas they were lowest during pre-monsoon and post-monsoon periods, respectively. The SiO_4–Si concentrations varied significantly, ranging from 5.44±4.60 to 15.82±2.0 mg/l at S1 and S6, respectively. Geographically, the highest concentrations of total phosphorus (TP) and total nitrogen (TN) were seen at Pothagad (S4) which then steadily declined through downstream in the estuaries. There were no statistically significant differences ($p>0.05$) in nitrogen content (NO_3–N and TN) across seasons. The TN:TP ratios were consistently lower than the Redfield ratio throughout the year, suggesting that the system is predominantly constrained by nitrogen. Seasonal changes in Chlorophyll-a (Chl a) concentration were not significant ($p>0.05$). The highest concentration was observed in the post-monsoon (3.26±2.95 µg/l), whereas the lowest was during the monsoon season (2.97±1.70 µg/l). The substance content was higher in S1 (3.83±4.06 µg/l) and lower in the upper estuary, near the Ganjam Road bridge (S5; 3.65±1.87 µg/l). The primary output of phytoplankton peaked before the monsoon and dropped throughout the monsoon. In the middle part, gross primary production (GPP) was strong and peaked in S4 at 656.0 mgC/m^3/day. The river sites had low gross primary production, with site S6 producing 262.5 mgC/m^3/day.



Pearson's correlation showing the significant relation between the water variables

Pearson's correlation analysis revealed a negative association between temperature and DO ($r = -0.641$; $p<0.01$) and PO_4-P ($r = -0.302$; $p<0.01$). Nutrient variables correlated best. Chl a correlated positively with conductivity ($r = 0.384$; $p<0.01$), PO_4-P ($r = 0.292$; $p<0.01$), TP ($r = 0.263$; $p<0.01$), and weakly with temperature and transparency. However, Chl-a correlated negatively with turbidity ($r = -0.123$) and SiO_4-Si ($r = -0.247$; $p<0.01$). The correlation between transparency and turbidity was substantial ($r = -0.503$; $p<0.01$). Salinity was negatively correlated with turbidity ($r = -0.257$; $p<0.01$) and positively correlated with sp. cond. ($r = 0.488$; $p<0.01$).

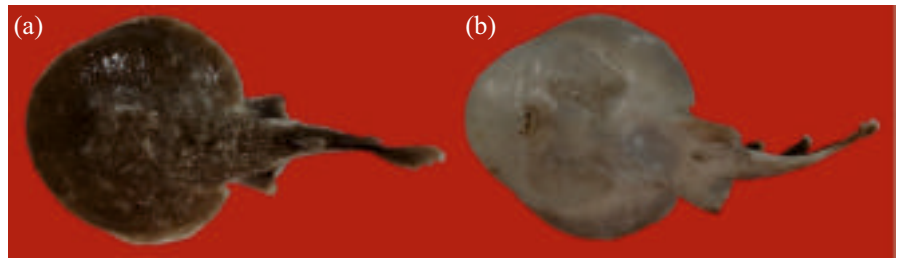
Fish and fisheries

Rushikulya harbours 75 fish species (35 families). The estuary is dominated by commercially priced mullet species in terms of total fish landings. In terms of species richness, Carangidae and Leiognathidae dominated (8 species each), followed by Engraulidae and Clupeidae (5 species each). The flathead grey mullet (*Mugil cephalus*) contributed more than 38% of the total fish landings (biomass). In addition, shrimps, mainly the Indian white shrimp and banana shrimp, were the major catch. The assessment of water quality stated that the estuary had a moderate degree of eutrophication with 'good' water quality and 'biomass saturated'; indicating that the estuary was ecologically productive. Furthermore, the natural production of Asiatic hard clam in the upper estuary provides an additional income (subsistence) to the fisherfolks dominated by women. The catch per unit effort came around 40-60 kg/day/women for this clam. Regular monitoring of fish catch data showed that the fish catches during post-monsoon season had drastically declined especially in the month of November (20-30 kg/day) compared to previous months (avg. 85 kg/ day). The catches of green back mullet, *Planiliza subviridis* (one of the major contributors) and carangids including catfish (*Arias arius*) have decreased by almost 20% compared to previous months, likely due to low precipitation.

New records

The electric ray, *Narcine timlei* (Bloch & Schneider, 1801), (Family:

Narcinidae; order: Torpediniformes), was recorded for the first time from the Rushikulya estuary. The specimen was collected from a shore seine net operated at a depth of 2.0–2.2 m. This species was not reported earlier from the Rushikulya coast with this depth range, and lower magnitude of salinity (8.15‰) as well.



Dorsal (a) and ventral (b) view of *Narcine timlei* (Bloch & Schneider, 1801), TL161 mm

Occurrence of isopod parasite

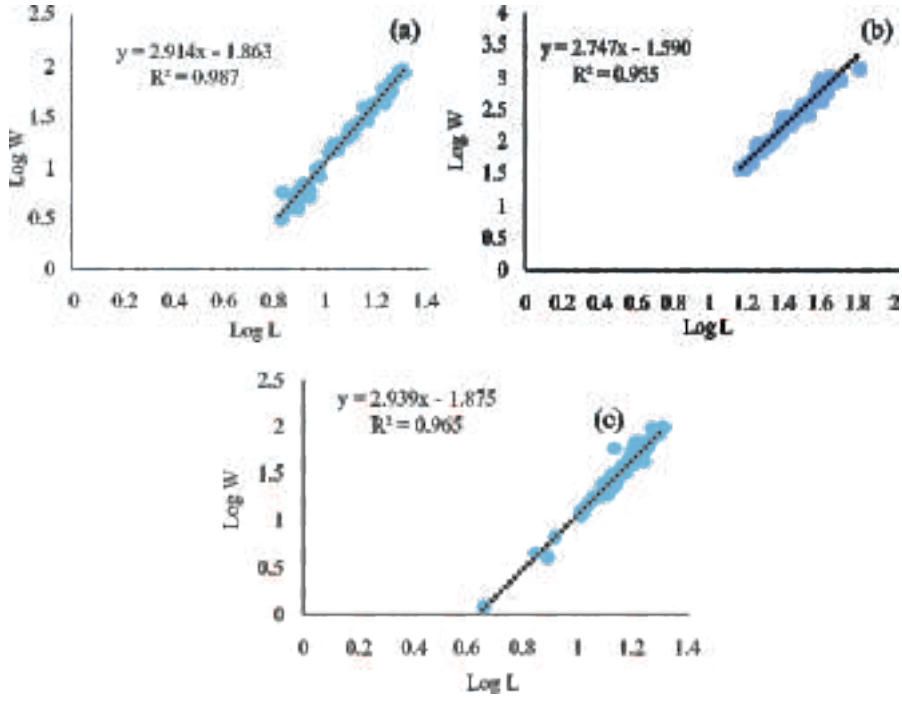
The record of Cymothoid isopod parasite *Nerocila phaiopleura* Bleeker, 1857 (Isopoda: Cymothoidae) from *Stolephorus rex* Jordan & Seale 1926 is acclaimed as the first report for this host from the Rushikulya river-estuary and the Odisha coast, coupled with the extension of its habitat to the riverine environment, where salinity meets 0.64 ± 0.36 %.



Host fish species *Stolephorus rex* (a) with the isopod *Nerocila phaiopleura* (b)

Stock estimation

Three species, namely, *Chelon parsia*, *Mugil cephalus* and *Planiliza subviridis* were assessed for population characteristics from Rushikulya estuary, Odisha. The length frequency data of 247 fish specimens were in the sizes of 6–20.5 cm (*C. parsia*), 14.4–63.0 cm (*M. cephalus*) and 4.5–20.5 cm (*P. subviridis*). The lowest total weight was measured for *P. subviridis* (1.2 g) and the maximum for *M. cephalus* (1400 g). The regression coefficient 'b' ranged from 2.7469-2.9394 with the highest being for *P. subviridis* and the lowest for *M. cephalus*, indicating isometric growth pattern. Values for condition factor (K) and relative condition factor (Kn) ranged from 1.1249–1.1467 and >1.0, respectively, indicating a healthy condition of the studied fish species. The study on population characters of greenback mullet, *Planiliza subviridis*, from Rushikulya estuary revealed that the current exploitation rate (U=0.366) was below the biological target reference point (Emax=0.693), indicating the stock of this species is under exploited.



Logarithmic relationship of length and weight of *C. parsia* (left), *M. cephalus* (right) and *P. subviridis* (below) from Rushikulya estuary

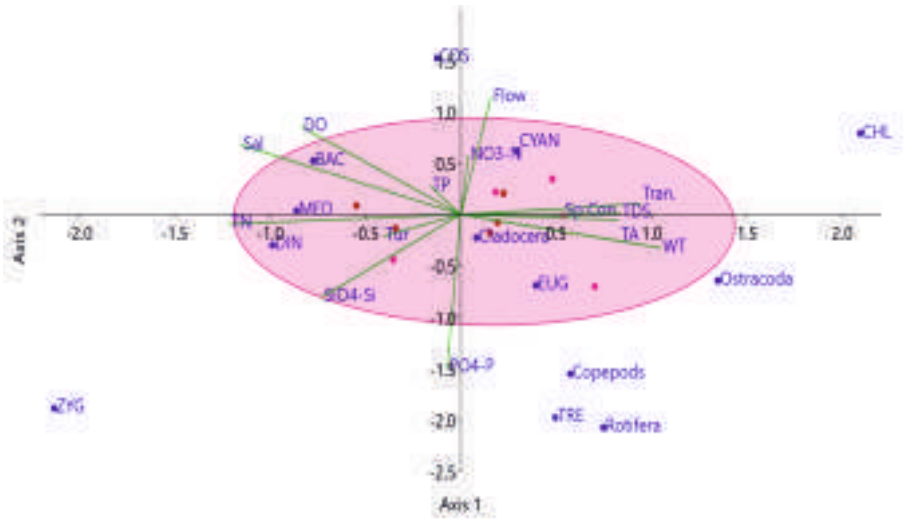
Plankton assemblages

A total of 63 species of phytoplankton were recorded under 48 genera in the Rushikulya estuary. Genus *Chaetoceros* exhibited maximum diversity (6 species). *Rhizosolenia setigera* and *Pseudonitzschia* spp. contributed substantially to the total phytoplankton population. Significant variation ($p<0.05$) of phytoplankton abundance was seen between the seasons. Holoplankters contribution ranged between 36-60%, whereas meroplankters contributed 39-63% of total zooplankton. The zooplankton abundance ranged from 9000-27,700 ind./m^3. Species environment relationship showed that algal groups Cyanophyceae and Chlorophyceae exhibited strong correlation with

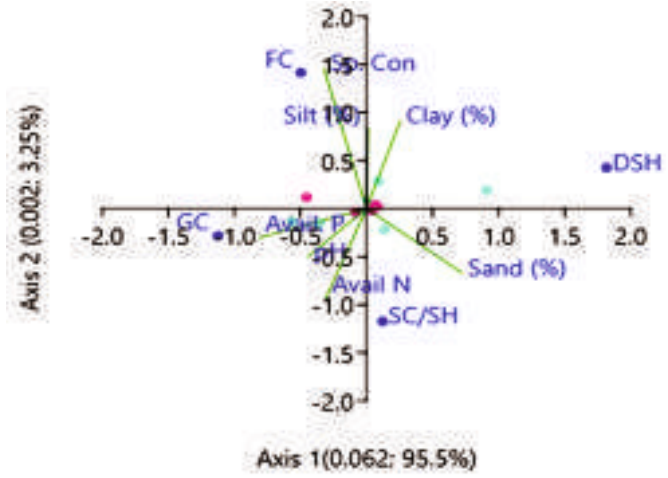
water flow, transparency, and NO_3-N. Similarly, Cladocera, Rotifera, Ostracoda and Copepods showed positive association with temperature, total and total dissolved solids. Dinophyceae had a negative correlation with total nitrogen and turbidity.

Macro-benthic functional groups

Four functional groups of benthos, namely, Scrappers/Shredders (SC/SH), Filter collectors (FC), Collector gathers (GC) and Detrital Shredders (DSH) (Cummins and Klug, 1979; Cummins, 2018) were recorded comprising 21 taxa. Genus *Prionospio* dominated in the upper estuary and *Nepthys* in the lower part. Among Gastropods, *Pirenella cingulata* and *Clithon oualaniensis* were dominant across seasons. The biota-environment relationship showed that sand, silt and clay (%) were positively associated with the benthic functional groups. More specifically, the DSH and SC/SH were positively gradient with clay and sand. However, GC had negative association with available-P and pH.



Species-environment relationship of plankton population in Rushikulya estuary



CCA showing the relationship between macrobenthic functional groups and sediment variables

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

Duration: April 2020 to June 2023

Scientific Personnel: M. Feroz Khan (Sub-project Leader), Sibina Mol (Leave 28.11.22-01.09.23), Ajoy Saha (01.04.2021 to 31.03.22), Sonalika Sahoo (w.e.f. 01.04.22)

Summary

- Water quality varied with relatively higher nutrient concentrations in the Gurupur stretch than the Netravathi channel, potentially due to sewage dumping. Higher concentrations of sediment organic carbon were found in the Gurupur estuary.
- The water quality index (based on the guidelines of brackishwater fisheries) indicated fair quality in pre and post-monsoon seasons but poor quality during the monsoon.
- Metal quantification in fish fleshes showed THQ values below 1 indicatig that indirect intake of metals through fish consumption will not result in potential health hazard in humans.
- Fish catch was dominated by *Sillago sihama* and *Rastrelliger kanagurta* in different seasons.
- A static mass balance model estimated trophic levels and system throughput, with simulations suggesting stable stocks for some species until specific years.
- Reduction in fishing effort was recommended for sustainability. The study predicted a decline in trophic levels but a recovery process starting after 2030.

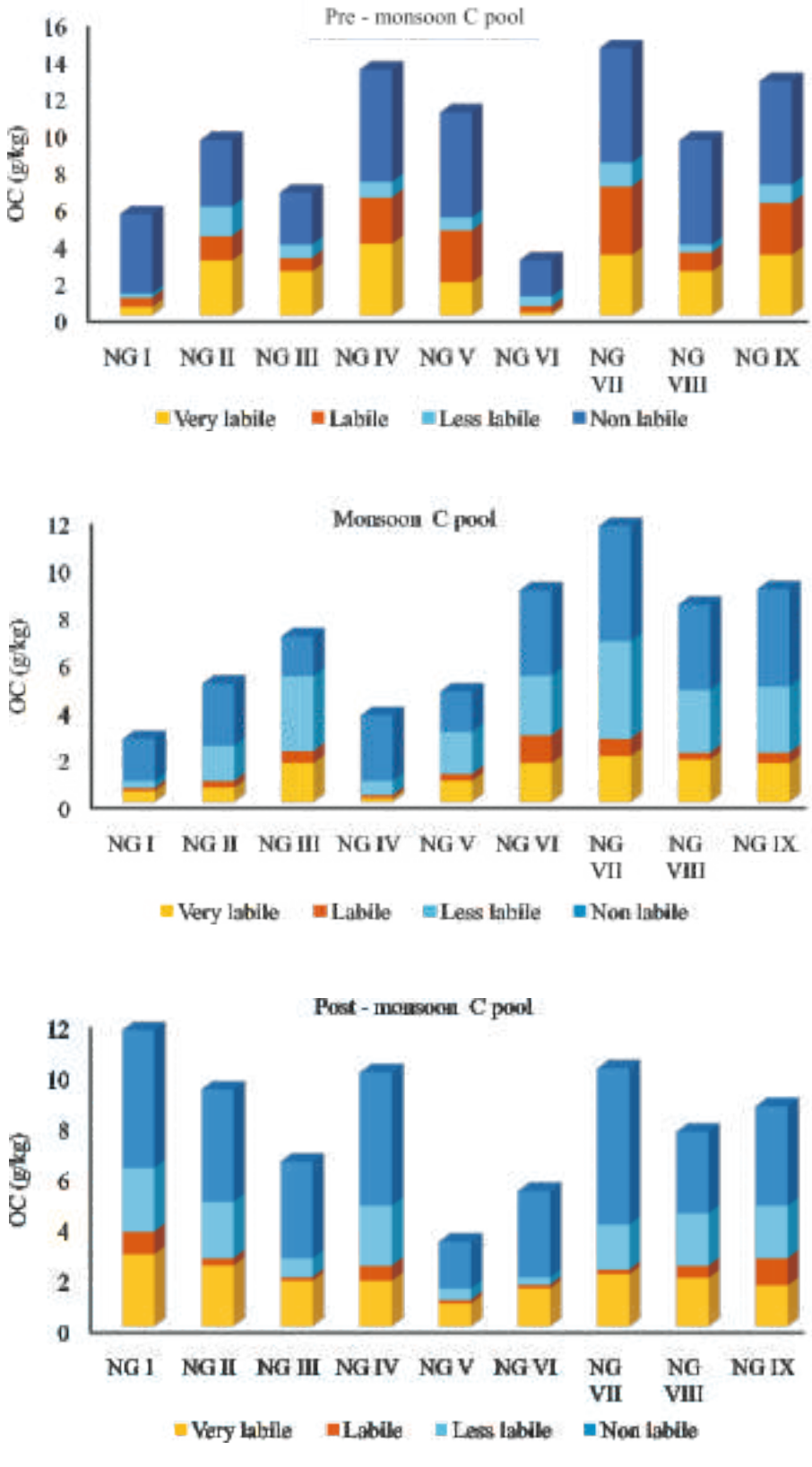
The Netravati River (148 km) originate at Kudremukh in Chikkamagaluru. It flows through famous pilgrimage place Dharmasthala and is considered one of the holy rivers of India. The Gurupura River (87 km) originates in the Western Ghats and is a tributary of the Netravati River. The rivers form an estuary at the southern region of the Mangalore and subsequently flows into the Arabian sea.

Labile and recalcitrant sediment organic carbon pools

Surface sediment samples of Netravathi-Gurupur estuary were collected seasonally to analyse variations in labile and recalcitrant pools of organic carbon. Concentrations of total labile and recalcitrant organic carbon (ROC) ranged from 2.99 to 13.36g/kg, 0.33 to 6.43 g/kg, and 2.07 to 7.33 g/kg, respectively. ROC was the chief fraction of SOC and higher concentrations of SOC were found in the Gurupur estuary stretch due to higher anthropogenic organic carbon contribution. Sediment C/N ratio varied from 3.52 to 14.82, 7.71 to 32.05, and 4.85 to 13.36 in pre-monsoon, monsoon and post-monsoon seasons respectively indicating seasonal changes in sources of organic matter and depositional environment.This high C/N values suggested that the organic material of the sediment has a terrestrial origin and is mainly composed of cellulose and lignin. Lower C/N ratio and higher content of labile C pool in Gurupur stretch indicated that the sediments of this area are more prone to CO_2 emission.

Trace metals in commercially important fish and crab species

Chemical pollution in estuarine ecosystems leads towards an increase in the concentrations of heavy metals in fish body, which may negatively impact human health through consumption of fish. We present a comprehensive picture of the numerous trace metal (Cd, Co, Cr,



Spatio-temporal variations of Carbon pools in sediments of N-G estuary

Cu, Fe, Ni, Pb, Zn and Mn) levels in estuarine fish species (*Nematalosa nasus*, *Gerres filamentosus*, *G. erythrourus*, *Arius arius*, *Sardinella fimbriata*, *Caranx ignobilis*, *Etroplus suratensis*, *Mugil cephalus*, *Sillago sihama*, and *Euryglossa orientalis*) and crab (*Portunus pelagicus* and *Scylla serrata*), from Netravathi-Gurupur estuary, India and quantify their potential risk to human by measuring the estimated daily intake (EDI), target hazard quotient (THQ), hazard index (HI), and target cancer risk (TR). The hierarchy of toxic metals (mg/kg) in different species showed as Fe (12.83 ± 6.30) > Pb (3.19 ± 1.86) > Cr (1.18 ± 0.51) > Mn (0.61 ± 0.33) > Zn (0.52 ± 1.13) > Cu (0.19 ± 0.34) > Ni (0.14 ± 0.08) > Cd (0.08 ± 0.07) > Co (0.005 ± 0.01) in muscle and Fe (70.17 ± 24.91) > Pb (3.19 ± 1.21) > Cr (1.61 ± 0.97) > Mn (0.91 ± 0.34) > Zn (0.32 ± 0.37) > Ni (0.17 ± 0.16) > Cu (0.02 ± 0.02) > Cd (0.015 ± 0.01) > Co (0.012 ± 0.01) in gill. For all species evaluated, the EDI shows values below its reference dose (RfD). The THQ values for all the metals in respective fishes are below 1 that indicate that indirect intake of metals by consuming these selected fishes will not result in potential health hazard in humans. However, estimated HI values were > 1 for children who are thus more susceptible to health risks in continuous consumption of contaminated fish from the target area. On the other hand, the target cancer risk for Cr, Cd, and Pb was found within an acceptable level. Though the results indicate that heavy metal concentrations detected in the study do not pose a major risk to human beings, it is suggested for continuous monitoring of the study area as some of the fishes show a tendency of accumulating metals.

Fishery

During the pre-monsoon season, the dominant catch in the estuarine fishery was *Sillago sihama* (31.07%), followed by *Scylla serrata* (19.47%), *Cynoglossus orientalis* (12.98%), *Gerres filamentosus* (9.99%), *Caranx sexfasciatus* (7.71%) and *Nematalosa nasus* (7.08%). In the monsoon season, *Sillago sihama* continued to dominate the catch at 34.15%, followed by *Gerres filamentosus* (23.14%), *Etroplus suratensis* (12.4%) and *Lates calcarifer* (8.67%). The Indian mackerel, *Rastrelliger kanagurta* was the dominant species in post-monsoon at 20.5%, followed by *Gerres filamentosus* (15.9%), *Etroplus suratensis* (12.1%), *Nematalosa nasus* (11.3%), *Sillago sihama* (10.4%) and *Scylla serrata* (6.3%).

The sizes of *R. kanagurta* ranged from17.5 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.

Our study estimated the pre-monsoon estuarine fish catch in the Nethravathy-Gurupur estuary at 31.2 metric tonnes. A static mass balance model was developed for the Nethravathy-Gurupur estuary using Ecopath with Ecosim, involving 28 functional groups. Trophic levels were determined, with birds occupying the highest trophic level (3.8), followed by catfishes (3.3) and eels (2.2). The total system throughput was estimated at 22691 t/km^2, and the mean trophic level of the catch was 2.9.

Simulations were conducted to assess the impact of fishing efforts on the ecosystem. For the dominant species, *Sillago sihama*, simulated yields remained similar in years with the same effort, indicating no significant changes in fishing efforts. Even with increased or decreased fishing efforts, the fishery outcomes did not show signs of depletion over the study period. The stock of *Nematalosa nasus* remained stable beyond its limit and target. *Sillago sihama*, anchovies, crabs, eels, and belonids stocks were found to be sustainable until 2038 and 2042. A reduction in 25% effort was recommended for sustaining certain stocks, while a precautionary approach was advised for mullets, snappers, and mollusks until 2039. The breams did not show signs of depletion beyond their limit even under scenarios of increased fishing efforts. The L index, measuring the exploitation level, remained relatively high, with values at or below 0.020 during the simulation period. The simulation predicted a significant decline in the trophic level of the fish catch over five decades, but a recovery process was anticipated.

The study indicates that changes in the trophic structure of the Nethravathy-Gurupur estuary ecosystem, predicted from 2030 onwards, can be attributed to factors such as targeting high trophic level species, the impact of invasive species, and changes in habitat. The Kempton Q Biomass Diversity index reflects a gradual decline, indicating depletion of fishes above trophic level three. However, a recovery process initiates after 2030. The study suggests potential strategies for sustainable management, including reduced fishing effort and restoring fish populations. The findings underscore the vulnerability of certain fish stocks to fishing pressure and emphasize the importance of considering trophic interactions and ecosystem dynamics in fisheries management for long-term sustainability. It emphasizes the need to balance fishing effort with stock conservation and manage anthropogenic activities to protect and restore water quality and the estuary's ecosystem.

Crafts and gears

Plank built canoes were found to be the major craft operated in the freshwater stretch and motorized boats in the estuarine stretch of Netravathi-Gurupur estuary. Gill nets, trammel nets, cast nets and hooks and lines were the gears operated in the waterbody.

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

Duration: April 2020 to March 2024

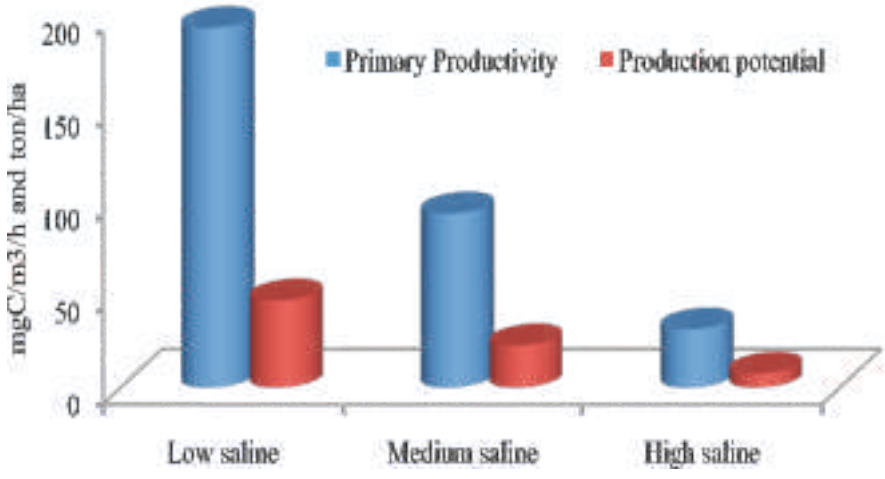
Scientific Personnel : Thankam Theresa Paul (Sub-project Leader), Deepa Sudheesan

Summary

- The primary productivity of the estuary was found to be decreasing towards high saline zone. It ranged from 193.75 mgC/m^3/h (low saline) to 31.25 mgC/m^3/h (high saline).
- The production potential of the lake varied from 46.96 t/ha (low saline) to 7.6t/ha (high saline).
- LWR of ten (10) commercially important species have been estimated and it was found that three (3) species, namely, *Etroplus suratensis,* Leiognathids and *Fenneropenaeus indicus* exhibited positive allometry.
- Species accumulation curve and rarefaction curve indicated that adequate number of samples have been analysed and only rare samples were left out in this study.

Primary production and production potential of Vembanad

The primary productivity of the estuary was found to be decreasing towards high saline zone. It ranged from 193.75 mgC / m^3 / h (low saline) to 93.75 mgC / m^3 / h (medium saline) to 31.25 mgC / m^3 / h (high saline). The production potential of the lake varied from 46.96 t/ha (low saline) to 7.6 t/ha (high saline).



Primary production and production potential of Vembanad estuary

LWR of commercially important species

The length–weight relationship (LWR) of commercially important species from Vembanad estuary was determined. The estimated parameters of LWR including sample sizes (N), total length (TL), weight (W), regression parameters '*a*' and '*b*' and the coefficient of determination (r^2) are given in Table.

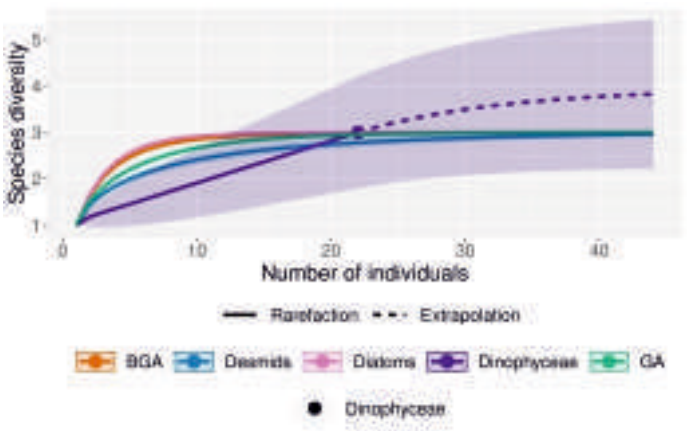
The study indicated that three (3) species namely *Etroplus suratensis,* Leiognathids and *Fenneropenaeus indicus* exhibited positive allometry.

Table: Descriptive statistics and estimated length-weight relationship parameters of commercially important species/groups from Vembanad estuary

Species	N	TL range (cm)	W range (g)	*a*	*b*	r^2
Etroplus suratensis	59	8.4-32	10-900	0.0157	3.138	0.961
Pseudetroplus maculatus	203	4.5-10	1.61-16.3	0.0283	2.792	0.929
Leiognathids	115	6.5-10	3.16-16.64	0.0055	3.414	0.814
Cynoglossus spp.	167	7.4-14	2.58-18.3	0.0092	2.872	0.900
Ambassis ambassis	168	5.5-16	1.8-39.36	0.0105	2.963	0.942
Oreochromis mossambicus	52	11.7-22.2	29.2-193.18	0.0492	2.614	0.942
Stolephorus indicus	263	4.1-14.8	0.67-25.74	0.0084	2.957	0.957
Liza spp.	149	11-26	14.4-160	0.0611	2.341	0.867
Fenneropenaeus indicus	127	9-15.4	4.22-20.25	0.0049	3.049	0.739
Metapenaeus dobsoni	131	5.3-11.5	1.9-8.69	0.0406	2.106	0.745

Rarefaction curve of plankton

Species accumulation curve and rarefaction curve indicated that adequate number of samples have been analysed and only rare samples were left out in this study. The study indicated more samples for group Dinophyceae.



Rarefaction curve

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

Project Code: REF/20-23/12

Duration: April 2020 to March 2024

Scientific Personal: A. K. Sahoo (PI), S. K. Das, Raju Baitha (upto 31.03.22), Mitesh Ramteke (upto 31.03.2021), Sangeetha M Nair (w.e.f. 01.04.2021)

Summary

- An investigation on the impact of dam on the river ecology and fisheries was undertaken during the lean period (Jan-Feb) representing the low river flows of river Rangit.
- Both biotic and abiotic parameters were collected from six sites representing both upstream and downstream of the dams.

Fish diversity

A total of 9 fish species were recorded in the selected stretches of the river Rangit. Lean season low river flows showed maximum catch of snow trout *Schizothorax richardsoni* in the upstream of the river *i.e* at site 1 to site 3, while maximum catch of Chocolate Mahseer *Neolissocheilus hexagonolepis* was recorded in the Site 5. Interesting observation on the reproductive biology of snow trout showed fully matured female and males and also spawn. The preferred spawn habitat was recorded as depth of 15cm and velocity less than 0.1 m/s. The cyprinids dominated in the total fish catch from the river. Analysis of biodiversity indices indicated low Pielou's evenness (0.54) in Jorethang due to occurance of maximum population of *Opsarius bendelisis*. Site Tashiding exhibited highest evenness (0.98) with an even distribution of fish species. Concurrently Manpur showed high Margalef richness (d) of 0.95 and Shannon index (H') of 1.02 with moderate fish diversity. A comparison between monsoon and post-monsoon/lean season on fish diversity in river Rangit showed low flows mostly prefer the chocolate mahseer and small bodied carps.

Water quality parameters

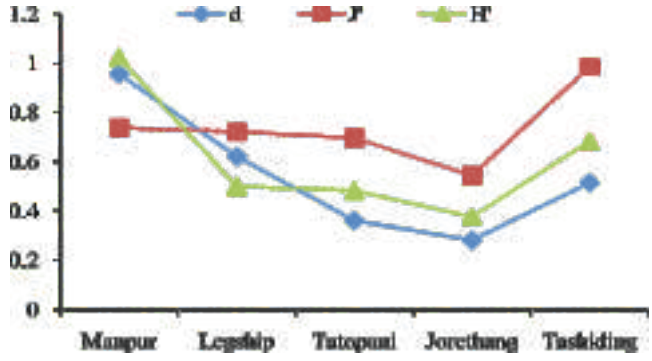
Low water temperature (14-15°C) prevailed across the sites. Only at downstream site near confluence the temperature was slightly higher. All the stations except S4 and Confluence site had a pH range from 7.3 – 8.05 with a mean value of 7.6; only two stations, *viz*., S4 and near confluence sites were having pH less than 7.0. The reduction in pH may be correlated with the higher turbidity of the places on the specific sampling date and this may be corroborated with the observation that on the first day of sampling site near confluence (S6) exhibited pH of 8.05 (alkaline). The major part of Rangeet river stretch was highly transparent and at the dam upstream site the turbidity was only 1.42. This is because at the lower stretches, where we found high turbidity, had undergone the status only temporarily due to the cleaning of the dam upstream and consequent release of turbid water. Another significant observation was the low total alkalinity at all the places: it was less than 100 ppm and it measured as low as 24 ppm only at Legship (S2). This may not be very congenial environment for many fish species and only some will dominate. The specific conductance of none of the sites was very high, but amongst that the site near the confluence had significantly higher value of conductivity than all other sites.



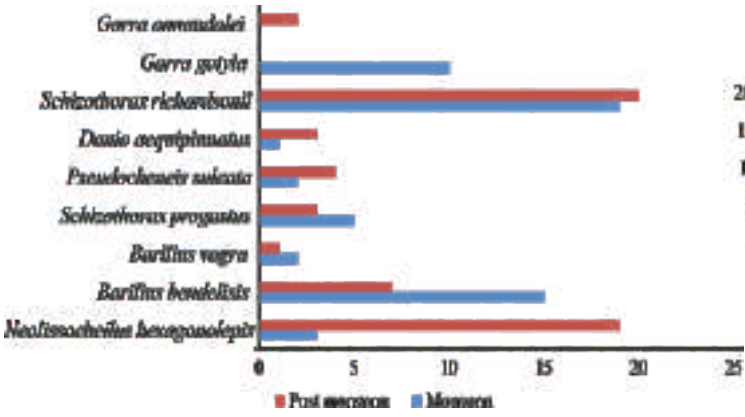
Sampling site below the dam during low river flows



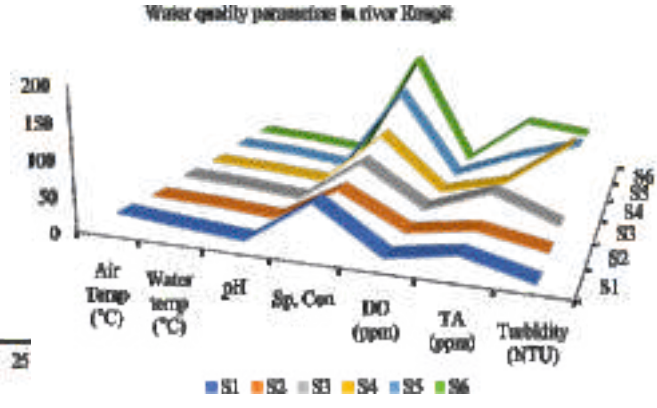
Fully matured snow trout female, and fingerlings of snow trout in low flow area



Fish diversity indices at different sites of River Rangit



Seasonal comparison of fish diversity in River Rangit



Variation in water quality parameters due the dam impact

The above observations furnish that the downstream of the dam has more impacts on both fish abundance and water quality parameters particularly on turbidity and specific conductivity.

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 2022 to September 2023

Scientific Personnel : B. K. Das (PI) (w.e.f. 01.04.22); Rosith C. M. (PI) (01.04.20-31.03.22); Chayna Jana (upto 31.03.22), Lohith Kumar (upto 08.12.22), Raju Baitha, Arun Pandit, Cancyal Johnson (upto 31.03.22; w.e.f. 01.04.23), Mitesh Ramteke (w.e.f. 01.09.2021), Niti Sharma (w.e.f. 01.04.22)

Summary

- Observed and recorded 56 fish species, Sahora (Bhagalpur) was having highest fish species richness (33 species) while fish species richness was least (13 species) at Piparahipatti Golari (Supaul) of River Kosi.
- Major commercially important fishes in River Kosi are *Bagarius* sp., *Sperata* spp., *Wallago attu*, *Labeo catla*, *L. rohita*, *Notopterus chitala* and *Rita rita.*
- The estimated fish landing pattern of commercially important fish group along Kosi River during post-winter in descending order is Bhagalpur> Saharsa> Supaul> Khagaria.
- In River Kosi, fishing gears comprised of gillnet, cast net, dragnet, dip net, hook and line and indigenous traps.

Kosi River

Reconnaissance survey

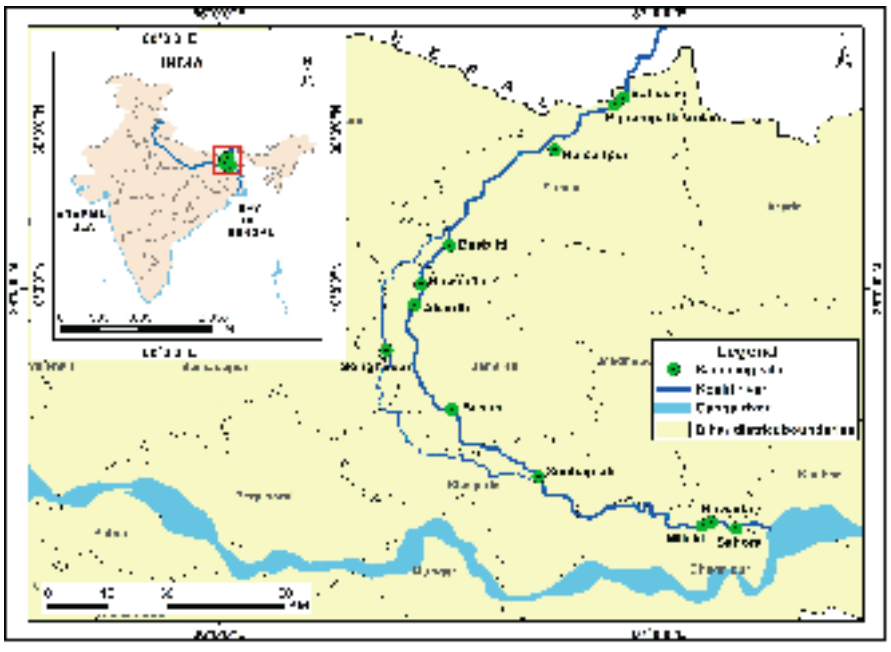
Kosi River originates at an altitude of over 7,000 m above MSL in the Himalayas. The upper catchment of the river system lies in Nepal and Tibet. It traverses a total distance of 736 km and joins the River Ganga near Kursela in Bihar. The river Kosi drains a total catchment area of 74030 sq. km - 11410 sq. km in India and the rest in Tibet and Nepal. The present exploration was done to collect information on fish and fisheries and other aquatic animals of the Kosi River during post-winter, 2023. The exploration covered 12 riverine villages in Supaul, Saharsa, Khagaria and Bhagalpur districts.

Soil and water quality

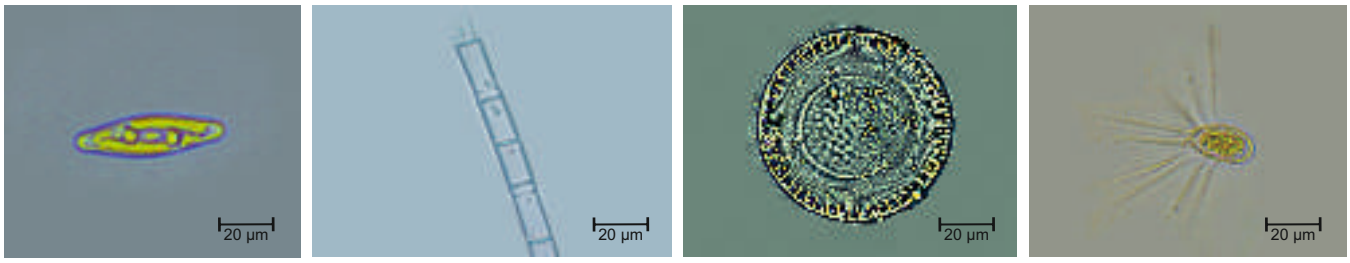
Sediment pH along the studied stretch of Kosi River was alkaline (8.28±0.17) in nature. Bottom sediment had low organic carbon content due to the dominance of sand (88.5±6.17%). Distribution of $CaCO_3$ followed the similar pattern of sand content which indicates that shell fragments associated with sand are the main contributor of $CaCO_3$.The water was optimally transparent and having higher dissolved oxygen. Water pH (8.5±0.03) and total alkalinity (97.5±14.86 ppm) were optimum for sustaining aqua-life of the river.

Plankton community

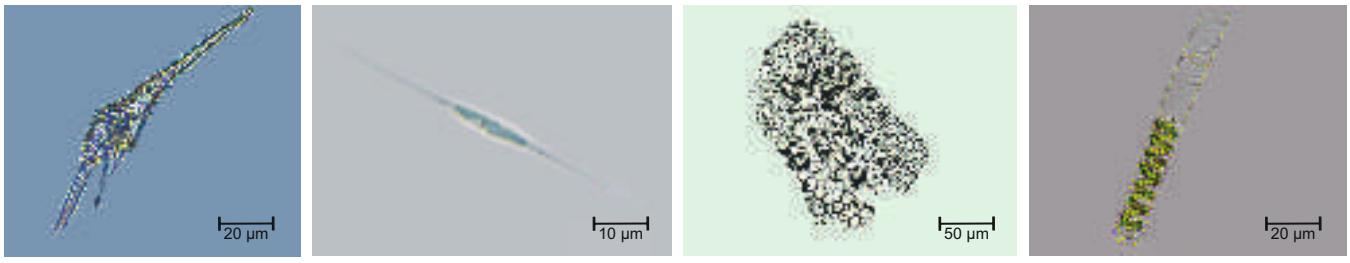
Eleven groups of plankton were recorded, of which 10 belonged to phytoplankton and one to zooplankton group. The relative abundance of plankton groups were: Bacillariophyceae (35.94%), Trebouxiophyceae (31.95%), Cyanophyceae (10.38%), Coscinodiscophyceae (10.14%), Chlorophyceae (8.79%), Zygnematophyceae (1.81%), Rotifera (0.33%), Dinophyceae (0.26%), Mediophyceae(0.13%), Synurophyceae (0.13%) and



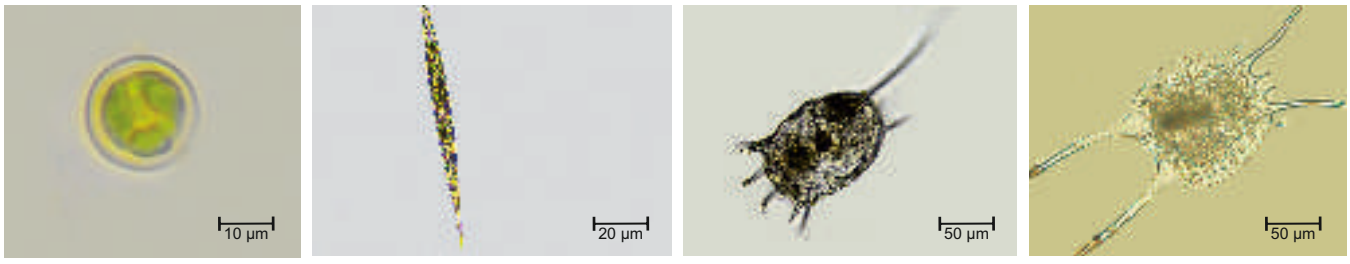
GIS map of surveyed stretch of the Kosi River



Navicula sp. (Bacillariophyceae) | *Aulacoseria* sp. (Coscinodiscophyceae) | *Cyclotella* sp. (Mediophyceae) | *Mallomonas* sp. (Synurophyceae)



Ceratinum sp. (Dinophyceae) | *Monoraphidium* sp. (Chlorophyceae) | *Merismopedia* sp. (Cyanophyceae) | *Spirogyra* sp. (Zygnematophyceae)



Chlorella sp. (Trebouxiophyceae) | *Euglena* sp. (Eiglenophyceae) | *Keratella* sp. (Rotifera) | *Brachionus* sp. (Rotifera)

Representative of planktons in River Kosi

Euglenophyceae (0.13%). Among the phytoplanktons *Keratella* sp. and *Brachionus* sp. were most abundant.

Benthic community

Three freshwater gastropods, namely, *Filopaludina bengalensis, Mekongia crassa* and *Lymnaea acuminata* were recorded in the surveyed stretch of the Kosi River.



(a) *Filopaludina bengalensis* (b) *Mekongia crassa* (c) *Lymnaea acuminata*

Freshwater gastropods

Fish community and landing pattern

The survey recorded 56 fish species, Sahora (Bhagalpur) had the highest fish species richness (33) while fish species richness (13) was least at Piparahipatti Golari (Supaul). Major commercially important fishes observed were *Bagarius* sp., *Sperata* spp., *Wallago attu*, *Labeo catla*, *L. rohita*, *Notopterus chitala* and *Rita rita*. Among small indigenous fishes, major catch was composed of *Aspidoparia morar>Ailia coila>C. reba>L. bata>L. boga>Salmostoma bacaila.* Invasion of exotic fishes were not recorded, however pond cultured exotic fishes were seen in the fish market.

The landing pattern of fish catch was assessed by interviewing more than 300 fishers through semi-structured questionnaire. It revealed that *Bagarius* sp., *Sperata* spp., *Wallago attu*, *Labeo catla*, *L. rohita*, *Notopterus chitala* and *Rita rita* were major commercial fish groups along the surveyed stretch of Kosi River.

Further, the study revealed fish catch pattern in the selected landing centres in descending order, Bhagalpur (22.24 MT), Supaul (11.952 MT), Saharsa (9 MT) and Khagaria (2.24 MT).

Crafts and gears of Kosi River

The fishing crafts operated in river Kosi were wooden boats (plank built) locally known as *naav*. The boats were varying in size, can carry 2-4



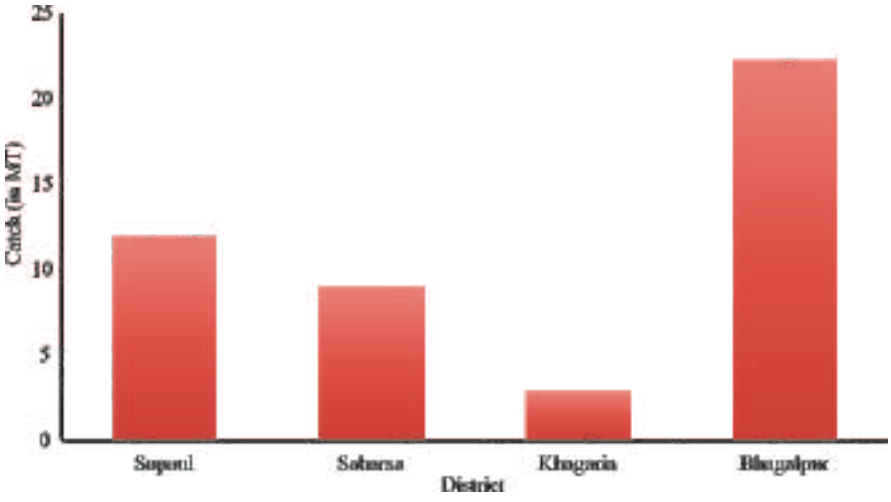
Fish catch diversity of Kosi River



Interview of fishers on fish diversity and catch pattern

persons and non-motorized generally. These fishing crafts are mostly used for gill net, cast net and drag net operation.

Fishing gears comprised of gill net, cast net, dragnet, dip net, hook and line and indigenous traps used in river Kosi. Traps are very common gear used in the entire stretch of the river during monsoon and post-monsoon seasons. Large valuable fishes have been caught by gill nets of larger mess size. Gill nets having mess size 1-28 cm have been in operation to catch different size of fish like gill net (mesh size-1 cm) are operated during August to October to catch SIFs and younger size group of non-SIFs; gill net (mesh size: 3-4 cm) are operated during May-August to catch *Labeo* spp., *Sperata* spp., *W. attu, N. notopterus, Cirrhinus mrigala* and sub-adult size of large sized fish and gill net (mesh size:12-14 cm) are operated during June-July to catch breedable population of *Bagarius* spp., *L. catla*, *N. chitala*, *Sperata* spp. and *W. attu*.



District-wise landing pattern of commercially important fish group along Kosi River during winter (in MT)

Notable observation of aquatic life in Kosi River

The Gangetic dolphin (*Platanista gangetica*) was sighted in all the surveyed districts of Bihar. Additionally, the crowned river turtle, (*Hardella thurjii*) was recorded in Paharpur, Nauhatta (26º00' 46.1 " N, 86º27' 31.0") of Saharsa district while Indian peacock soft shell turtle (*Nilssonia hurum*) was recorded from Dumrighat (25º32' 35.7 " N, 86º43' 23.4" E) of Khagaria district.

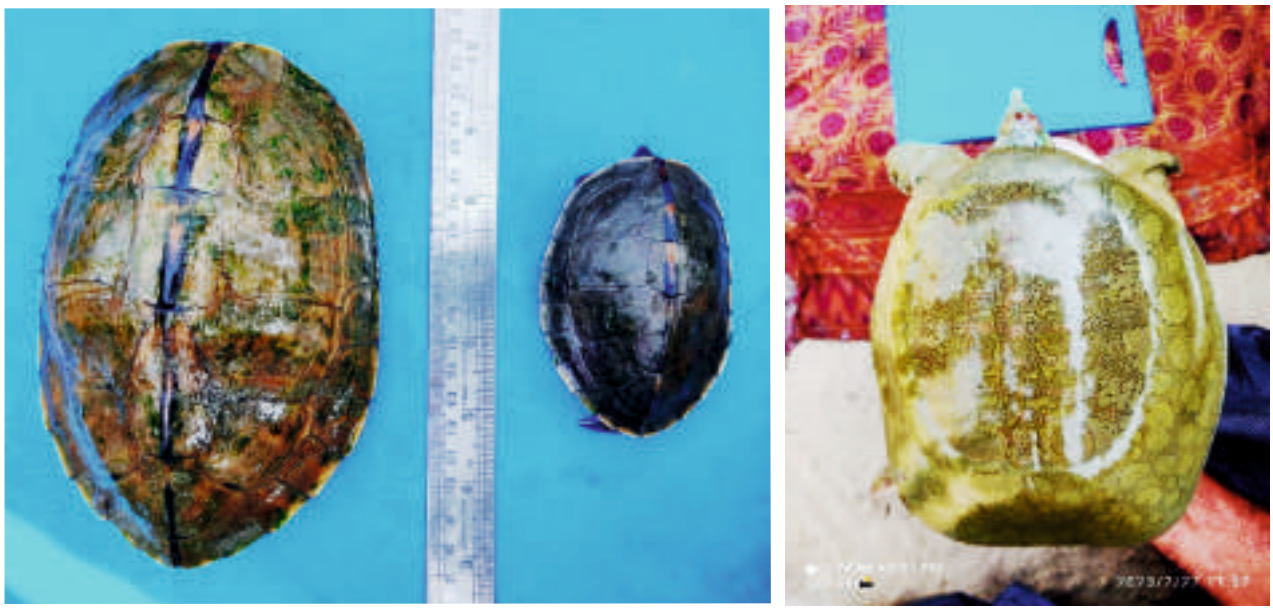


Fishing craft of Kosi River



a) b) c)

Fishing gears of Kosi River, a) Dip net, b) Traps and c) Gill net



a) b)

a) Crowned river turtle - *Hardella thurjii* and b) Indian peacock softshell turtle - *Nilssonia hurum*

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

Project Code: REF/ 20-23/14

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

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)

Duration: April 2020 to March 2023

Scientific Personnel: Ranjan K. Manna (PI), Dibakar Bhakta, Sangeetha M. Nair, D. N. Jha, A. Alam, J. Kumar

Summary

- Two cyprinids, *Chagunius nicholsi* (Myers, 1924) and *Opsarius dogarsinghi* (Hora, 1921), were recorded for the first time from the Torsa River in the Jaldapara National Park, extending their distribution range beyond northeastern India.
- *Eustrongylides ignotus* (Jagerskiold, 1909), a nematode known for causing the parasitic disease 'Eustrongylidosis' in fish and birds, has been detected in four different indigenous fish species *Channa marulius* (Hamilton, 1822), *Clupisoma garua* (Hamilton, 1822), *Ompok bimaculatus* (Bloch, 1794) *and Rita rita (Hamilton, 1822) from Ken River in Panna National Park*
- Heavy silt deposition in Ken River at Panna National Park after rain is harmful to benthic communities and bottom dwelling fishes.
- Lack of awareness on conservation of aquatic animals like tortoises in Panna National Park was revealed through presence of live specimens with peoples' possession as observed during the survey.

Two new records of cyprinids from river Torsa at Jaldapara National Park complex

Two cyprinids *Chagunius nicholsi* (Myers, 1924) and *Opsarius dogarsinghi* (Hora, 1921) were recorded for the first time from the Torsa River in the Jaldapara National Park. Two specimens of *Chagunius nicholsi* and three specimens of *Opsarius dogarsinghi* were collected from the gill net (mesh size 30 mm) catch along the flowing stretch at Kodalbasti region of the river Torsa. Only a few north-eastern locations in India have been reported to host both these two indigenous fish species. The distributional range of these species has thus expanded from its native habitat to the river Torsa in West Bengal, India. The samples were caught from sandy and stony bottoms when the river had strong currents and water was translucent.



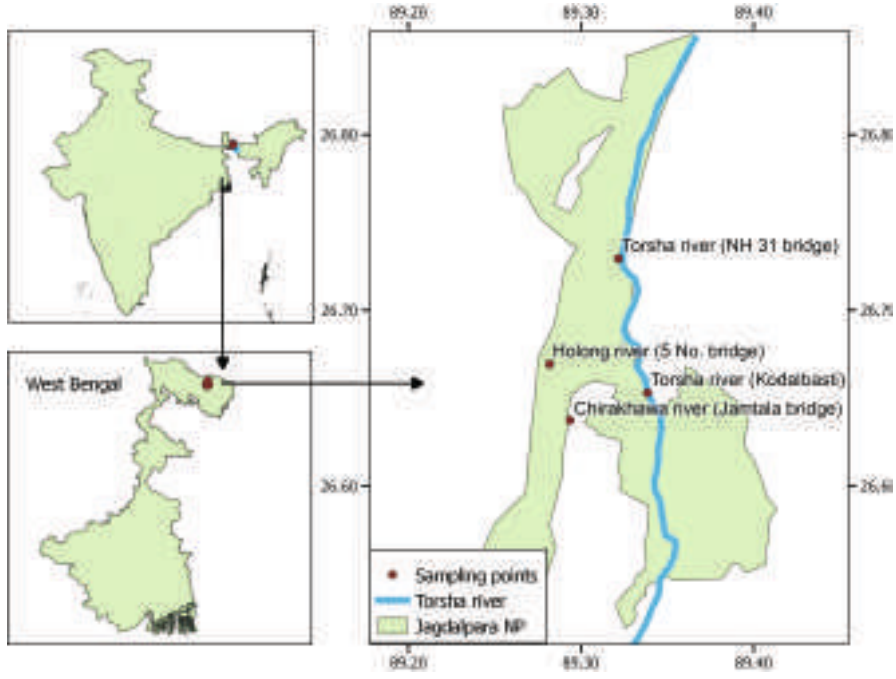
C. nicholsi (fresh specimen) collected from river Torsa at Jaldapara NP complex



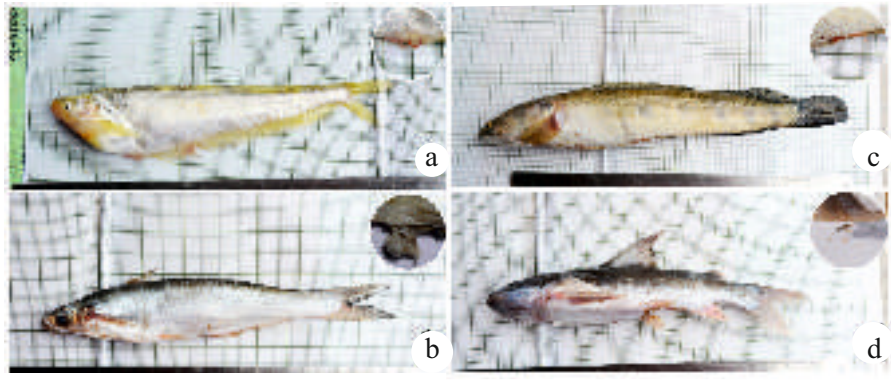
O. dogarsinghi (formalin preserved specimen) collected from river Torsa at Jaldapara NP complex

Occurrence of parasitic nematode *Eustrongylides ignotus* (Jagerskiold, 1909), in fishes of Ken River around Panna National Park

Eustrongylides ignotus (Jagerskiold, 1909), a nematode known for causing the parasitic disease 'Eustrongylidosis' in fish and birds, has been detected in four indigenous fish species *viz. Channa marulius* (Hamilton, 1822), *Clupisoma garua* (Hamilton, 1822), *Ompok bimaculatus* (Bloch, 1794) and *Rita rita* (Hamilton, 1822) out of a total of 46 finfish species collected from a pristine stretch of the Ken River in Panna National Park, India. Except *Ompok bimaculatus*, other three fish species are new host record for *Eustrongylides*. The specimens of nematodes collected from all four fish species were observed to be morphometrically identical and identified as *Eustrongylides ignotus* Jagerskiold, 1909 (Phylum: Nemathelminthes, Class: Adenophorea, Order: Enoplida, Family: Dioctophymatidae). Molecular identification (NCBI ACCESSION OQ885489) of the specimen showed a 100% similarity with *Eustrongylides excises* Jägerskiöld, 1909, and *Eustrongylides ignotus* Jagerskiold, 1909.



Map showing the collection sites from river Torsa, India



Fishes infected with *Eustrongylides ignotus*, a-*Ompok bimaculatus* (Bloch, 1794), b-*Clupisoma garua* (Hamilton, 1822), c-*Channa marulius* (Hamilton, 1822), d-*Rita rita* (Hamilton, 1822)



Eustrongylides ignotus collected from the fishes

The highest abundance of 6-7 number of nematode was recorded in *Clupisoma garua*; other fish species contained 2-3 numbers of parasite in their gut. The river water and sediment quality data revealed that the aquatic environment was free of city-derived organic pollution. The observation indicated that plant-based organic detrital load in a waterbody inside a reserved forest might also support the occurrence of the parasite, in contrast to most of the earlier reports of *Eustrongylides* from waterbodies with anthropogenic organic enrichment. The four fishes containing parasites are carnivorous or omnivorous, like earlier observations from India. The existence of the nematodes in fish also indicates the role of fish-eating

birds in this protected forest area in completing the parasite's life cycle. Factors like the food and feeding habits of the fish and the presence of hosts at all stages of life cycle of the parasite in forest-based aquatic ecosystem with organic matter-rich environment may also support the occurrence of *Eustrogylides ignotus* in fishes.

Huge silt load in surface run-off: a major issue in Panna National Park

In Ken River, siltation was identified as a big issue during sampling. It was observed that Madla Ghat on River Ken was totally covered with huge load of silt, carried by the River after heavy downpour in the area few days back. Such heavy silt deposition is harmful to benthic communities as well as bottom dwelling fishes.



Huge deposition of silt on Madla Ghat of river Ken after heavy rains

Lack of awareness on conservation of aquatic animals in Panna National Park

Live tortoise specimens were discovered in peoples' possession during sampling along the Ken River in the Panna National Park Complex in Madhya Pradesh. These animals were accidentally caught by local fishers during a gill net operation and were kept in one of the fish merchant's house tank for ornamental purposes. Freshwater turtle conservation knowledge is lacking, as evidenced by the fact that accidental captures are not immediately released back into the river, instead are maintained and raised in homes for display purposes. Since it is illegal to possess this turtle, as given in part II of Schedule I of the Wildlife (Protection) Act of 1972, local fishers, including stakeholders, should be made aware of this fact. If they accidentally catch one of these turtles or catch them on purpose, they must release it right away in appropriate water bodies.



a) Ganges softshell turtle (*Nilssonia gangetica)* from river Ken; b) Ken River tortoise under captivity, revealing lack of awareness about their conservation among local people

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

Duration: April 2020 to March 2023

Scientific Personnel: Suman Kumari (P.I.), Sajina A. M., B. K. Bhattacharjya, N. S. Singh (upto 30.04.22), Simanku Bora, D. N. Jha, A. Alam, J. Kumar

Summary

- A comparative analysis of three protected areas viz. Kusheshwar Asthan chaurs, Nagi and Nakti Twin Bird Sanctuaries and Kulik Bird Sanctuary revealed the highest values of alpha diversity Kusheshwar Asthan chaurs indicating it as unambiguously more speciose than others despite less access regulation
- Observation of threatened fishes like *Clarius magur* (EN), *Ompok bimaculatus* (NT), *Ompok pabda* (NT) and *Wallago attu* (VU) and also otters in and around the wetlands

Summary

under the Dudhwa National Park, which are some national priority animals for conservation gives recognizance to the importance of these freshwater habitats to ensure continued presence of these aquatic animals.

- Heavy infestation of *Eichhornia crassipes* in water bodies of Arga-Parvati bird sanctuary makes the water body less congenial for aquatic organisms and hence necessitates management interventions.
- Among 53 indigenous fish species recorded from Rowmari beel, Orang National Park, Assam, 45 are reported to be under IUCN status Least Concern (LC) category, 5 are categorized as Near Threatened (NT), 1 Vulnerable (VU), 1 Data Deficient (DD) and 1 Endangered (EN).
- One of the major problems identified in Rowmari beel, Darrang, Assam is the continuous siltation of the beel caused by flood reducing the water depth and effective water area. Steps should be initiated in this direction to contain the problem of siltation and conserve this important water resource.

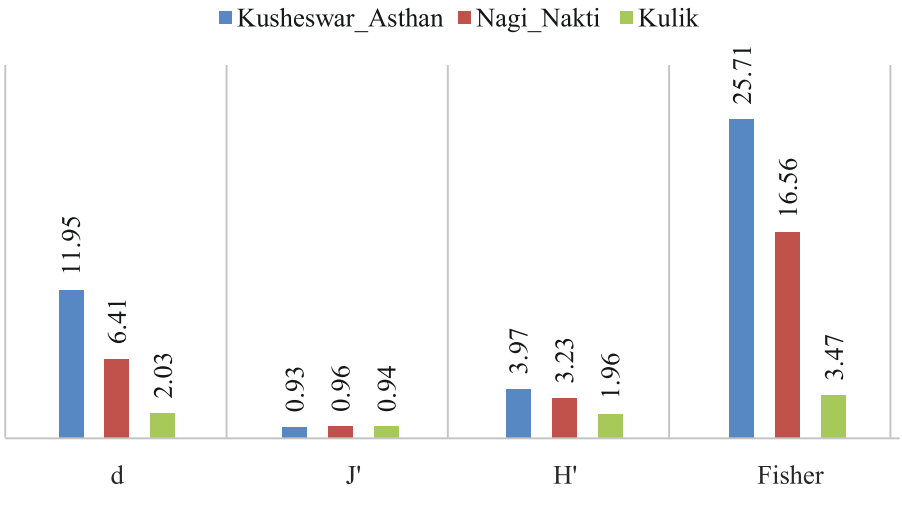
Fish diversity of three categories of protected aquatic habitats of Eastern India

In order to examine the efficacy of fish conservation and develop a framework for resolving resource users conflicts, a comparative analysis was carried out in the selected three categories of Protected Areas (Pas) *viz*. (i) a natural wetland system with minimum access regulations (Kusheshwar Asthan chaurs, Darbhanga, Bihar), (ii) two completely protected reservoir systems within completely closed bird sanctuaries (Nagi and Nakti Twin Bird Sanctuaries, Jamui, Bihar), and (iii) a man-made canal system within a bird sanctuary (Kulik Bird Sanctuary, Raigunj, Uttar Dinajpur, West Bengal). The fish faunal diversity of these three categories of aquatic habitats was explored through seasonal samplings during 2021-22.



Most dominant fisheries (as biomass) is *Wallago attu* (bual) in Kusheshwar Asthan chaur

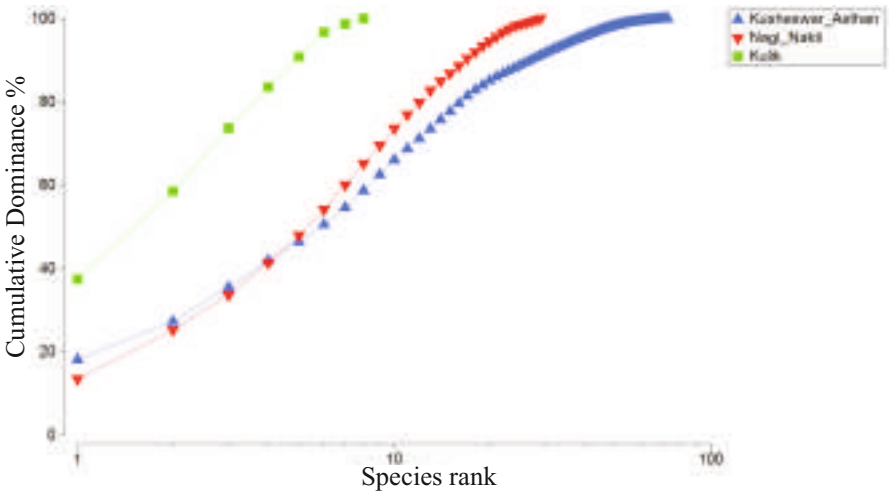
A total of 73 species of fin fish and 3 shell fish was recorded from Kusheshwar Asthan chaur, including near threatened (6.94%), vulnerable (4.16%), and endangered (1.39%) categories based on IUCN Red data list.The conservation status of 29 fish species recorded from Nagi and Nakti are : 3.4% under near-threatened category, 6.9 % under LC-decreasing, 34.5 % under LC-Stable and 55.1% under LC-Unknown. Only 8 fish species were recorded from Kulik Bird Sanctuary, dominated by indigenous fish species



Diversity indices for three categories of PAs

was *Amblypharyngodon mola*. In Kusheshwar Asthan chaurs the most dominant fisheries (in biomass) was *Wallago attu* (bual).

Among the diversity measures such as Margalef species richness (d), Pielou's evenness (J′), Shannon diversity (H') and Fisher's α statistic, all the values were highest in Kusheshwar Asthan and lowest in Kulik Bird Sanctuary (except for evenness values). The k-dominance plot also depicted the dominance pattern of the PAs. The highest values of alpha diversity of Kusheshwar Asthan chaurs is unambiguously more speciose than others, despite minimum access regulation and rampant fishing operations. The Kusheshwar Asthan chaurs also yielded high values for Average Taxonomic Distinctness (AvTD; △ +) with more regularities in the taxonomic hierarchy in comparison to Nagi and Nakti Twin Bird Sanctuaries and Kulik Bird Sanctuary.



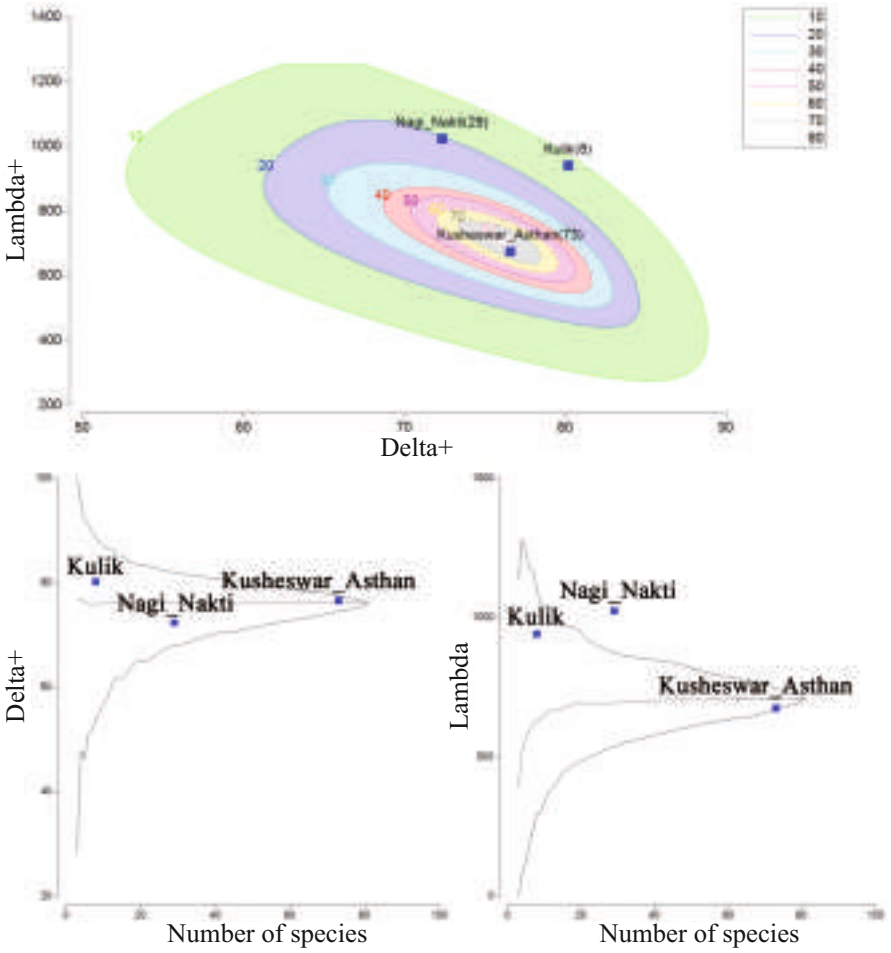
The k-Dominance plot for three categories of PAs

Fish diversity status of Parvati Arga Bird Sanctuary and Dudhwa National Park

Fish diversity status of waterbodies in two protected habitats, Parvati Arga Bird Sanctuary and Dudhwa National Park in Uttar Pradesh was studied. A total of 44 species of fish were recorded from wetlands under Dudhwa National Park, whereas, 51 fish species were recorded from Parvati and Arga Bird Sanctuary.

Major issues in fisheries of Dudhwa National Park and Parvati Arga Bird Sanctuary

- Observation of threatened fishes like *Clarius magur* (EN), *Ompok bimaculatus* (NT), *Ompok pabda* (NT) and *Wallago attu* (VU), and also otters in and around the wetlands under the Dudhwa National Park, which are some national priority animals for conservation gives recognizance to the importance of these freshwater habitats to ensure continued presence of these aquatic animals.



Funnel and ellipse plot of taxonomic distinctness test of three categories of Pas

• Heavy infestation of *Eichhornia crassipes* in water bodies of Arga - Parvati bird sanctuary makes the water body less congenial for aquatic organisms and necessitates management measures.

• Record of *Craspedacusta sowerbii*, a freshwater jelly fish from the Parvati Lake, may cause the water bodies unfit for drinking and also harm the other trophic level organisms including the winter migratory birds. Earlier reports showed that freshwater jelly fishes have positive correlation with higher phosphate level.

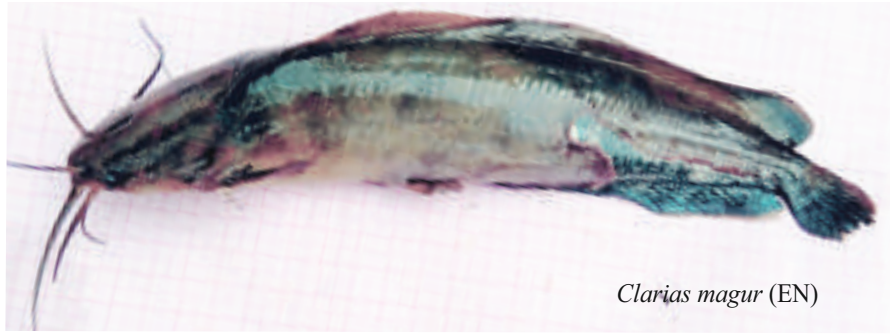
• Record of a zoonotic trematode, *Fasciola* sp. from the Parvati wetland of Arga Parvati Bird sanctuary, Gonda, Uttar Pradesh that causes the infection in the liver called fascioliasis which is a foodborne infection and is a zoonosis, referring to an animal infection that may be communicated to humans. The life cycle of *Fasciola* involves the defecation of eggs in the stool by the final host (ruminant cattle), which infects an intermediate host (snail, Family Lymnaeidae), particularly species in the genera *Lymnaea*, *Galba*, *Fossaria*, and *Pseudosuccinea*.

Fish diversity of Orang National Park (ONP), Assam

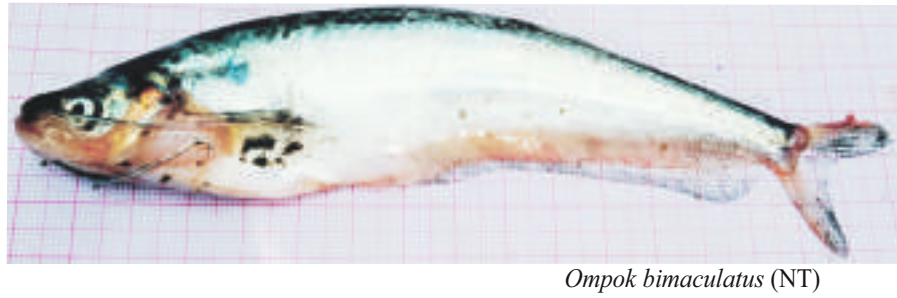
56 fish species under 34 genera, 16 families and 8 orders were documented from Rowmari beel, a seasonally open floodplain wetland located inside Orang National Park (ONP), Darrang, Assam was studied for fish diversity. Out of the total number of species reported 53 are indigenous, among which 45 are reported to be under IUCN status Least Concern (LC) category, 5 are categorized as Near Threatened (NT), 1 Vulnerable (VU), 1 Data Deficient (DD) and 1 Endangered (EN). The beel is an important repository of indigenous fishes. However, one of the major problems identified during our survey is the continuous siltation of the beel

Table: IUCN status of the documented fishes

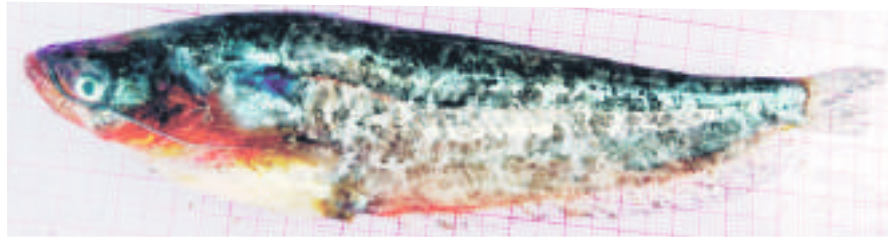
Sanctuary	Water bodies	Total	EN	NT	VU	LC	NE	DD
Dudhwa National Park	Majula tal	39	1	2	1	35	0	0
	Jainagara tal	29	1	1	1	26	0	0
	Bandarbharari tal	22	0	1	0	21	0	0
Parvati Arga Bird Sanctuary	Arga lake	51	1	2	1	45	1	1
	Parvati lake	49	1	2	1	44	0	1



Clarias magur (EN)



Ompok bimaculatus (NT)

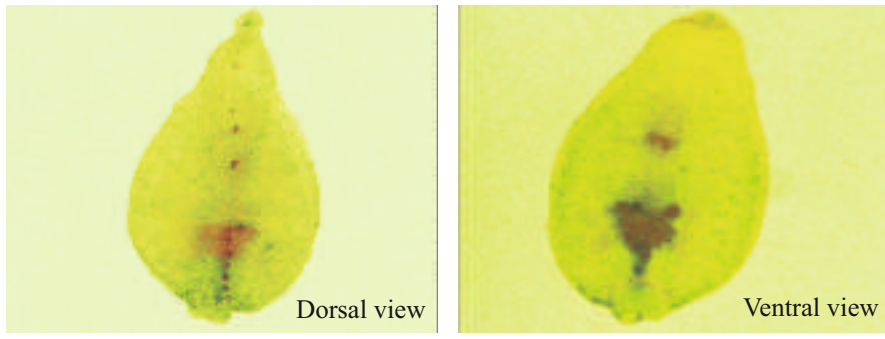


Ompok pabda (NT)



Wallago attu (VU)

Threatened fishes of Dudhwa National Park



Dorsal and ventral view of the wet mount of *Fasciola* sp. recorded from the Parvati wetland of Parvati Arga Bird sanctuary, Gonda, Uttar Pradesh

caused by flood, reducing the depth and effective water area of the beel.

Water quality of Rowmari beel

Water temperature of Rowmari beel during the survey was 25.90 ± 0.60 °C. Water pH was in the congenial range of 7.83± 0.27. Sufficient dissolved oxygen (8.06 ± 0.52) was recorded. Electrical conductivity of 170.13 ± 13.31 µS/cm indicated less human intervention. Higher transparency (58.50 ± 5.96 cm) indicated low plankton density in the wetland. Total alkalinity was low (40.25 ± 3.61 mg/l) indicated moderate productivity of the waterbody.



Sampling team along with forest department staff at Rowmari beel inside Orang National Park, Assam

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 to March 2024

Scientific Personnel: D. N. Jha (PI), A. Alam, J. Kumar, V. R. Thakur, Monika Gupta (upto 08.10.21), Vikas Kumar (w.e.f. 01.04.23)

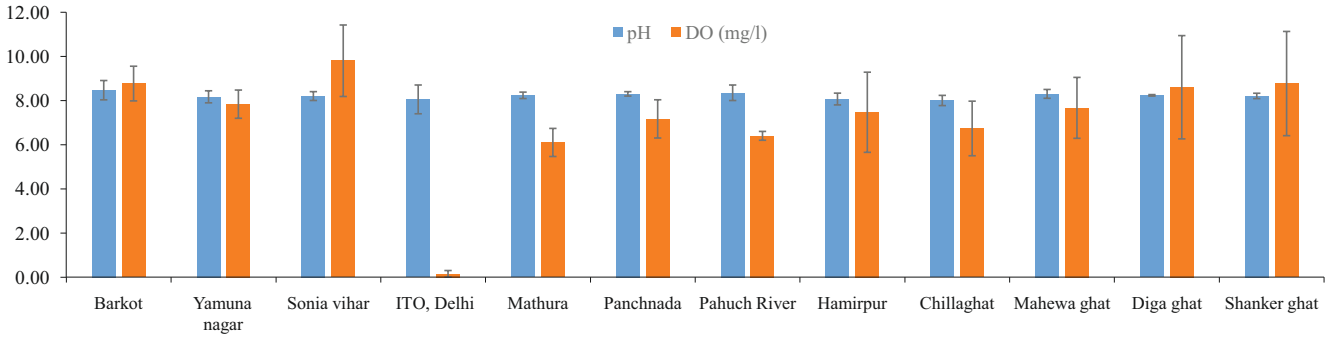
Summary

- Study showed improvement in the water quality in comparison to earlier study.
- A total of 195 plankton species belonging to 7 phyla were identified during the period. Upper zones of Yamuna river were dominated by diatoms while middle and lower were dominated by green algae.
- A total of 181 periphyton species belonging to 6 phyla were identified. 26 species of macrobenthos belonging to 9 orders and 15 families were documented.
- The only freshwater sinistral gastropod *Physa acuata* was found in Wazirabad site indicating inorganic pollution.
- Fish diversity in the river Yamuna was recorded as 124 species, belonging to 80 genera, 33 families and 13 orders.
- Eight exotic fish species were recorded. Exotics contributed more than 65% of the fish catch between Delhi to Chilla Ghat stretch of the river Yamuna.
- Estimated fish landing from Prayagraj stretch of the river Ganga-Yamuna was 141.16 t in 2023 with about 11.33 % share of exotic fishes.

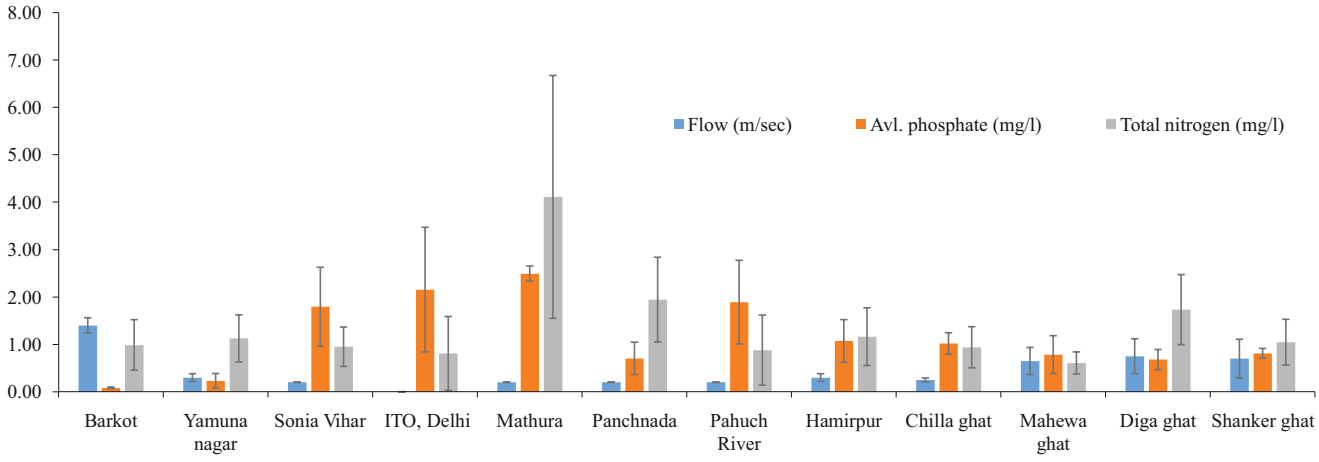
Physicochemical characteristics of water and sediment

Water temperature ranged from 8.40 - 35.6 °C with an average of 26.89 °C. The pH, specific conductivity, and TDS ranged from 7.40 – 9.00, 46 – 952 µS/cm, 22 - 1500 mg/l with mean values of 8.22, 402.26 µS/cm, and 242.06 mg/l, respectively. DO content ranged from BDL (at ITO, New Delhi) to 13.00 mg/l (Diha ghat). The average DO content at ITO, Delhi was 0.15 mg/l. Minimum water flow (BDL) was noticed at ITO, Delhi. The total alkalinity and hardness ranged from 28.00 - 314.00 mg/l and 52.00 - 256.00 mg/l, respectively. Nutrient parameters like available phosphate, total phosphate, nitrate and total nitrogen ranged from 0.01 – 3.47 mg/l, 0.10 – 5.71 mg/l, 0.03 – 3.14mg/l and 0.02-9.22mg/l with a mean value of 1.09 mg/l, 1.68 mg/l, 1.03mg/l and 1.39 mg/l, respectively. At Barkot, most of the water quality parameters were within the safe limit for drinking water purposes, suggesting that water is pristine in the hilly stretch of river Yamuna. Conductivity, TDS, turbidity, DO, DOM, COD were relatively higher at most of the sampling sites compared to Barkot, and the highest values of conductivity, TDS, turbidity, DO, DOM, COD were recorded at New Delhi (ITO) and Mathura region. Water is highly polluted at ITO, Delhi and Mathura region.

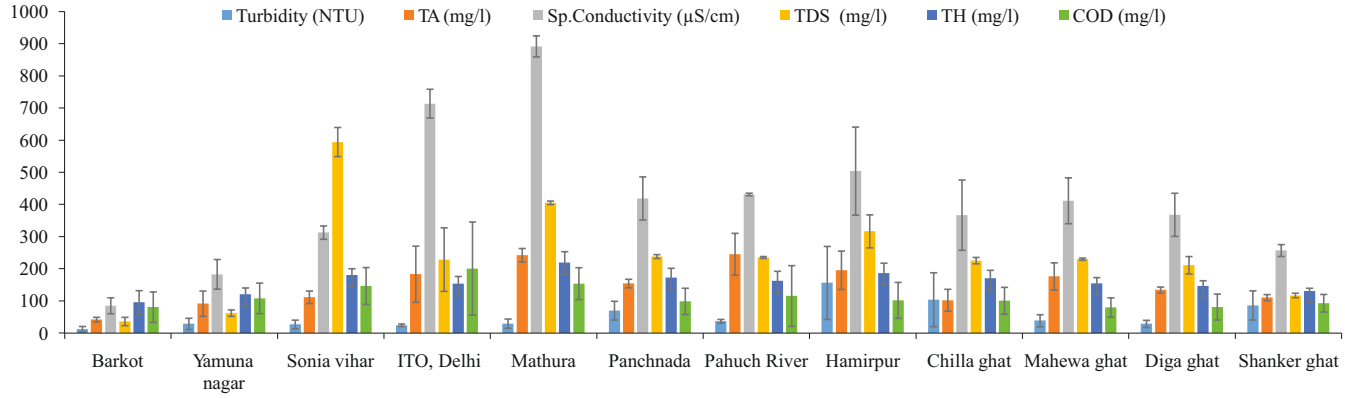
Sediment of Yamuna was alkaline in



Variations in pH and dissolved oxygen (DO) content across sampling stations of river Yamuna



Variations in flow, available phosphate and total nitrogen content of water across sampling stations of river Yamuna



Variations in turbidity, total alkalinity (TA), specific conductivity, total dissolved solid (TDS), total hardness (TH) and chemical oxygen demand (COD) across sampling station of river Yamuna

Table: Sampling station wise physicochemical characteristics of sediment of river Yamuna

	pH	Sp. Conductivity (µS/cm)	Sand (%)	Silt (%)	Clay (%)	Free $CaCO_3$ (%)	Organic Carbon (%)	Available Phosphate (mg P/100 g sediment)	Available nitrogen (mg N/100 g sediment)
Barkot	8.81±0.33	57.00±6.08	97.33±0.93	1.83±0.83	0.83±0.17	4.83±4.33	0.28±0.16	10.25±4.54	6.66±2.83
Yamuna Nagar	8.72±0.52	103.67±20.76	97.00±1.53	2.33±1.36	0.67±0.17	6.33±3.53	0.36±0.27	7.83±1.13	19.05±4.56
Sonia Vihar	8.32±0.42	352.00±86.40	97.50±1.26	1.50±0.76	1.00±0.50	6.25±3.91	0.35±0.12	11.95±2.91	19.35±4.73
ITO, Delhi	8.80±0.43	167.55±30.45	98.75±0.25	0.75±0.25	0.75±0.25	7.75±6.25	0.35±0.20	10.47±0.27	14.98±8.54
Mathura	8.38±0.39	285.67±22.92	97.50±0.58	1.67±0.44	0.83±0.17	6.75±5.65	0.27±0.06	17.53±3.91	21.48±1.67
Pauch river	9.30±0.16	163.55±44.45	82.5±5.00	17.25±4.75	0.75±0.25	16.75±12.2	0.21±0.06	5.37±1.23	17.08±0.84
Panchnada	8.57±0.33	237.20±57.15	74.67±12.77	20.67±11.28	4.33±1.92	3.43±0.89	0.43±0.05	11.41±5.58	15.97±5.15
Hamirpur	8.84±0.53	184.60±51.87	81.17±2.68	16.33±1.96	2.50±0.76	20.75±17.94	0.26±0.11	11.66±2.01	7.24±2.84
Chilla ghat	8.93±0.64	158.87±58.15	83.83±8.82	12.83±7.08	3.33±1.74	8.50±4.62	0.34±0.06	11.71±1.45	19.38±9.91
Mahewa ghat	9.00±0.60	152.33±43.95	85.83±6.34	11.50±5.27	2.67±1.30	6.67±1.86	0.28±0.18	20.28±11.83	15.05±8.76
Diga ghat	8.97±0.49	67.33±4.26	98.33±0.33	1.17±0.33	0.50±0.00	5.83±2.77	0.22±0.07	19.55±9.71	8.48±2.92
Shanker ghat	8.62±0.57	112.77±24.08	98.00±0.01	1.17±0.17	0.83±0.17	8.25±4.13	0.30±0.13	20.15±11.22	16.03±4.61

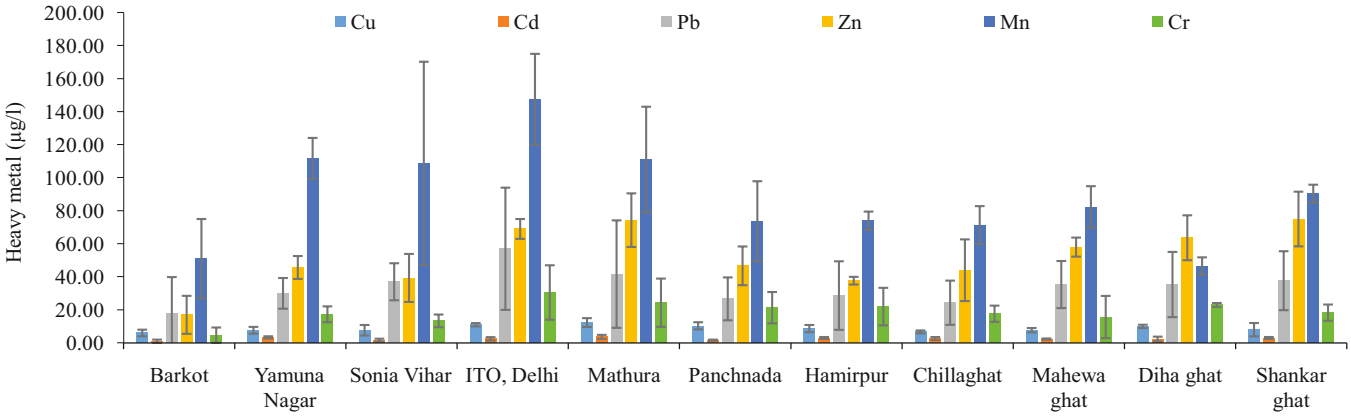
nature, having an average pH of 8.76. The sediment was dominated by sand (91.03 %) followed by silt (7.32 %), and clay (1.63 %). The average available phosphate and available nitrogen was 13.49 mg P/100g sediment and 15.01 mgN/100 g sediment respectively. Average free calcium carbonate and organic carbon content was 8.29 % and 0.31 % respectively.

Heavy metals in water, sediment and fish

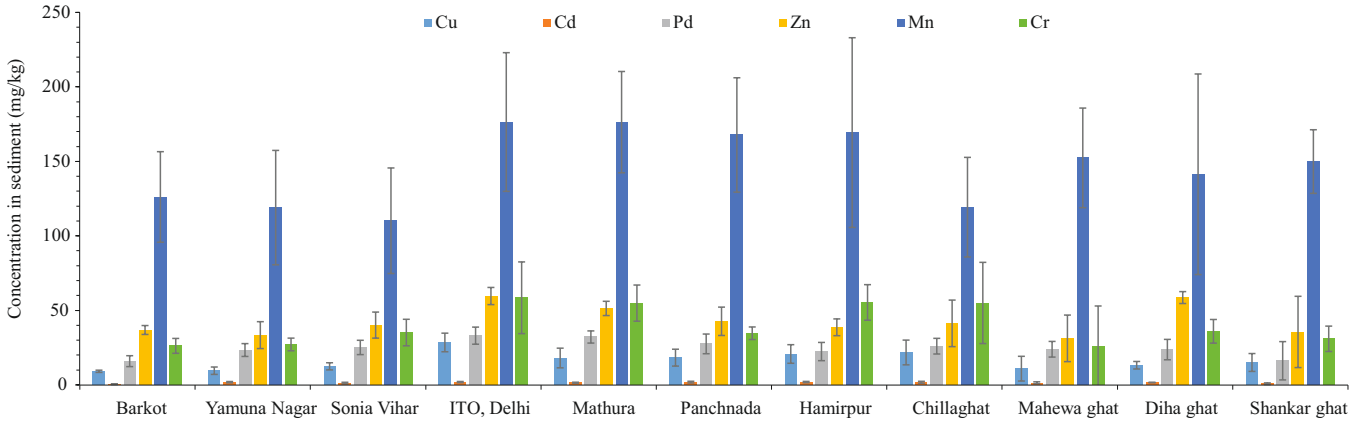
The average metal concentrations in water followed the order Mn (87.41 µg/l) > Zn (50.14µg/l) > Pb (32.31µg/l) > Cr (18.85µg/l) > Cu (8.65µg/l) and Cd (2.51µg/l). The concentrations of all metals in water were relatively higher at ITO, New Delhi and Mathura region. The concentration of Cd at all sampling sites (except at Barkot), Pb concentration at all sampling sites, Mn concentration at Yamuna Nagar, Sonia Vihar, ITO-Delhi, and Mathura exceeded the safe limit for drinking purposes (Indian Standard, 2012).

Metal concentrations in sediment followed the order Mn (149.86 mg/kg) > Zn (43.00 mg/kg) > Cr (40.51 mg/kg) > Pb (24.50 mg/kg) > Cu (16.59 mg/kg) and Cd (1.58 mg/kg). The concentrations of Cd and Pb in sediment were above the background values of 0.3 mg/kg and 20 mg/kg, respectively (earth shell crust value, Turekian and Wedepohl, 1961).

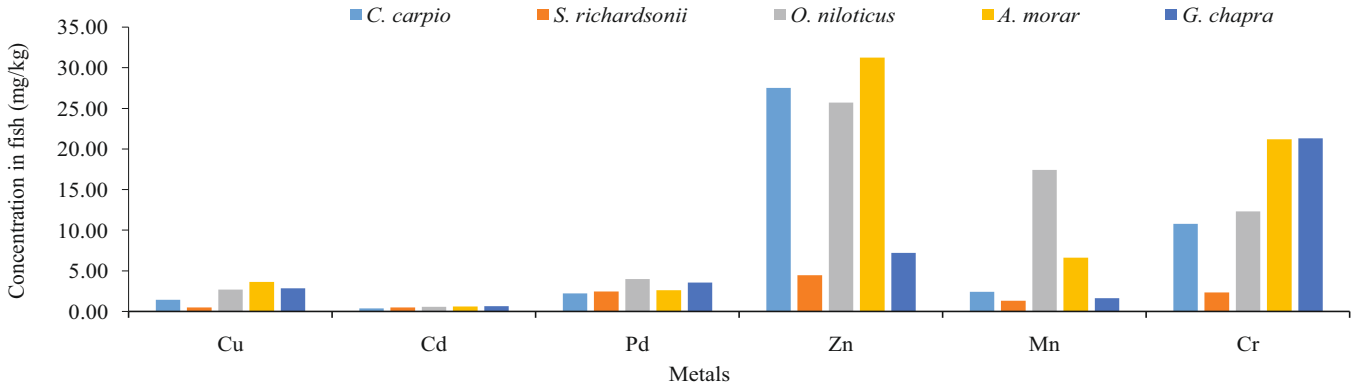
The mean concentration of Cu, Cd, Pb, Mn and Cr in *C. carpio* (n=4), *S. richardsoni* (n=4), *O. niloticus* (n=4), *A. morar* (n=4), and *G. chapra* (n=4) in the muscle tissue ranged from 0.48 – 3.62 mg/kg, 0.37 – 0.63 mg/kg, 2.20 – 3.96 mg/kg, 4.42 – 32.25 mg/kg, 1.28 – 17.41 mg/kg and 2.31 – 21.29 mg/kg, respectively. The concentrations of Cd, Pb and Cr in all studied fish were higher than the



Heavy metal concentrations in water of river Yamuna



Heavy metal concentrations in sediment of river Yamuna



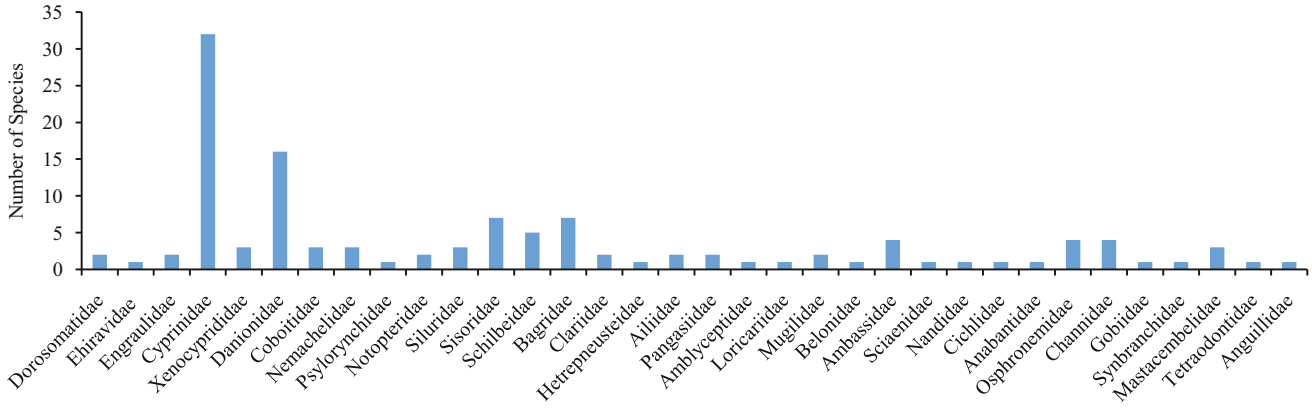
Heavy metal concentrations in fish of river Yamuna

recommended safe limit of 0.3 mg/kg for Cd, 0.50 mg/kg for Pb, and 12.00 mg/kg for Cr, (FSSAI, 2011; WHO, 1989).

Fish diversity

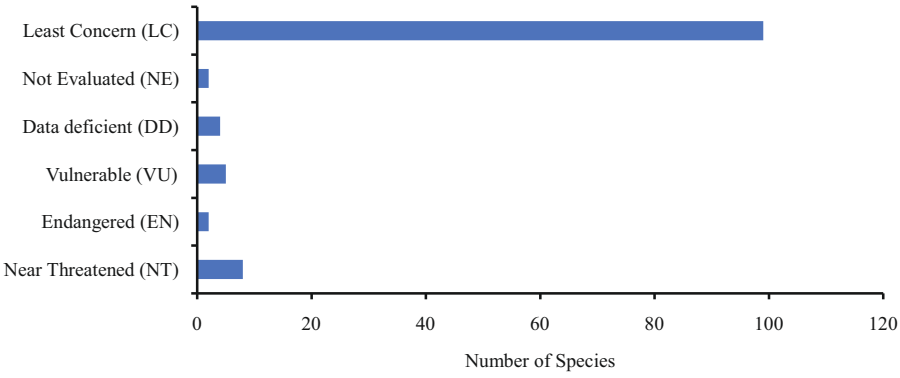
Fish diversity in the river Yamuna comprised of 122 fish species belonging to 13 orders, 34 families and 82 genera. Of these, 8 are exotics fish species *viz. Oreochromis niloticus, Cyprinus carpio, Clarias gariepinus, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis, Ctenopharyngodon idella, Pangasianodon hypophthalmus* and *Pterygoplichthys disjunctivus*. Fish species richness at Barkot, Yamuna Nagar, Delhi (Sonia Vihar), Mathura, Panchnada, Hamirpur, Chillaghat and Mahewa ghat, Diha ghat and Shankar ghat were 10, 94, 84, 67, 94, 91, 93,91,90 and 88, respectively.

As per IUCN red list, out of the 122 species recorded, 15 are threatened (Fig. 2). Two species, *Tor putitora* and *Clarias magur* are endangered (EN), 5 are vulnerable (*Naziritor chelynoides, Schizothorax richardsonii, S.esocinus, Wallago attu* and *Cyprinus carpio*) and 8 are Near threatened (*Anguilla bengalensis, Parambassis lala, Ompok bimaculatus, Ompok pabda, Ailia coila, Bagarius bagarius, Labeo pangusia*) requiring urgent attention for their conservation and maintenance of their habitat. The fishery in the Himalayan stretch is mainly contributed by the snow trouts (*Schizothorax plagiostomus*, *S. richardsonii*, *S. progastus* and *S. esocinus*). At the upper stretches of Yamuna Nagar fishery is mainly



Number of fish species in each family in river Yamuna

contributed by the Common carp, *Cyprinus carpio* (55%), followed by the medium carps (17%), miscellaneous group of fishes (15%), catfishes (12%), and mahseers (1%). The landing of mahseers showed a declining trend. In the middle and the lower stretches, fishery is mainly contributed by the Common carp. The catch composition analysis indicated that the earlier dominant Nile Tilapia has been partially replaced by the Common carp, *C. carpio*. The catch of Indian Major carp also showed a declining trend (<5%).



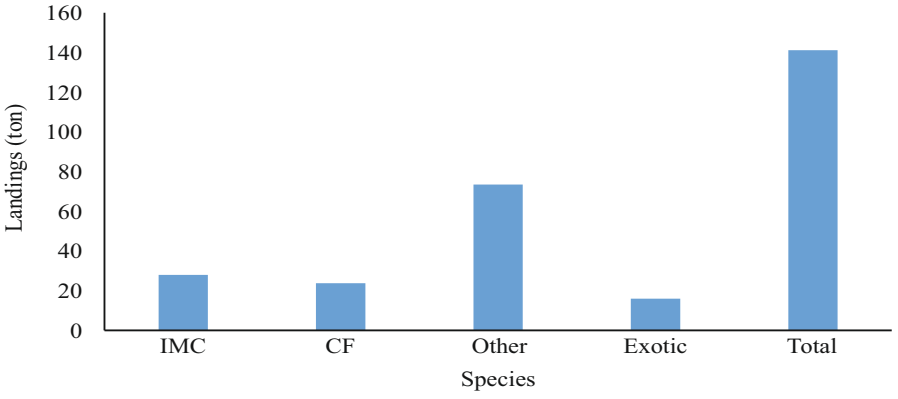
IUCN conservation status of fish species in the River Yamuna



A hill stream catfish *Pseudocheneis sulcata* recorded from the Himalayan stretch (Barkot) of the River Yamuna

Fish landing at Prayagraj

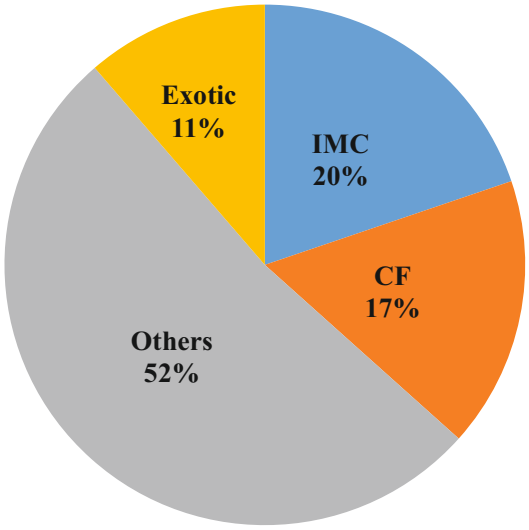
Estimated fish landing from Prayagraj stretch of the river Ganga was 141.16 tonnes during 2023 with about 11.33 % share of exotic fishes. In total fish catch miscellaneous groups dominated (52.04%), followed by Indian major carps, cat fishes and exotic fishes. Among the exotic fishes, common carp dominated over tilapia while Mrigal had maximum contribution than Rohu, Catla and Calbasu among IMC. There is an increase of about 34.24% in average fish landing in respect to previous year which could be attributed due to increase in fishing efforts linked to lockdown due to COVID-19 pandemic in 2022. Increase in share of IMC in total landing also has been observed with respect to previous years. This may be due to ranching effort by the institute in the river.



Fish landings at Prayagraj during 2023

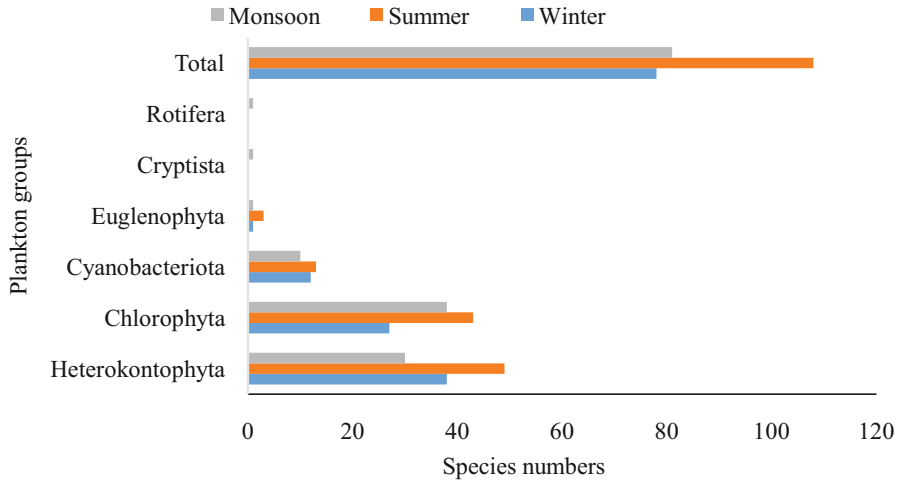
Plankton

A total of 182 plankton species were recorded in river Yamuna contributed by Heterokontophyta (diatoms), Chlorophyta (green algae), Cyanobacteriota (blue-green algae), Euglenophyta (euglenoids), Cryptista (cryptomonads) and Rotifera during winter, summer and monsoon seasons in 2023. Diatom was dominant in the winter and summer seasons while green algae was dominant in the monsoon season. Species richness of plankton varied greatly seasonally and spatially. The



Share of fish groups in total catch at Prayagraj during 2023

highest species richness was recorded at Hamirpur during winter, Chilla Ghat during summer, and Mathura during monsoon seasons. Similarly, the lowest species richness was recorded at Delhi during winter, Barkot during summer and Pachnada during monsoon seasons. Plankton abundance varied seasonally and spatially in river Yamuna. The abundance (u/l) ranged from 8.8 x 10^5 to 5.5 x 10^6 during winter, 6.12 x 10^5 to 9.15 x 10^6 during summer and 2.2 x 10^5 to 4.24 x 10^6 during the monsoon season. The highest abundance was recorded during the summer season while the lowest was recorded during the monsoon season.



Seasonal variations in plankton diversity in river Yamuna

Plankton biomass (Chlorophyll-a)

Plankton biomass can be calculated in terms of chlorophyll a. Chlorophyll-a (mg/m^3) ranged from 5.34 to 166.82 during winter, 7.34 to 166.57 during summer and 2.6 to 34.57 during monsoon season. The highest value of chlorophyll-a was recorded during the summer season while the lowest value was recorded during the monsoon season. The highest chlorophyll-a was recorded in the middle while lowest value recorded in upper stretches of river Yamuna.

Periphyton

A total of 170 species of periphyton were recorded from the river Yamuna during 2023. The periphytic species belonged to Heterokontophyta (diatoms), Chlorophyta (green algae), Cyanobacteriota (blue-green algae), Charophyta (desmids) and Euglenophyta (euglenoids). Periphyton was dominated by diatoms followed by green algae and blue-green algae. The highest species richness was recorded during summer followed by monsoon and winter seasons. The species richness of periphyton varied seasonally and spatially. The highest species richness was recorded at Chillaghat during the winter and summer seasons and at Madauka during the monsoon season. The lowest species richness was recorded at Delhi ITO during winter, at Shankarghat during summer and at Hamirpur during monsoon seasons. Periphyton abundance (u/cm^2) varied seasonally and spatially. Periphyton abundance ranged from 4.8 x 10^5 to 4.64 x 10^6 during winter season, 9.6 x 10^5 to 1.08 x 10^7 during summer and 1.2 x 10^5 to 1.87 x 10^7 during monsoon season. Periphytic abundance showed an increasing trend from upper to lower sampling places.

Diversity indices

Plankton

Plankton diversity varied seasonally and spatially. Simpson's index ranged from 0.8 to 0.92 during winter, 0.83 to 0.93 during summer and 0.43 to 0.91 during monsoon season. Shannon diversity index ranged from 2.09 to 2.75 during winter, 2.24 to 3.04 during summer and 0.90 to 2.95 during monsoon season. Diversity indices were low in the monsoon season and high in the summer season.

Periphyton

Periphyton diversity indices also varied greatly seasonally and spatially in the river Yamuna. Simpson's diversity index ranged from 0.72 to 0.91 during winter, 0.75 to 0.94 during summer and 0.41 to 0.93 during monsoon season. Similarly, the Shannon diversity index ranged from 1.47 to 2.54 during winter, 1.61 to 3.14 during summer and 0.60 to 3.00 during monsoon season. The diversity of periphyton was low in the monsoon season and high in the summer season.

Macrobenthic communities

A total of 26 species of macrobenthos communities (Mollusc 13 species, Bivalves 06 and Insects-07 species) belonging to 9 orders and 15 families were documented from the selected sites of river Yamuna. The higher abundance of the benthos was observed in summer season (20-900 N/m^2) followed by the winter season (20-720 N/m^2) and in monsoon season (10-650 N/m^2). The *Chironomous* larvae were observed at almost all sites downstream during winter season indicating organic pollution. The only freshwater sinistral gastropod *i.e. Physa acuata* were found in Wazirabad, Hamirpur and Pachnada site which mainly prefer polluted water and is an indicator of inorganic pollution. The insect component was dominant in upstream Barkot (*Polycentropus* sp., *Rhyacophila,* etc) which favours clear, cold & fast running water of streams and found associated with bottom sediments. In the downstream gastropods such as *Filopaludina bengalensis, Tarebia lineata* and bivalves *Corbicula striatella* were dominant during winter, 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 to March 2023

Scientific Personnel: B. K. Das (PI, w.e.f. 01.04.22); S. Dam Roy (PI, w.e.f. 01.04.20-31.03.22), Rosith,C. M., Lohith Kumar, T Nirupada Chanu (upto 31.03.22), H. Chowdhury (upto31.03.2021). Ajoy Saha (w.e.f. 01.04.22), P. J. Majhi (w.e.f. 01.04.22), Pranab Gogoi (w.e.f. 01.04.22)

Summary

- Leaf litter decomposition of major mangrove species from Indian Sundarbans indicates that *Avicennia* spp. (Half life: 86.63-115.5 days) showed higher decomposition rate with shorter half life as compare to *Rhizophora mucronata* (115.5-173.25 days) and *Ceriops tagal* (231 days).
- Sediment organic carbon (SOC) distribution indicates that the Indian Sundarban mangroves act as a natural C sink but can be a significant source of greenhouse gases, if the mangrove vegetation is not protected.
- Sundarban estuarine system demonstrated that the surface layer of sediment possessed higher metal contents than other layers indicating the freshly contamination by metals.
- Different geochemical fractions of phosphorus in the sediment cores collected from Indian Sundarbans followed the order: Ca-P > Org- P > Fe-P > Al-P > Ex-P.
- Small-bodied copepod showed dominance over the large-bodied copepods in the Sundarban estuarine system. The dominance of herbivory zooplankton (~57%) in the mangrove dominated sites indicating maximum utilization of trophic energy of the strata.

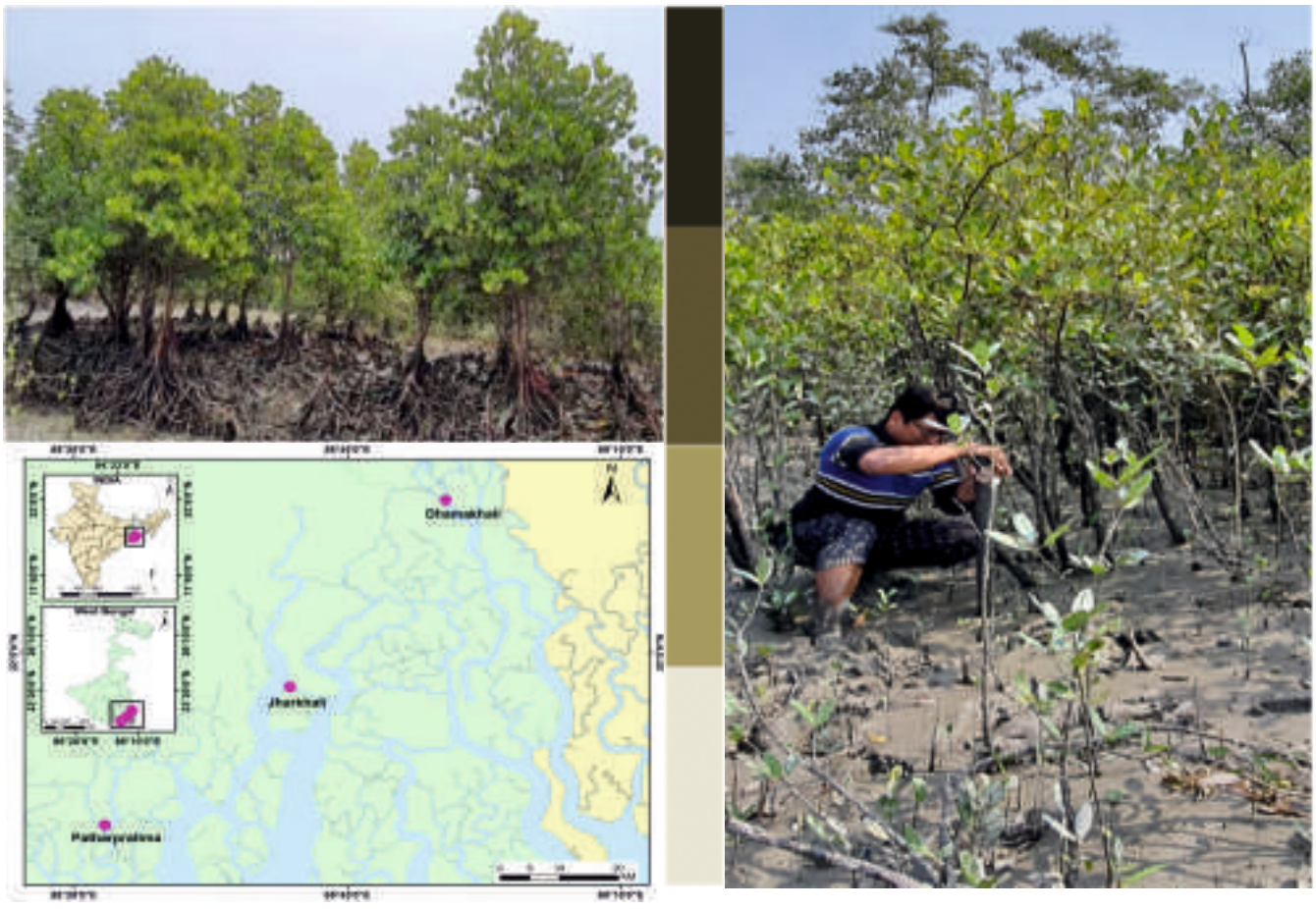
Mangrove litter decomposition

Surveys were conducted at Jharkhali, Dhamakhali and Patharpratima stations of Indian Sundarbans eco-region on environmental parameters, mangroves and other biota. In order to understand the potential of mangrove leaf litter in supplying nutrients and carbon in coastal ecosystem, decomposition of mangrove leaf litter through a 120 day laboratory incubation study was carried out. Regression analyses resulted in decomposition rates (k) which was estimated as 0.006 day^{-1} in *Avicennia officinalis*, 0.006-0.008 day^{-1} in *Avicennia alba*, 0.004-0.005 day^{-1} in *Rhizophora mucronata* and 0.003 $days^{-1}$ in *Ceriops tagal* indicating slower decopmsoiton rate. Half life value i.e. the time needed until half of the litter is degraded was calculated and values were 115.5 days for *Avicennia officinalis*, 86.63-115.5 days for *Avicennia alba*, 115.5-173.25 days for *Rhizophora mucronata* and 231 days for *Ceriops tagal*.

Core sediment collected from different stations were analyzed for sediment physicochemical analysis and to determine phosphorus speciation, carbon fractionation and metal content. Sediment pH, specific conductivity (EC) were obtained in different profiles in three sampling stations. The lower pH with increasing sediment depth attributed to release of low molecular weight organic acids through decomposition of root material and/or oxidation of sulfide minerals. Comparatively lower pH value in Jharkhali sediment was attributed to the more dense mangroves. EC values were decreasing with increasing sediment

Table : Decomposition rate (k) and half-life of leaf litter of the investigated mangrove species

Plants	Jharkhali		Dhamakhali		Patharpratima	
	Decay constant (k, day^{-1})	$t_{1/2}$ (days)	Decay constant (k, day^{-1})	$t_{1/2}$ (days)	Decay constant (k, day^{-1})	$t_{1/2}$ (days)
Avicennia officinalis	0.006	115.5	0.006	115.5	0.006	115.5
Avicennia alba	0.006	115.5	0.008	86.625	0.007	99
Rhizophora mucronata	0.004	173.25	0.004	115.5	0.005	138.6
Ceriops tagal					0.003	231

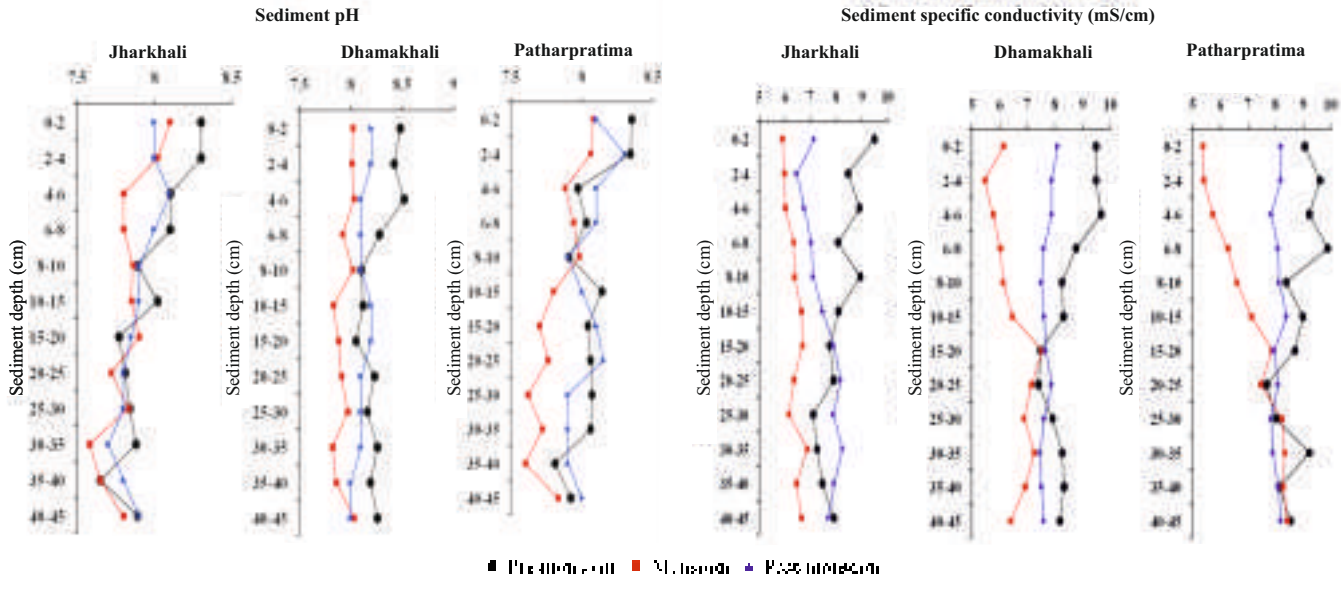


Map of the study area and sampling points at Indian Sundarbans and collection of sediment depth profile

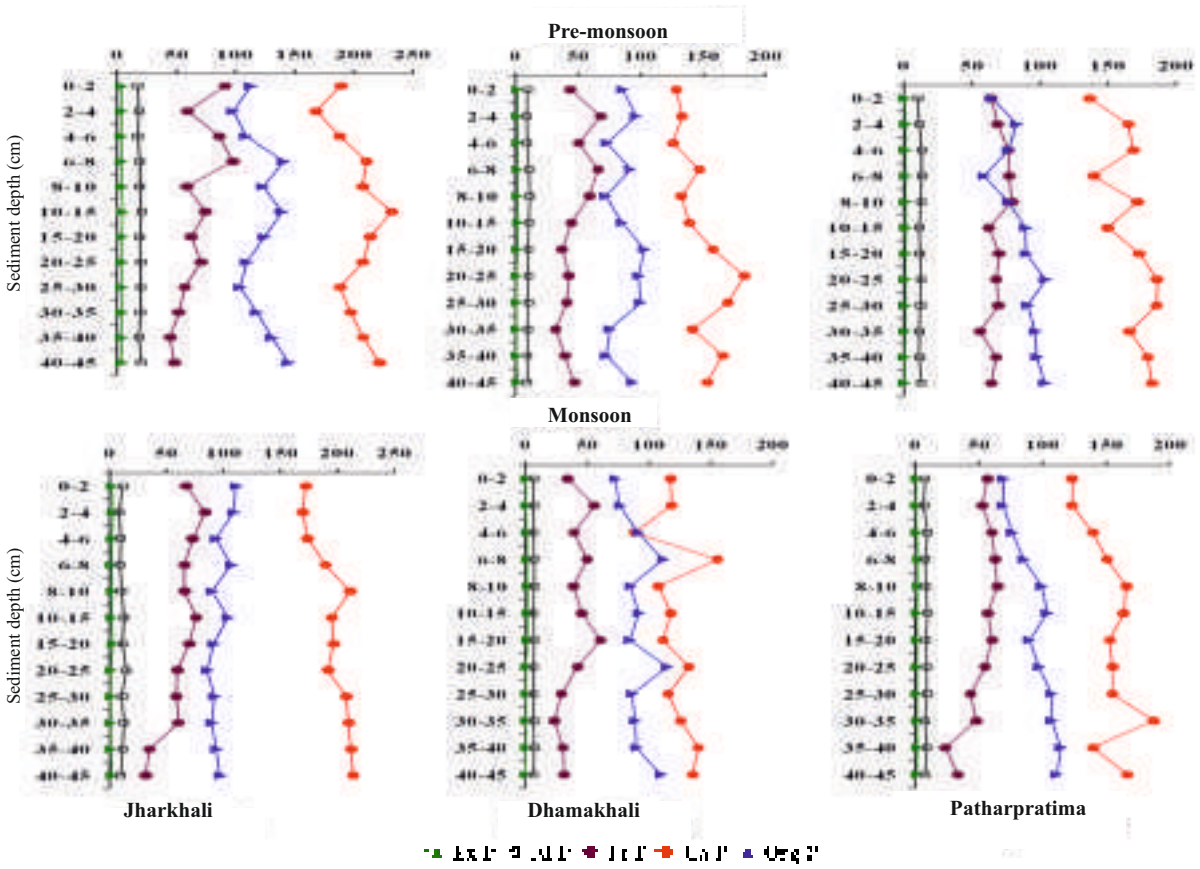
depth in non-monsoon season while EC in the surface sediment was lower during monsoon season due to freshwater influence. Sediment was dominated by silt, followed by clay and sand.

P. fractions in the sediment core

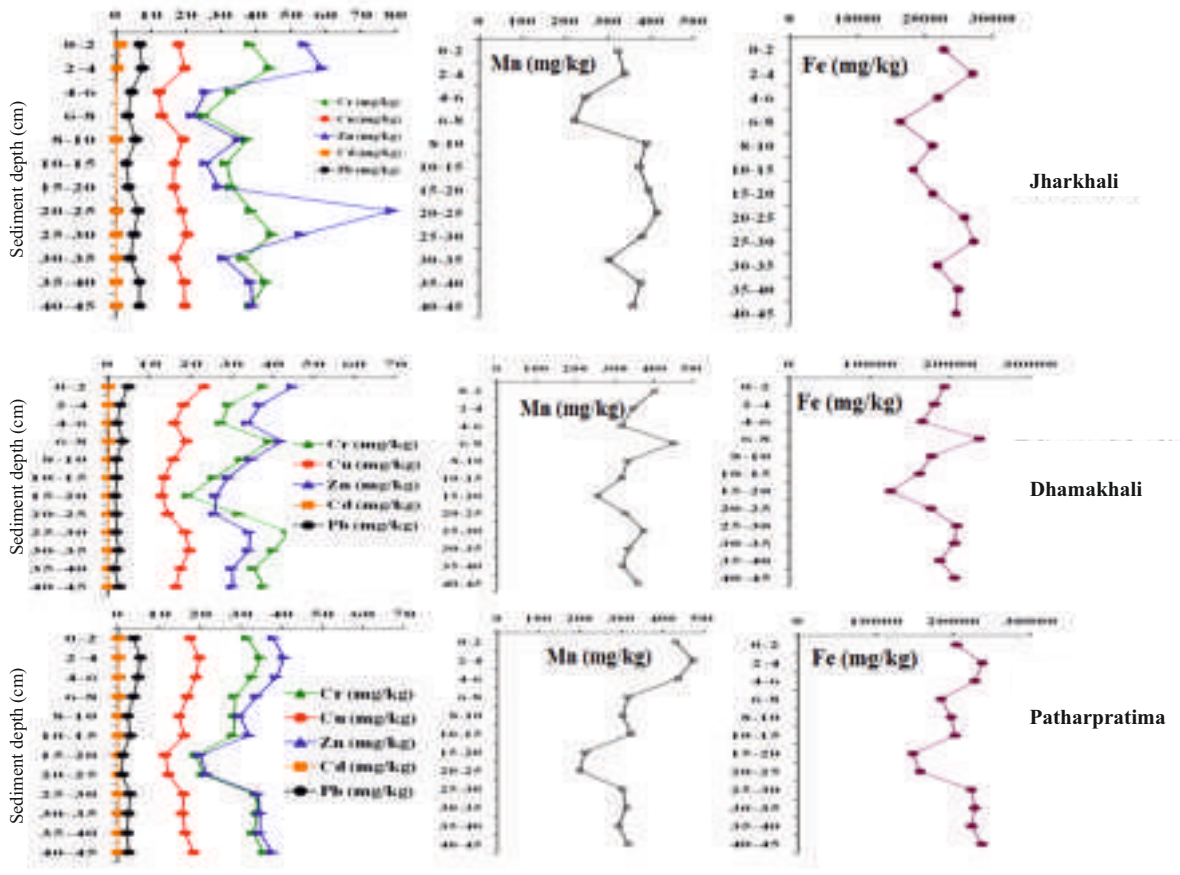
Different geochemical fractions [exchangeable (Ex-P), aluminium bound (Al-P), iron bound (Fe-P), calcium bound (Ca-P), and organic bound phosphorus (Org-P)] of phosphorus in the core sediments were studied to understand the biogeochemical cycling and bioavailability of phosphorus in the mangrove sediments. The total



pH and specific conductivity in sediment profiles of the three sampling stations in the Indian Sundarbans mangrove environment

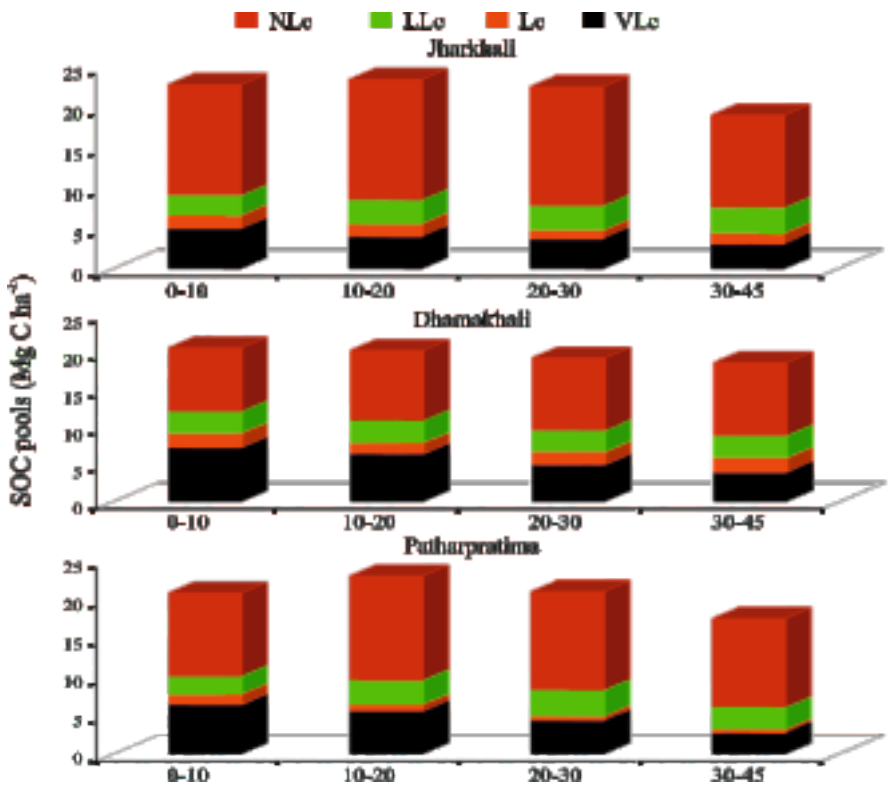


Depth-wise concentration of phosphorus (mg/kg) species in sediment of Indian Sundarbans



Metal concentrations in the core sediment of Indian Sundarbans

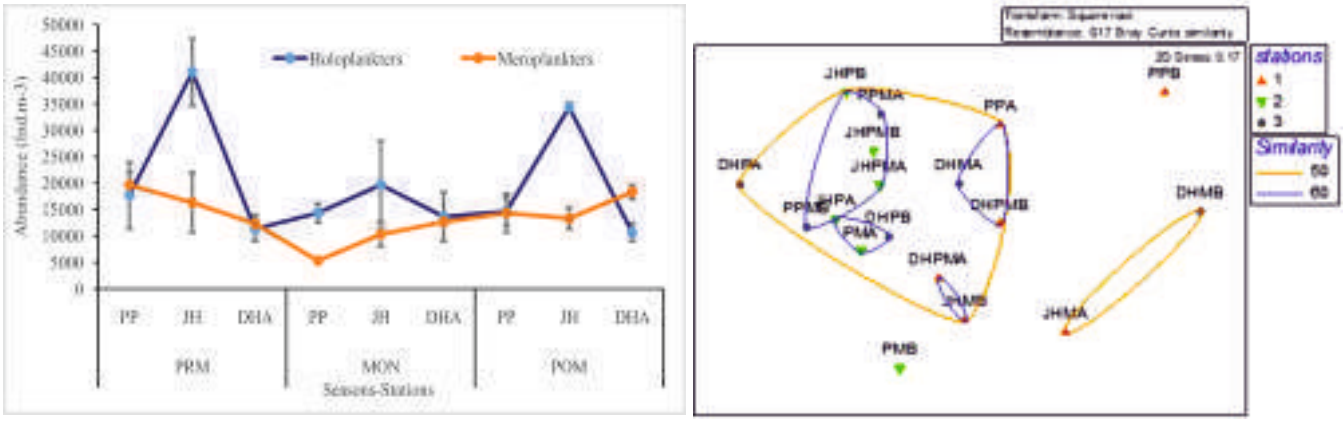
sedimentary P in the cores varied between 227.2-473.0 mg/kg. The average concentration of respective P fractions in the three cores collected from Indian Sundarbans followed the order: Ca-P > Org- P > Fe-P > Al-P > Ex-P. Jharkhali sediment contains maximum total P which may be due to the comparative pristine nature and mangrove preserve more P. Fe-P fraction decreased with depth which implies that the sedimentary redox conditions regulate the adsorption of phosphate onto Fe-oxides/ hydroxides. Ca-P increased with depth which may be due to post-depositional transformation from Fe-P and Org-P into Ca-P. However, total phosphorus content was less than 600 mg/kg which is the minimum level to show any potential ecological risk. Bioavailable phosphorus (BAP) accounted for more than 50% of total P which showes that mangrove sediments act as an important internal nutrient source of phosphorus for coastal eutrophication.



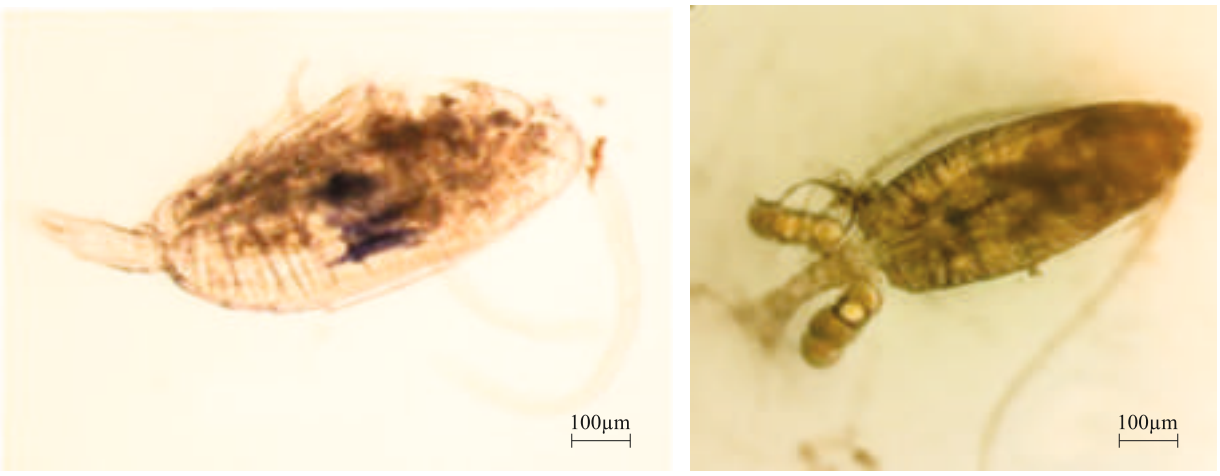
Variations in soil organic carbon fractions among different stations of Indian Sundarbans. (VLc-very labile carbon, Lc-labile carbon, LLc- less labile carbon, NLc-non-labile carbon concentrations)

Trace metals in sediment core

Sediment cores were also subjected to various geochemical analyses to determine concentration of selected metals *viz.*, Cr, Mn, Fe, Cu, Zn, Cd and Pb. The trace metal concentration in the surface sediments was higher and decreased with depth in the vertical profile. Heavy metals concentrations in sediment core varied in the range: Cr (19.0- 44.8 mg/kg), Mn (199.7 - 474.5 mg/kg), Fe (12580.0 - 27190.0 mg/kg), Cu (11.5 - 23.4 mg/kg), Zn (20.2 - 78.8 mg/kg), Cd (BDL - 1.3 mg/kg) and Pb (1.0 - 7.5 mg/kg). Samples from the Patharpratima were found to be enriched with metals may be due to more human intervention. On the other hand, the sediment core collected from Jharkhali and Dhmakhali showed relatively lower concentrations of metals probably due to flushing and dilution by the river influx and tidal actions. Fe and Mn showed synchronous distribution with depth in the core reflecting similarity in their redox behaviours. The higher concentration of some of the trace metals in the lower part of the cores indicated lithogenic input. Further, based on the sediment metal indices, the sites can be categorized to show less pollution with all the metals analyzed.



Station-wise abundance of holo and meroplankters in different seasons (left) and similarity pattern of zooplankton compositions (right); 1: Patharpratima; 2: Jharkhali; 3: Dhamakhali



Bestiolina similis *Pseudodiaptomus annadalei*

Small (left) and large (right) copepods

Variabilities in carbon fractions

To investigate the role of Sundarbans mangroves in climate change mitigation, particularly for sustainable mangrove management various C pools, *viz*., very labile (VLc), labile (Lc), less labile (LLc), non-labile (NLc) fractions were measured To address this, sediment depth profiles (0–10 cm, 10–20 cm, 20–30 cm and 30–45 cm) were sampled from Jharkhali, Dhamakhali and Patharpratima stations of the Indian Sundarbans. Results showed that the mean value of Sediment organic carbon (SOC) in all the stations and seasons decreases with depth. The highest total sediment carbon stock was found in Dhamakhali, which is under constant anthropogenic pressure. A substantial quantity of carbon is predominantly associated with the non-labile carbon, since most of the C is stored as resistant pools in mangrove sediment. Thus, this carbon fraction is sequestered into the sediment of the Indian Sundarbans. Overall, the Indian Sundarbans mangroves act as a natural C sink but can be a significant source of greenhouse gases, if the mangrove vegetation is not protected.

Zooplankton assemblages

A total of 46 zooplankton taxa were recorded from the mangrove-dominated sites (Jharkhali, Dhamakhali and Patharpratima) of the Sundarbans with Copepoda (42%) dominating the community. The small-bodied copepods *viz. Oithona* spp. and *Bestiolina similis* attributed their maximum abundance across seasons and showed dominance over the large-bodied copepods. The abundance of holoplankters was highest in Jharkhali during the pre-monsoon (41000±6133 Ind./m^3). However, abundance of meroplankters was maximum at Patharpratima (19666±6100 Ind./m^3). The quantitative spectrum of total zooplankton ranged from 17321 – 56400 Ind./m^3. The dominance of herbivory zooplankton (57%) in the mangrove dominated sites may be a good indication of maximum utilization of trophic energy of the strata. Non-metric dimensional scaling (NMDS) portrayed overall 38% similarity of zooplankton assemblage between the stations. The significant heterogeneity in zooplankton composition between the stations (p>0.05) is mainly due to the variations in density and diversity of mangrove stands across sites, hydrological characteristics and, human induced anthropogenic interference particularly at Dhamakhali. Copepod species such as *Oithona rigida, O. similis, Bestiolina similis, Paracalanus parvus, Acartia spinicauda, Pseudodiaptomus serricaudatus* which are depicted as indicator taxa (Dufrene and Legendre, 1997) *IndVal* of ≥25% across stations indicated partially impacted sites by anthropogenic and climatic variables. The ecological guilds of coepods (feeding), carnivory was negatively correlated with water temperature. However, the detritivores were associated with transparency, salinity and pH and omnivory with DO.

Benthic assemblages

Four functional groups of macro benthos *viz.,* Scrappers/Shredders (SC/SH), Filter collectors (FC), Collector gathers (GC) and Detrital Shredders (DSH) were recorded comprising 24 taxa in the mangrove dominated sites of Sundarbans. Of the 24 taxa, species *Nerita articulata* (18%), *Pirinella cingulata* (16%), *Littorina melanostoma* (14.5%), *L. scabra* (9%) were the major contributors to the total macrobenthic assemblages at sites of mangrove stands (*Avicenia marina. A. alba, Ceriops tagal* and *Argicerops corniculatum*). The association of the *L. melanostoma* and mangrove species *A. marina* was maximum as compared to the other mangrove species across seasons. Species *Nerita articulata* was found to have lower abundance (2 – 32 nos./ tree), irrespective of specific association of

mangrove species at a height of <1.0 m. The association of these macrobenthos can be attributed to the acceptance and availability of planktonic foods attached in these mangrove trees after high tides (leaf, smooth tree trunk, roots) which favours their attachment. Overall, the mean macrobenthic abundance was maximum during pre-monsoon (885 nos./m^2) followed by monsoon season (336 nos./m^2).

a)



b)



Association of *Nerita articulata* (a) *L. melanostoma* (b) with mangrove species *Avicenia alba* and *Ceriops tagal*, respectively.

Reservoir and Wetland Fisheries



वार्षिक प्रतिवेदन

Annual Report

2023

Reservoir and Wetland Fisheries

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

Principal Investigator: U. K. Sarkar (up to 19.10.2022), A. K. Das (since 20.10.2022)

Sub-project 1: Understanding spatio-temporal variations of large reservoir ecosystems (Hirakud, Panam and 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 and Sunei) in different ecoregions

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

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

Duration: April 2020 to March 2024

Scientific Personnel: A. K. Das (Sub-project Leader), Canciyal Johnson (upto 31.03.22; since 01.04.23), Deepa Sudheesan, T. T. Paul, Anand Meiti (upto 31.03.22), Vaishakh G. (upto 31.03.23), Satish Koushlesh (w.e.f. 01.04.22), Sajina A. M. (w.e.f. 01.04.23)

Summary

- A total of 68 fish species under 17 families and 9 orders were recorded from the commercial catches in Hirakud reservoir. Economically important indigenous fish catch groups include carps, catfishes, freshwater eels, *etc.*
- Carps contributed around 38.4% of the fish catches while catfishes contributed to the tune of 27.3% of the fish catch of Hirakud reservoir
- Catch per unit effort (CPUE) in Hirakud reservoir ranged from 1.5-28.4 kg/day/fisher for gill net fishing fleet while it was 90-200 kg/day for drag nets
- Study recorded a total of 41 fish and 2 prawn species from Panam reservoir. Fish catch was dominated by *Labeo rohita, Sperata seenghala, Oreochromis niloticus, Notopterus notopterus, Systomus sarana, Wallago attu* and *Labeo calbasu*
- Study conducted in Panam reservoir revealed the recent establishment of exotic Nile Tilapia (*Oreochromis niloticus*) in this reservoir
- Analysis indicated predominance of exotics in Idukki reservoir to the tune of 40% and above, followed by murrels as indigenous group
- Ecopath model of Idukki reservoir has been constructed for sustainable fisheries management

Panam Reservoir

It is one of the six large reservoirs located in Panch Mahal District of Gujarat, and is the only large reservoir in the district which is given importance towards fisheries development besides other purposes of reservoirs.

Fisheries and ecological status

A total of 41 fish and 2 prawn species were recorded from the reservoir during the study period. The major landing fishes in quantity were *Labeo rohita, Sperata seenghala, Oreochromis niloticus, Notopterus notopterus, Systomus sarana, Wallago attu* and *Labeo calbasu.* There are plenty of SIFs such as *Puntius* spp, *Pethia* spp, *Rasbora* spp, *Chanda nama, Parambassis* spp, *Macrognathus puncalus, Glossogobius giuris, Channa punctata* etc, which are not caught or utilized for nutritional security of riparian population. The physico-



Sampling work in Panam Reservoir

chemical and habitat parameters indicated congenial environment in the reservoir for good fish production, as evidenced by the large-sized fishes caught from the reservoir. CBF is being practiced in the reservoir, with stocking of IMCs carried out by the State Department of Fisheries through PFCs. There was a disruption in stocking during 2020 to 2022 and it has been resumed in 2023 by stocking 9,42,000 fingerlings of rohu and mrigal.

A total of 25 phytoplankton genera under 9 classes and 4 zooplankton genera were recorded during the study period. Bacillariophyceae formed the major phytoplankton class with six genera followed by Cyanophyceae (four genera) and Dinophyceae (three genera). The mean annual gross productivity (GPP) of Panam reservoir estimated as 155.8 mg/m^3/hour. Based on the Morpho-edaphic index (MEI=28.48) the estimated annual yield was estimated as 103.63 kg/ha. The actual yield from the reservoir was estimated as 18.26 kg/ha, depicting the scope of further enhancement in production.

Invasion of Exotics

The study conducted in Panam reservoir revealed the recent establishment of exotic Nile Tilapia (*Oreochromis niloticus*) in the reservoir. Unlike in case of most Indian reservoirs, this is the first case of invasion of an exotic fish species in Panam reservoir. The pathway analysis of invasion indicated towards unintentional introduction of the species through accidental escape from cage culture practiced in the reservoir. The cage system was installed in reservoir in 2018 and the major accidental loss of entire stocked fish happened in 2019. Until 2022, the species was only caught as some random specimens in the catch and the occurrence of the species became evident in catch yet contributed less than 5% of catch. In 2023, the fish catch analysis showed that the species has emerged as the third major landed fish after the stocked fish rohu (*Labeo rohita*) and the native self-recruiting species Singhari (*Sperata seenghala*) harvested from the reservoir system contributing more than 20% of the catch within a span of four years of entry into the system. Though, pangas (*Pangasionodon hypophthalmus*), another exotic species popularly used in cage culture, also got accidental entry to the reservoir along with Tilapia, the species did not establish a population in the reservoir and has not been recorded in fish landings.

Socio-economics of fisherfolks

There is a total of 52 villages in the



The recently established exotic Nile Tilapia in Panam reservoir

riparian zone of Panam reservoir and among these six major fishing villages in the proximity of dam site and other major landing places are Dazer, Vagoi, Hareda, Kaid, Nasirpur and Gugadiya. The fishers of the reservoir mainly belonged to Nayaka caste, which comes under the Scheduled Tribe category who traditionally do farming in hills. They often involve women and children in fishing and most important fishing gear is gill net and cast netting in the marginal areas. Most of the fishers are illiterate and a few young fishers are educated to primary level. One or two buyers come to the landing place and collect fish from the fishers. The domestic consumption of fish by the fisher families are relatively less, around twice per month. There exist two primary fisheries co-operative societies for Panam reservoir and one of them, The Panam Jalashay Hareda Matsya Uchher Sahakari Mandli Ltd. is functional at present as it has taken up the reservoir on lease. Due to the relatively high leasing amount and lack of expertise of local fishers, the Society is hiring migrant fishers from other states, mostly Bihar for fishing in the reservoir. Among the fishes caught, murrel, *Channa marulius* is the most priced fish, which fetches around ₹ 400 per kg, followed by Catla and Singhadi (*S. seengala*) (₹ 300/kg). Spiny eel, *M. armatus* price around ₹ 150/kg and Rohu fetches around ₹ 100 and other minor carps like *Systomus sarana* fetch only ₹ 20-30/kg.

Lack of interest and fishing skills of the riparian tribal farming population who carry out fishing as a part time occupation, lead to poor fishing effort. The relatively low catch and lower market price of fish and relatively high lease amount of reservoir cause constant conflicts between state administration and fisher folks. The pristine and unpolluted catchments, habitat supporting breeding of self-recruiting species including commercially important ones, network of approach roads for accessibility are the positive aspects. There is great scope for developing this highly productive reservoir for playing vital role in providing food and nutritional security of vast catchment and adjacent region through interventions in stocking and management policies, leasing system and market structure, enclosure culture popularization with skill development, etc.



A three-member fisher family involved in fishing in Panam reservoir

Hirakud reservoir

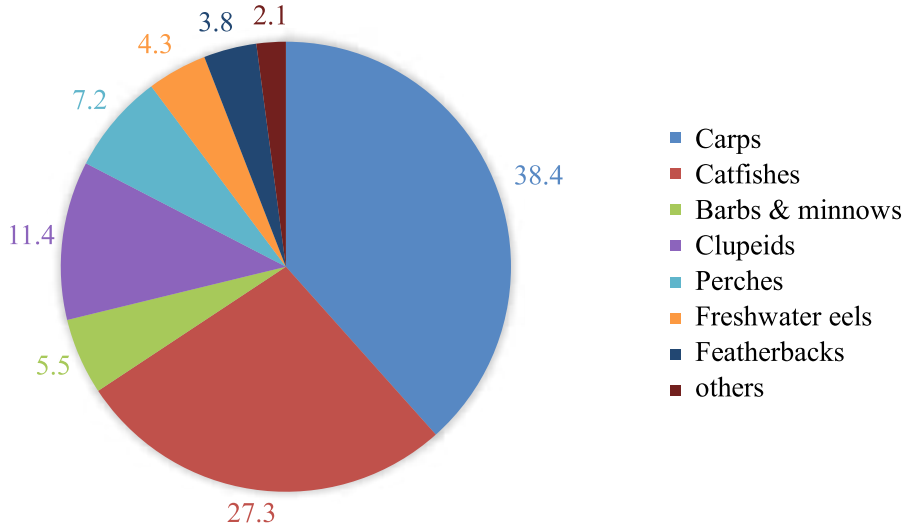
Hirakud Dam built on Mahanadi River is the longest dam in India with a 4.8 km main dam and a total length of 25.8 km with dam and dykes taken together. It is situated in Sambalpur, Jharsuguda, and Bargarh districts of Odisha on river Mahanadi. It has a water spread area of 74,592 ha, catchment area of 83,395 km^2 and shoreline of 643.60 km. The reservoir serves the irrigation needs of 2,64,038 ha of land and is a major resource for fish production. About 5000 fishermen families are dependent on this reservoir for their livelihood. The fishing right of the reservoir was conferred on the state fisheries department in as early as 1960 and leasing right was entrusted with the fishery department by the revenue department for commercial exploitation. Seasonal sampling was carried out at five sampling points namely, Jarimuli (Tamdei), Birenbandh, Kurla, Mahamadpur and Zeropoint (Durrakusum) in pre-monsoon, monsoon and post-monsoon season.

Limnology and fisheries

The transparency of reservoir water measured via Sechhi depth ranged from 16.0-201.5 cm, pH ranged from 7.1 – 8.6 with an average of 7.9, which is slightly alkaline. The average DO value was found to be 6.9 mg/l, average total alkalinity was 80.4 mg/l, average specific conductivity was 201.2 µS/cm and total dissolved solids (TDS) was 146 mg/l. The average nutrient contents nitrate-N and total phosphorus were found to be 0.01 and 0.042 mg/l respectively indicating moderate productivity of the reservoir. The gross primary productivity of Hirakud reservoir was estimated at 146.25 $mgC/m^3/hr$ while the net primary productivity was 77.4 $mgC/m^3/hr$. Dominance of Cyanophyceae was observed in the reservoir during post-monsoon season. The trophic state index showed that the reservoir varied from oligotrophic to mesotrophic state. The annual potential fish yield based on MEI (Sugunan, 2002) was found

to be more than 70 kg/ha which was found to be in proximity with the previous estimate (72.04 kg/ha in year 2021; 76 kg/ha in 2022). The primary reason for the slight variation in the estimates were variation in the depth measurements recorded during the study period.

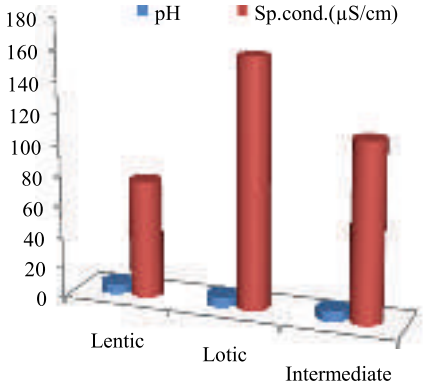
The Catch Per Unit Effort (CPUE) varied from 1.5 to 28.4 kg/day per fisher for gill net fishing, and it was between 90 and 200 kg/day for drag nets. In the lotic zone of the reservoir, especially during monsoon season, hooks and lines were used with observed CPUE that fluctuated between 0.15 and 0.45 kg/hr. Catfishes made up approximately 27.3% of the fish caught, while carps, including Indian Major Carps (IMC), accounted for about 38.4% of the fish catch in the Hirakud reservoir. A slight increase in the carp while a slight decline in the catfish landing was recorded than previous years; however the inter-annual variation of these fishes were also noted in previous studies in many peninsular reservoirs. There were no changes in the cumulative fish diversity recorded from commercial catches in the Hirakud reservoir, which comprised a total of 68 fish species from 18 families and 8 orders, which is significantly more than the 54 species reported in earlier studies. The indigenous species included carps, catfishes, freshwater eels, among others. Exotic species recorded from the reservoir included *Oreochromis niloticus, Clarias gariepinus*, *Pangasianodon hypophthalmus*, *Hypophthalmichthys molitrix*, *H. nobilis*, *Cyprinus carpio*, and *Pterygoplichthys disjunctivus*.



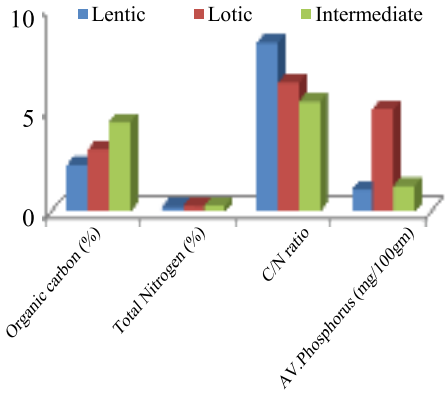
Fish catch composition of Hirakud reservoir



Fishing in Hirakud reservoir



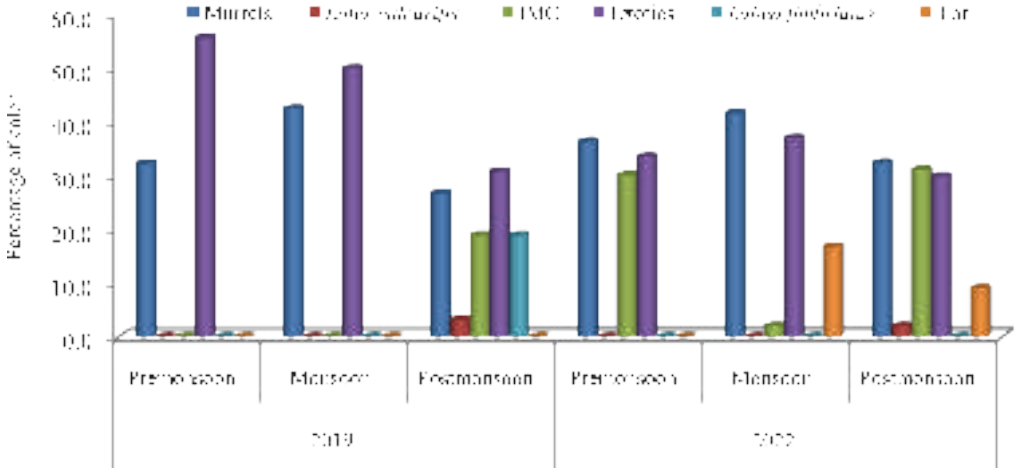
Zone-wise physical variables of soil



Zone-wise chemical variables of soil

Idukki reservoir

The specific conductivity of soil increased from lentic (76.56 µS/cm) to intermediate (115.2 µS/cm) to lotic (160.46 µS/cm) zones. This is indicative of low available nutrients and organic matter levels which are often found in sandy soils. The gradient in specific conductivity is negatively related to gradient in percent of sand in soil. Relatively higher soil organic carbon (4.4%) in intermediate zone indicates deposition of organic matter in the zone. Elevated level of Phosphorus in lotic zone may be due to allochthonous nutrient influx from river discharges leading to planktonic bloom and turbid water. The organic carbon was found higher during post-monsoon season due to decaying natural organic matter (e.g. plants and other vegetation), microbiological activity, and other processes related to plant and animal life.



The analysis indicated predominance of exotics in the reservoir to the tune of 40% and above followed by murrels as indigenous fishes. Ecopath model was constructed for sustainable management in fisheries in Idukki reservoir.

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

Duration: April 2020 to March 2023

Scientific Personnel: Sajina A. M. (w.e.f. 01.04.22); M. A. Hassan (01.04.20-31.03.22), T. Tayung (upto 05.10.21), M. Karthikeyan, Ramya V. L., Dipesh Debnath, S.C.S. Das, Satish Koushlesh, Preetha Panikkar, Ajoy Saha, Jesna P. K. (w.e.f. 01.04.22)

Summary

- Studies carried out in three medium reservoirs, viz. Kodar reservoir of Chattisgarh, Poondi of Tamil Nadu and Serlui-B of Mizoram, indicated towards the need for strengthening of CBF management of medium reservoirs with proper stocking of IMC and commercially important indigenous species fingerlings in ideal stocking density as per the carrying capacity of reservoir.
- The commercial catch of Poondi reservoir is dominated by Cichlids, mainly *Oreochromis niloticus* (92%). A total of 47 species belonging to 17 families and 7 orders were reported from the reservoir with significant difference in spatio-temporal fish diversity and distribution.
- Seasonal succession in plankton abundance and diversity was prominent in Poondi reservoir. A total of 55 phytoplankton and 11 zooplankton genera were recorded with higher abundance observed at the cage site during all the seasons with peak during summer. The algal genus pollution index less than 20 indicating less organic pollution both spatially and temporally. Significant correlation was observed between plankton abundance and abiotic parameters such as dissolved oxygen, NO_3-N, PO_4-P, Chlorophyll-a and water temperature.
- Forty six fish species were recorded from Serlui-B reservoir, Mizoram belonging to 6 orders, 18 families and 35 genus.
- Recommendations for sustainable fisheries management of Serlui-B reservoir have been formulated: (i) Increasing lease period from one year to 5 years; (ii) Banning destructive fishing methods such as dynamite and electric fishing; (iii) Adoption of cage culture following scientific protocols; (v) Controlling infestation and profuse growth of *Eichhornia crassipes*; (vi) Training of departmental officers and fishers of Mizoram on reservoir fisheries management in general and cage culture technology in particular.

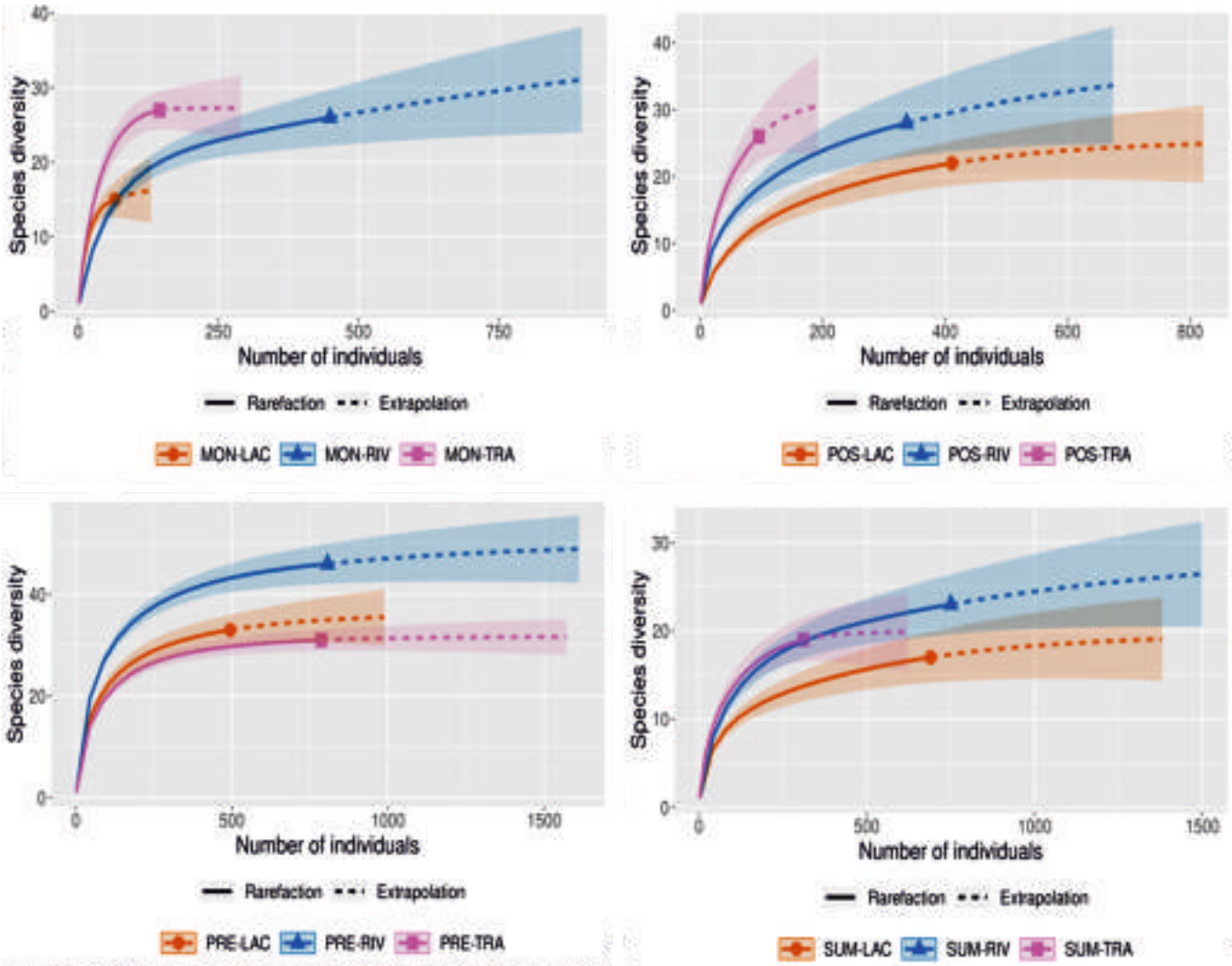
Three medium reservoirs, viz. Kodar reservoir of Chhattisgarh, Poondi of Tamil Nadu and Serlui-B of Mizoram, were studied with an objective to develop eco-region-specific fisheries management strategies.

Poondi reservoir, Tamil Nadu

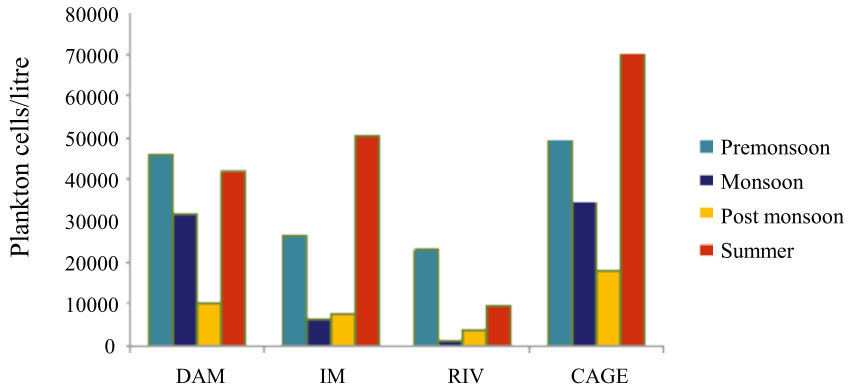
Poondi reservoir is located across Kosathalaiyar river in Thiruvallur district of Tamil Nadu. It acts as the important water source for Chennai city which is 60 km away. Cage culture is being practiced in this reservoir.

Fish assemblage pattern

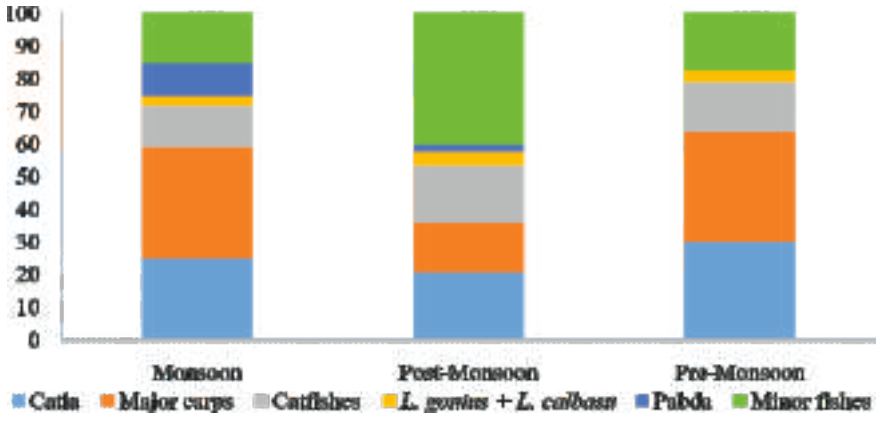
A total of 47 species belonging to 17 families and 7 orders were reported in the experimental catch of the Poondi reservoir. The spatio-temporal patterns of fish assemblage are depicted here. Maximum diversity was reported in lacustrine zone followed by riverine and transitional zones based on spatial scale. The pre-monsoon season recorded the maximum abundance, whereas minimum was observed in summer season. Relative abundance of murrels were high (>73%) in riverine zone of the reservoir and maximum catch of this species was observed in the post-monsoon and minimum in summer season. SIF species such as *Hyporhamphus xanthopterus* and *Xenentodon cancila* were abundant during the pre-monsoon. The most influenced environment variables on fish abundance were extracted through principal component analysis and the relationships were predicted using multivariate analysis. For generating the generalized linear mixed model (GLMM), different models were checked with principal components and best models were selected based on the least AIC (Akaike information criteria) value. The best GLMM for Poondi reservoir was Shannon diversity with PC2 environmental gradients as a fixed factor and sites as a random factor. The fish abundance of this reservoir is driven by the major environmental factors such as depth, transparency and dissolved oxygen. The present study on fish assemblage structure with environmental gradients helps in management plans such as fisheries enhancement and conservation plan.



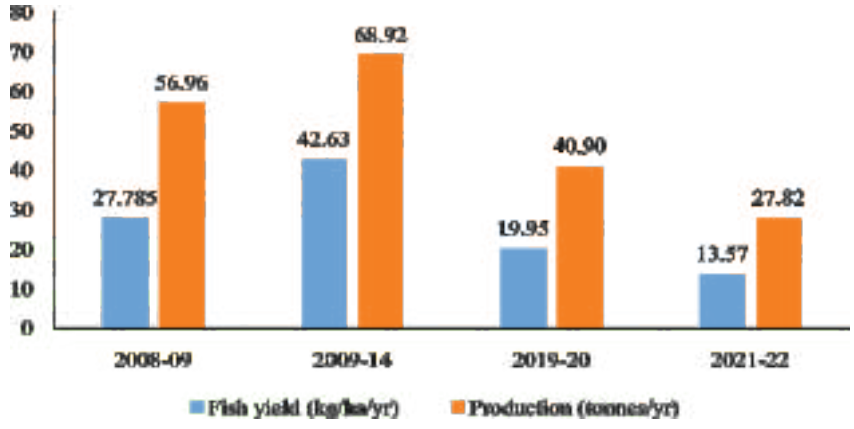
Species accumulation curve- Spatio-temporal pattern of fish assemblage in Poondi reservoir, PRE- Pre-monsoon, MON- Monsoon, POS- Post-monsoon, SUM- Summer, LAC- Lacustrine, TRA- Transitional, RIV- Riverine



Spatio-temporal variations in phytoplankton abundance of Poondi reservoir. DAM = dam site, IM = intermediate site, RIV = river site, CAGE = cage site



Fish catch composition in Kodar Reservoir



Trends in fish productivity in Kodar Reservoir

Plankton dynamics

A total of 55 phytoplankton and 11 zooplankton genera were recorded from Poondi reservoir. There was a seasonal succession in plankton abundance at different zones. Higher abundance was observed at the cage site during all the seasons with maximum abundance during summer, whereas higher plankton diversity was recorded at the river site during the monsoon (Shannon Weiner diversity index 2.177) and the lowest at dam site during the summer season (0.406). The algal genus pollution index was estimated to be less than 20 indicating less organic pollution in Poondi reservoir both spatially and temporally. The correlation between selected abiotic parameters and plankton class in Poondi reservoir was derived by estimating the Pearson's correlation coefficient. There was a significant ($p<0.05$) positive correlation of Cyanophyceae, Trebouxiophyceae, Ulvophyceae, Mediophyceae and Euglenophyceae with the dissolved oxygen. Likewise, Ulvophyceae and Xanthophyceae were found to have significant ($p<0.05$) positive correlation with NO_3-N content. Xanthophyceae was positively correlated with PO_4 and Chlorophyceae was significantly correlated with the Chlorophyll-a content while the water temperature was found to be negatively correlated ($p<0.05$) with Euglenophyceae. The studied parameters show that the Poondi reservoir is a healthy ecosystem, with a scope for possible development of fisheries enhancement programs.

Fish catch structure in Kodar Reservoir

The major landing species from Kodar reservoir were *Labeo catla*, *Cirrhinus mrigala, L. rohita, Sperata aor, S. seenghala, Labeo gonius, Osteobrama vigorsii, Wallago attu, L. calbasu*, *Notopterus notopterus, Systomus sarana* and *Oreochromis niloticus* among which the three IMCs are stocked species. The analysis of fishery dependent data revealed that both stocked and indigenous fishes constituted the major component of the catch structure. A temporal analysis of the landings showed dominance of major carps during pre-monsoon and monsoon (forming nearly 60% of total landings) whereas minor carps formed major catch in post-monsoon season. Catfishes such as *Sperata aor, S. seenghala* and *Ompok bimaculatus* formed an important constituent of the fishery contributing nearly 15-22% of the catch.

Impact of CBF and trends in fish yield

In Kodar, under the management of C G Co-operative Fisheries Federation Ltd., CBF is practiced with periodic



Catla caught from Kodar reservoir



Fishers sorting SIFs from the catch of Kodar reservoir

stocking of carps. During 2009-2014, the reservoir was stocked continuously under an NFDB sponsored project which resulted in an increased fish yield from the reservoir in the succeeding years and later declined in the recent years after the completion of the NFDB project. The present study has reported a further decline in the fish production as well as yield from the reservoir which is mainly attributed to inadequate stocking of reservoir and reduction in fishing effort and fishing efficiency, as the number of migratory fishers from Bengal reduced to a great extent. The strengthening of CBF management of reservoir with proper stocking of IMC fingerlings in ideal stocking density as per the carrying capacity of reservoir is recommended.



ICAR-CIFRI survey team at the landing centre of Kodar reservoir

Serlui-B reservoir

Serlui-B, a medium reservoir measuring 4000 ha at FRL is located in Bilkhawthlir, Kolasib district, Mizoram. It is basically a small hydroelectric project of 12 MW built across river Serlui and commissioned by BHEL in 2009. The river is also known as Rukni, that originates from the Serkhan village in the southern part of Kolasib district of Mizoram, and flows in the northward direction till its confluence with the Tuirial river in the Cachar district of Assam and finally discharges into the Barak river. Among the various drainage systems, Serlui river is one of the major sources of water within the



A view of Serlui-B reservoir, Kolasib district, Mizoram



Sampling for ecological parameters in Serlui-B reservoir, Kolasib, Mizoram

district with a length of about 55 km and width of 1.5 km. Builum village was submerged due to construction of the dam and the affected villagers were rehabilitated at Bawktlang near Kolasib. The dam is a 293 m long, 51 m high, 8 m narrow top and 394.2 m wide bottomed earth-fill embankment with a 135 m pressure tunnel, 415 m headrace tunnel and a semi-ground power house.

Water and sediment quality

Water quality was monitored in different seasons; water temperature ranged between 22.90 and 31.23°C, pH between 6.80 and 7.23, dissolved oxygen between 7.02 and 7.57 mg/l, electrical conductivity between 95.40 and 125.60 µS/cm, total dissolved solids between 33.35 and 39.67 mg/l, total alkalinity between 39.00 and 42.30 mg/l, Sechhi disk transparency between 2.90 and 3.60 m and depth between 8.63 and 12.60 m. Soil was mostly sandy loam in texture and was porous with poor water holding capacity. It was acidic in nature – pH ranging between 4.5-6.0. The topography of the area is undulating with parallel and sub-parallel mountainous ranges, the north or south-flowing rivers of the district created deep gorges. Owing to forest cover, the soil in the vicinity of the reservoir is rich in humus.

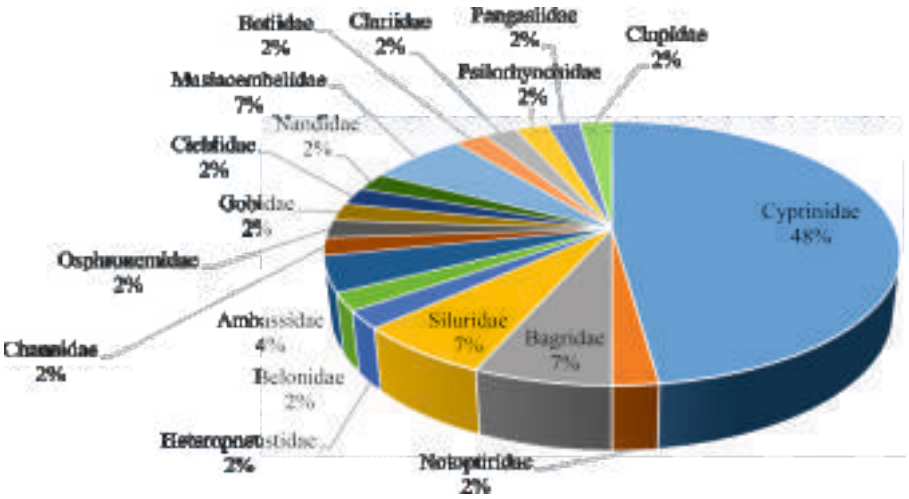
Plankton and macrophyte diversity

Plankton community in Serlui-B reservoir was dominated by Chlorophyceae (42-44%) 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*.

The aquatic macrophytes recorded from Serlui-B reservoir were categorized into 4 groups i.e., Emergent, Rooted with floating leaves, Free floating and Submerged. 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*. Aquatic macrophytes play a vital role in the functioning of an aquatic ecosystem.

Fisheries status

Forty six fish species were recorded from Serlui-B reservoir belonging to 6 orders, 18 families and 35 genus. Cyprinidae was the most dominant family (22 species contributing 48% of total number) followed by Bagridae, Siluridae and Mastacembelidae (3 species and 7% each). Five (5) exotic fish species *viz*., *Oreochromis niloticus, Cyprinus carpio, Hypophthalmichthys molitrix, Pangasianodon hypophthalmus* and *Ctenopharyngodon idella* were also recoded. 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*



Family-wise distribution of fish species recorded from Serlui-B reservoir, Kolasib, Mizoram

chitala) were found to be Near Threatened. Family-wise distribution of fish species recorded from Serlui-B reservoir, Kolasib, Mizoram is given in the figure.

Benthic communities

A total of 8 (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 from the reservoir, which ranged from 22-333 numbers per m^2.

Gear and crafts

Dominant gears operated were gill nets (7-19 cm mesh size, 150 m length and 5 m height) for catching Indian major carps, exotic carps, pangus, murrels and large catfishes. Dominant crafts operated in Serlui-B reservoir were wooden boat (length: 20-24 ft and breadth: 3-6 ft), bamboo raft (3 layers of bamboo, approximately 40 no. used in one raft) and FRP boats (length: 10 ft and breadth: 4 ft).

Primary productivity and production potential

The Gross Primary Productivity ($mgC/m^3/hr$) calculated based on plankton using dark and light bottle method in Serlui-B reservoir was 45. Considering 1% of this GPP, production potential of the reservoir was estimated to be 118.26 kg/ha/yr. Production potential estimated in the present study is based on phytoplankton food chain.

Fisheries management in Serlui-B reservoir

Serlui-B reservoir is under the administrative control of the Department of Fisheries, Govt. of Mizoram. The reservoir is normally leased out to individuals or groups for fishing on annual lease system. The lessee engages about 20 number of fishers' groups who catch fish by gill net, 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 thermocol boxes and transported to Silchar in the evening. The most common fishing method was gill netting. Other than this, practice of dynamite fishing and dynamo or electric fishing were reported from the reservoir. Based on field studies and information collected through focused group discussion, the following recommendations could be made for sustainable fisheries management of Serlui-B reservoir: (i) lease period may be increased from one year to 5 years which will indirectly reduce fishing pressure in the reservoir; (ii) destructive fishing methods such as dynamite and electric fishing should be banned; (iii) cage culture following scientific protocols should be taken up in the reservoir; (iv) stock enhancement practices should be carried out for enhancing productivity of the reservoir; (v) infestation and profuse growth of *Eichhornia crassipes* in the reservoir should be immediately checked and (vi) training of departmental officers and fishers of Mizoram on reservoir fisheries management in general and cage culture technology in particular needs to be imparted.



Small indigenous fishes caught from Serlui-B reservoir, Kolasib, Mizoram

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

Duration: April 2020 to March 2023

Scientific Personnel: Lianthuamluaia (Sub-project Leader), Ajoy Saha (upto 31.03.22), Sibina Mol, Sajina A. M., Suman Kumari, H. S. Swain, Hemanta Chowdhury, Mishal P., Preetha Panikkar, Jesna P. K. (w.e.f. 01.04.22), P. J. Majhi (w.e.f. 01.04.22)

Summary

- The fish species diversity was highest in Gayatri reservoir among studied reservoirs with 32 species.
- Small indigenous fish (SIF) contributed 18 to 20% in Kalo reservoir, Odisha and 25 to 40% in small reservoirs of Purulia, West Bengal highlighting its significant role in fish production in small reservoir.
- The stocked fish dominated the fish catch contributing 75 to 90% of the total fish catch in Sunei, Kalo, and Gayatri where regular stocking practices were implemented indicating the role of regular stocking efforts.
- The reproductive biology of *Notopterus notopterus, Heteropneustes fossilis* and *Channa punctata* of Gayatri reservoir, was studied. *Notopterus notopterus* from Gayatri reservoir were observed to be infected with the Yellow grub, *Clinostomum* sp. (Class: Trematoda).
- The water quality parameters of Gayatri reservoir was distinct from the other small reservoirs based on the Principal Component Analysis (PCA), possibly due to the influence of the geographical location.
- The phytoplankton community in the Gayatri reservoir comprised of 29 genera with the highest density during the pre-monsoon season.

Assessment of the ecology and fisheries 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.

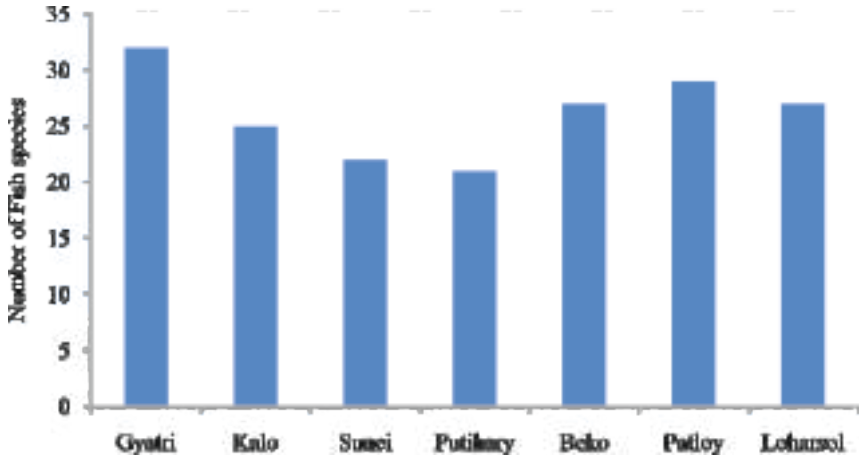
Fisheries status

Among the studied reservoirs, highest number of fish species was observed in Gayatri reservoir with 32 species. Fish diversity assessment of the small reservoirs indicated that highest number of exotic fish (*Oreochromis mossambicus*, *O. niloticus*, *Ctenopharyngodon idella* and *Cyprinus carpio*) was in Gayatri reservoir as compared to other small reservoirs of Odisha and West Bengal. Carnivorous fish *Channa striata, C. marulius* and *Wallago attu* were observed in Gayatri reservoir, *C. striata* and *C. marulius* in Kalo reservoir, *C. marulius* in Sunei reservoir, *C. striata, C. marulius* and *W. attu* in reservoirs of Purulia. The fish production pattern indicated that

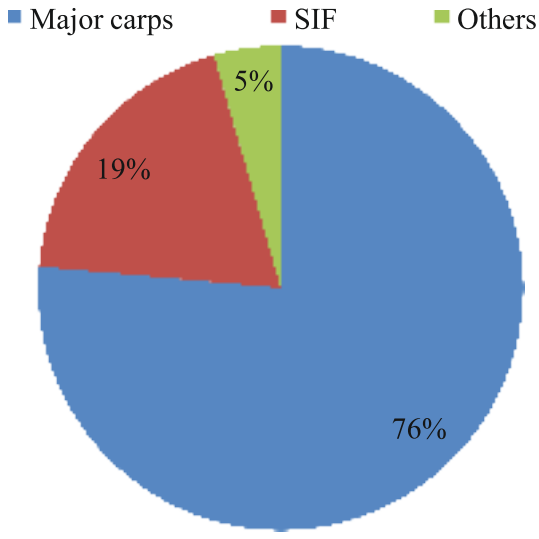


Observation of fish catch in Gayatri reservoir

small indigenous fishes contributed significantly to the total fish production. In Kalo reservoir, SIF contributed 18 to 20% of the fish production, highlighting their substantial role in overall fish production in the reservoir. The Kalo reservoir is home to a diverse range of SIF species, with *Salmophasia phulo, Chanda nama* and *Amblypharyngodon mola* being the most commonly found. SIF catch contributed 25 to 40% of the total fish catch in the small reservoirs of Purulia, West Bengal. In Sunei reservoir, around 10% of the fish production was attributed by the SIF and other indigenous fishes. The major carp contribution was in the range of 25 to 50% of the total fish catch in the small reservoirs of Purulia where stocking was not properly done. However, the major carps which were stocked in the reservoirs dominated the fish catch contributing 75 to 90% of the total fish catch in Sunei, Kalo and Gayatri reservoir where fish seed stocking are carried out regularly indicating the positive impact of stocking.



Number of fish species in small reservoirs of Karnataka, West Bengal and Odisha



Fish catch composition in Kalo reservoir

The reproductive biology of *Notopterus notopterus, Heteropneustes fossilis* and *Channa punctatus* from Gayatri reservoir was studied. The absolute fecundity of *N. notopterus* female was determined to be 11824 ± 546 during the month of June with gonadosomatic index (GSI) as 4.26%. The absolute fecundity of *H. fossilis* was found to be 18546 ± 298 (July) with a GSI of 13.12% and that of *C. punctatus* was estimated to be 27298 ± 421 (August) with 5.14% GSI. The relationship between absolute fecundity with total length, total weight, and gonad weight was determined using least squares regression. In *N. notopterus*, the absolute fecundity was significantly correlated ($P<0.05$) with the body weight, gonad weight, and the total length.

Notopterus notopterus is a commonly available species among the 32 fish species reported from Gayatri reservoir. *N. notopterus* was recorded both in the experimental fishing and commercial catch throughout the year. *N. notopterus* were observed to be infected with the Yellow grub, *Clinostomum* sp. (Class: Trematoda). The average length of this parasite was 1.0 ± 0.2 cm. Around 7.5-19% of the *Notopterus* population was infested with the parasite with peak infection observed during winter. The length and weight of the host fishes ranged from 10.4 to 22.5 cm and 10-71 g respectively during different months.

Environmental parameters

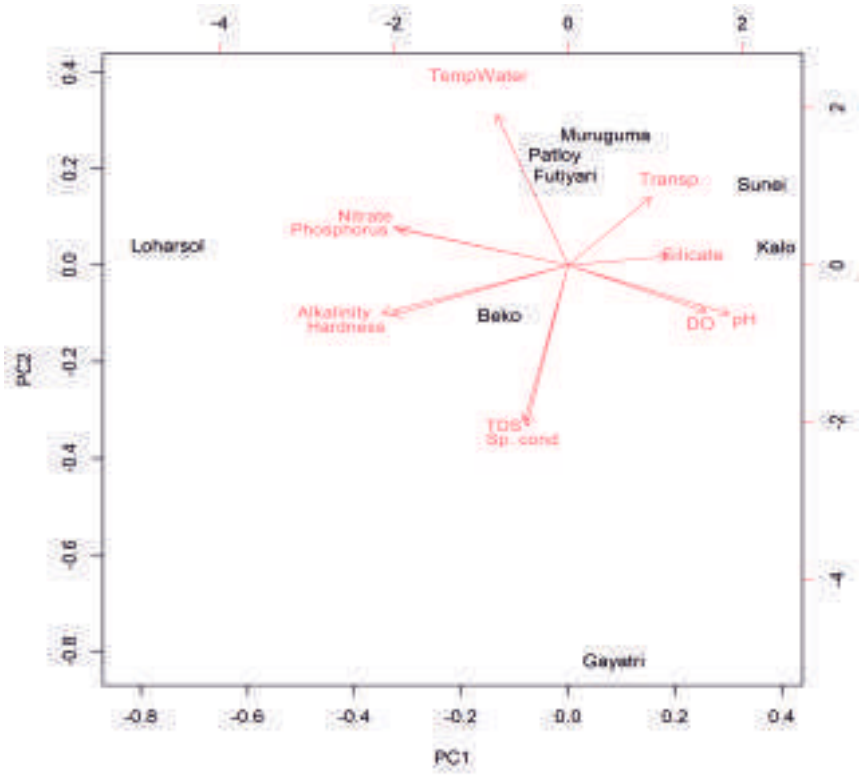
Seasonal sampling was done to assess the water quality parameters of the studied reservoirs. The Principal Component Analysis (PCA) was carried out for the water quality parameters to see the pattern of variation of the water quality parameters in the small reservoirs. The PCA indicated that Gayatri reservoir was distinct from the other reservoirs, which could be due to the geographical location of the reservoir. Gayatri reservoir is in the southern part of the country while the other reservoirs are in the eastern part. Most of the critical water quality parameters like pH, DO and nutrient parameters were in the favorable range for fish production. The DO

value was more than 5 mg/l in all the reservoirs. Slightly alkaline nature (pH > 7) of the water indicated the healthiness of the environment. Good amount of nutrients in the form of nitrate nitrogen and phosphate phosphorus indicated the capacity of the reservoirs to produce sufficient phytoplankton which are the main natural food in aquatic environment.

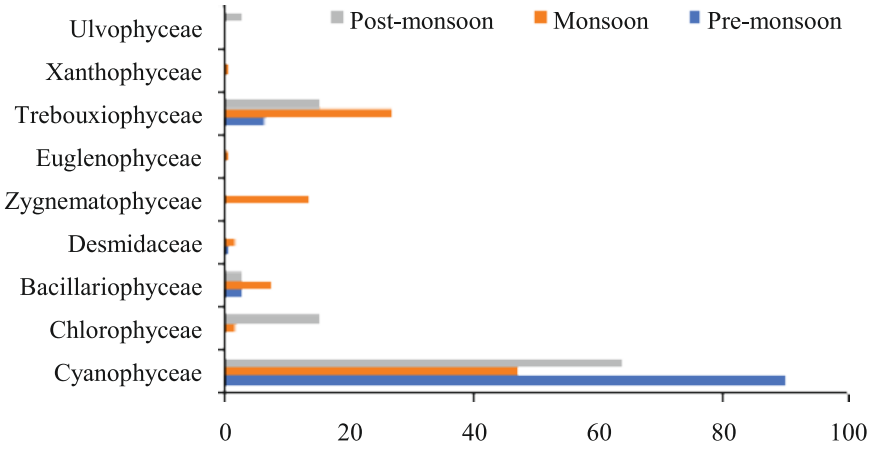
Plankton diversity and abundance

The phytoplankton community in the Gayatri reservoir comprised of 29 genera belonging to nine algal classes viz. Cyanophyceae (5), Chlorophyceae (2), Bacillariophyceae (9), Desmidaceae (3), Zygnematophyceae (3), Euglenophyceae (1), Trebouxiophyceae (4), Xanthophyceae (1) and Ulvophyceae (1). Cyanophyceae, Bacillariophyceae and Trebouxiophyceae were found to be present in the reservoir in all the three seasons. Blue-green algae, the Cyanophyceae dominated the reservoir in percentage composition of plankton in all the seasons (90%, 47% and 64% in pre-monsoon, monsoon and post monsoon seasons, respectively), followed by Trebouxiophyceae. Chlorophyceae also contributed equivalent to Trebouxiophyceae in the post-monsoon season. The maximum number of taxa was associated with the monsoon season (21) followed by pre-monsoon (15) and post-monsoon (7) seasons. *Microcystis*, *Polycystis* and *Oscillatoria* were the predominant genera among Cyanophyceae. The average phytoplankton density was also found to be the highest during the pre-monsoon season (9.3×10^4 No./L).

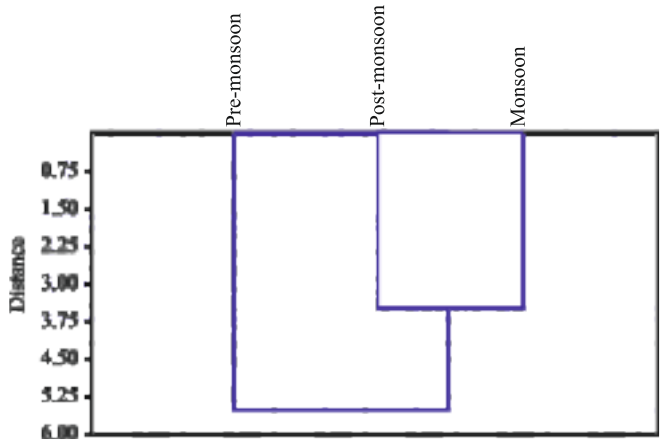
In the present study, the values of Simpson and Shannon indices were found to be the highest in the monsoon season followed by pre-monsoon and post-monsoon seasons. This means that the phytoplankton richness and diversity were highest during the monsoon season and lowest during post-monsoon season.



PCA of water quality parameters in the small reservoirs of Odisha, West Bengal and Karnataka



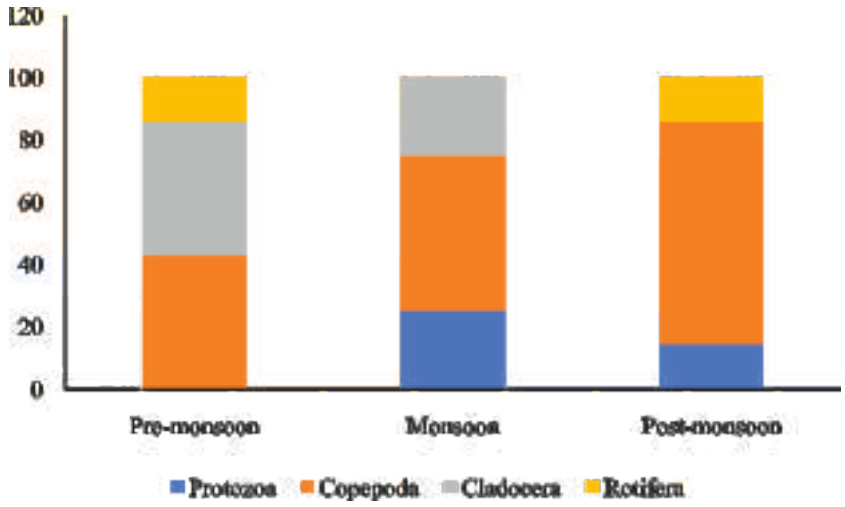
Percentage composition of phytoplankton group in Gayatri reservoir



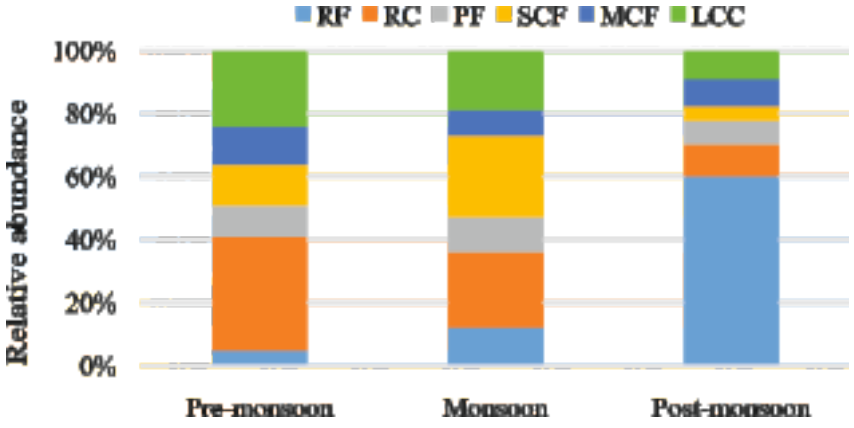
Hierarchical dendrogram of different seasons based on the phytoplankton abundance in Gayatri reservoir

But, the evenness was found to be highest in the post-monsoon season and lowest in the pre-monsoon season. The phytoplankton abundance data subjected to the hierarchical cluster analysis projected the similarity among the monsoon and post-monsoon seasons compared to pre-monsoon season.

Zooplankton in Gayatri reservoir comprised of protozoans, copepods, cladocerans and rotifers. Copepods comprising of *Calanus* spp. and *Paracalanus* spp. dominated in all the three seasons (43%, 50% and 71% in pre-monsoon, monsoon and post-monsoon seasons, respectively).



Percentage composition of zooplankton in Gayatri reservoir

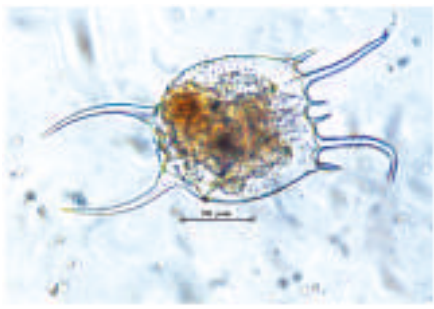


Relative abundance of zooplankton functional group in Kalo reservoir

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) in the small reservoirs of Odisha. Four algal groups, viz. Chlorophyceae, Cyanophyceae, Bacillariophyceae and Trebouxiophyceae, were the dominant quantitative component, remarkably influencing the total phytoplankton population in both the reservoirs, contributing ~87% of total phytoplankton. In Kalo reservoir, the mean phytoplankton density was maximum during pre-monsoon (3.51×10^4 cells l^{-1}) followed by post-monsoon (2.46×10^4 cells l^{-1}). However, in Sunei, the mean abundance was maximum during post-monsoon (2.45×10^4 cells l^{-1}) followed by pre-monsoon (1.86×10^4 cells l^{-1}). The Chlorophyta was ranked first in terms of species richness and numerical abundance in both the reservoirs. A total of 46 and 38 zooplankton species were observed from Kalo and Sunei reservoir, which were grouped into 6 functional groups based on their body size/length and mode of feeding such as rotifer filter feeders (RF), rotifer carnivore (RC), protozoa filter feeders (PF), small copepods and cladocerans filter feeders (SCF), middle copepods and cladocerans filter feeders (MCF), large copepods and cladocerans carnivore (LCC). The total mean zooplankton abundance was significantly lower in monsoon (673 ± 152.22 ind./l) compared to pre-monsoon (1194.54 ± 144.56 ind./l) and post-monsoon (1018.81 ± 124.02 ind./l) in Kalo reservoir. However, in Sunei reservoir, the mean abundance was maximum (984.63 ± 121.10 ind/l) in post-monsoon and minimum (635.25 ± 112.36 ind/l) in the pre-monsoon



Brachionus diversicornis



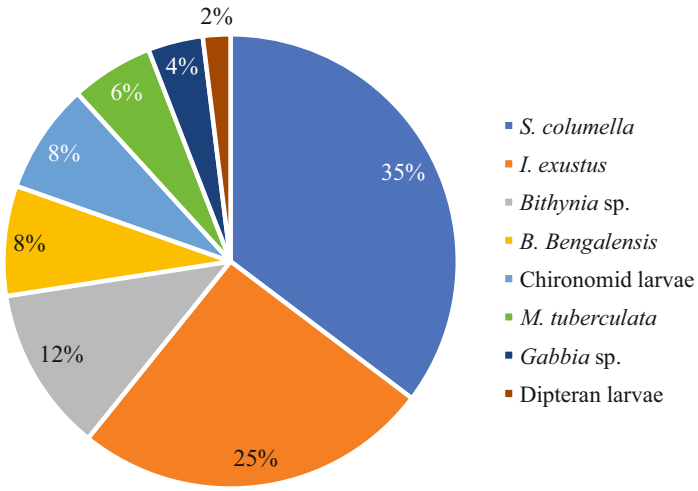
B. falcatus



Hexarthra sp.

Rotifers observed in small reservoirs of Odisha

season. In post-monsoon, RF was dominated mainly by *Brachionus calyciflorus*, *B. falcatus, B. diversicornis*, *B. forficula*, *B. angularis*, *Fillinia opoliensis*, *F. terminalis*, *Hexarthra* sp., which corresponded to about 60% of the total abundance, but in pre-monsoon RC accounted the highest percentage (36.14%) followed by LCC (24.24%), SCF (13.1%) and PF (9.8%). Spatially, RC dominated in upstream while, LCC, MCF and SCF contributed highest percentage in dam site and transition part of the studied reservoir.

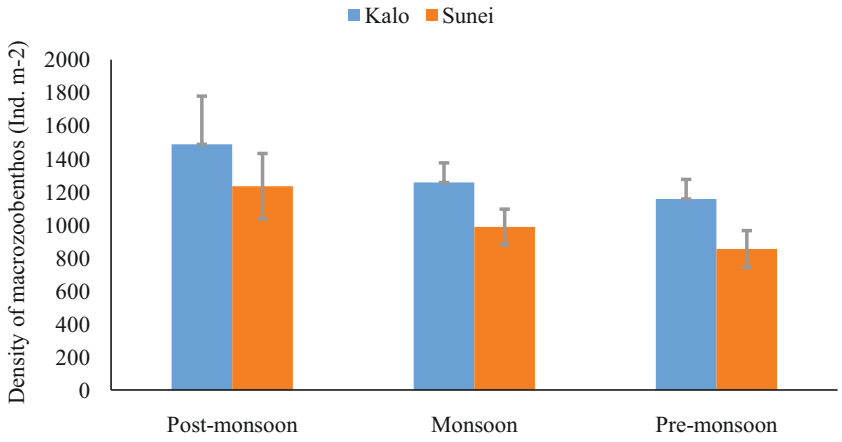


Percentage composition of benthos in Gayatri reservoir

Benthic community

Assessment of benthos from the Gayatri reservoir recorded six species of gastropods, chironomid larvae and dipteran larvae. The gastropods included *Filopaludina bengalensis, Indoplanorbis exustus, Speudosuccinia columella, Gabbia* spp., *Bithynia* spp. and *Melanoides tuberculata. S. columella* (35%) dominated the benthic community followed by *I. exustus* (25%).

A total of 16 and 12 taxa under 4 major groups of macrobenthos were recorded from Kalo and Sunei reservoir respectively. The group Oligochaeta (80%) forms the most dominating group followed by Insecta (16%), Gastropoda (2%), and Bivalvia (2%) in Kalo reservoir. *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, and *Chironomus* sp. were the most encountered species in all the sampling stations and seasons in Kalo and Sunei reservoir. Spatially, the macrozoobenthic density varied from 535±123 to 1449±289 ind./m^2 and maximum at transitional zone in Kalo reservoir.



Abundance of macrozoobenthic community of Kalo and Sunei reservoir

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

Duration: April 2020 to March 2023

Scientific Personnel: Preetha Panikkar (Sub-project leader), Feroz Khan, Sibina Mol, Satish Koushlesh

Summary

- The possible impact of a further increase in the biomass of important fish groups on the ecological attributes of Gayatri reservoir, Karnataka was evaluated by the use of Ecopath model with Ecosim (EwE).
- The geometric mean of the total trophic transfer efficiencies for the Gayatri reservoir was 21.9%. A mean transfer efficiency from the primary producers was 22.38% and 19.86% from the detritus. The murrels and *N. notopterus* are the most exploited fish groups whereas minnows, catfishes and the prawns are the least exploited groups.
- In Gayatri reservoir, trophic model estimated the carrying capacity of prawns 25%, *O.*

Summary

niloticus to 10% and it was found that the biomass of IMCs could be increased up to 75%.

- The primary production/ Respiration value is 6.12 in Gayatri reservoir and the system overhead value is 61.93%, which indicates that the ecosystem is in the developmental phase and is not fully resilient to perturbations

Trophic model of Gayatri reservoir, Karnataka

The trophic modeling study conducted in Gayatri reservoir, Karnataka with an area of 785 ha at Full Reservoir Level (FRL) is amenable for fishery enhancement through culture-based fisheries. The possible impact of a further increase in the biomass of important fish groups on the ecological attributes was evaluated by the use of Ecopath with Ecosim (EwE). Food web components classified into 14 ecological groups included the top predator (fish eating birds), seven fish groups (catfishes, murrels, Notopterus, Indian Major carps, Barbs, minnows and *Oreochromis niloticus*), 3 invertebrates (zooplankton, benthos and prawns), two primary producers (macrophytes and phytoplankton) and a non-living group (detritus). 32 fish species were recorded from the reservoir and the groupings were based on the abundance in the catch and on commercial importance.

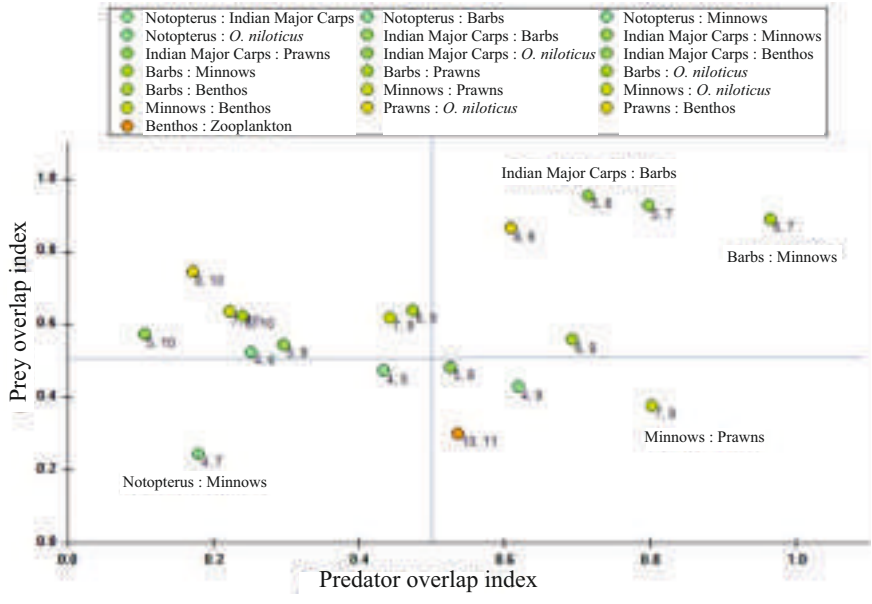
The food web structure of the reservoir consisted of four trophic levels which ranged from 1.0 (detritus and primary producers) to 3.55 (the top predators). The important commercial fishes had trophic levels of 2.65 (prawns), 2.59 (IMC) and 2.33 (*O. niloticus*). The EE values of all the ecological groups ranged from 0.00 (top predators) to 0.936 (zooplankton). The geometric mean of the total trophic transfer efficiencies for the Gayatri ecosystem was 21.9%. A mean transfer efficiency from the primary producers was 22.38% and 19.86% from the detritus. The murrels and *N. notopterus* are the most exploited fish groups whereas minnows, catfishes and the prawns are the least exploited groups.

Table: Key features of the ECOPATH model for Gayatri reservoir

S. No.	Name	Trophic level	Ecotrophic Efficiency	Omnivory index	Flow To Detritus (t/km²/year)
1	Fish eating birds	3.55	0.000	0.067	1.83
2	Catfishes	3.43	0.271	0.020	8.09
3	Murrels	3.45	0.860	0.016	6.12
4	Featherbacks	3.15	0.855	0.213	4.17
5	Indian Major carps	2.58	0.531	0.330	14.65
6	Barbs	2.48	0.512	0.340	34.43
7	Minnows	2.38	0.259	0.268	79.06
8	Prawns	2.65	0.362	0.352	40.57
9	Nile Tilapia	2.33	0.499	0.264	21.18
10	Benthos	2.29	0.926	0.206	48.68
11	Zooplankton	2.00	0.936	0.000	88.15
12	Macrophytes	1.00	0.892	0.000	8.98
13	Phytoplankton	1.00	0.197	0.000	2168.88
14	Detritus	1.00	0.085	0.240	-

The niche overlap analysis showed the prey-predator interaction levels among the various ecological groups. Barbs and minnows had the highest prey-predator overlap index whereas *Notopterus* and *minnows* had the least prey-predator overlap index. Highest prey overlap index was between IMCs and barbs.

Mixed trophic impact routine showed that the top predators (fish eating birds) had a highly negative impact on *Notopetrus*, IMCs and *O. niloticus* and positive impact on the benthos. Prawns and *O. niloticus* were highly impacted by the presence of catfishes. Phytoplankton and detritus had positive effects on most other groups. The stocked fishes IMC shows negative impacts on many fish groups except the carnivores (murrels and catfishes). The presence of *O. niloticus* showed negative



Niche overlap plot for the ecological groups in Gayatri reservoir

effects on *Notopterus* and prawns. Prawns did not severely impact any of the fish groups. Zooplankton is heavily predated followed by macrophytes. Phytoplankton is highly under-utilized.

The biomass of prawns, Indian major carps and *O. niloticus* estimated from the reservoir were 4.74, 4.50 and 4.90 t km^{-2} respectively. The biomass of each group was individually increased at varying levels and modeled to evaluate the effect of the increase on the other ecological groups. The model estimated the carrying capacity of prawns 25%, *O. niloticus* to 10% and it was found that the biomass of IMCs could be increased up to 75%.



Fish sampling at Gayatri reservoir, Chitradurga District, Karnataka

The total carrying capacity (total system throughput) of the reservoir ecosystem is 6453.96 t/km^2/yr. The primary production/ Respiration value is 6.12 and the system overhead value is 61.93% which indicates that the ecosystem is in the developmental phase and is not fully resilient to perturbations. On the basis of trophic model, this is an ecosystem which has a strong primary production but which uses little of it and depends especially on external inputs of energy.

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

Project Code: RWF/20-23/11

Principal Investigator: Dr. Archan Kanti 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

Duration: April 2020 to March 2024

Scientific Personnel: D. Debnath (Sub-Project leader), Simanku Borah, S. Yengkokpam, S.C.S. Das, Pranob Das, A. K. Yadav, B. K. Bhattacharjya, Niti Sharma (w.e.f. 01.04.2021)

Summary

- A total of eight floodplain wetlands of Assam spread across six districts of Assam *viz*. Dandua (50 ha; Closed beel) and 46-Morakolong (60 ha; Seasonally open) beels of Morigaon; Lakhanabandha (16 ha; Closed) and Rupahi (75 ha; Seasonally open) beels of Nagaon; Algapur anua (260 ha; Seasonally open) of Cachar district; Sone beel (400 ha; Open) of Karimganj; Tamranga beel (400 ha; Open) of Bongaigaon and Dhir beel (556 ha; Open) of Dhubri were studied for generating data on their fisheries and ecology.
- Bacillariophyceae dominated the plankton diversity in all the beels except in Dhir beel where Chlorophyceae is the dominant plankton group. Floating macrophyte coverage was observed to be low in open beels compared to the closed or seasonally open beels.
- The maximum number of fish species and families were recorded in Tamranga beel (97 and 31) and minimum in 46-Morakolong beel (47 and 16). Major constraints faced and management practices followed were beel-specific. Fish yield trends, major issues related to the beels, prevalent management practices, socio-economic status of beel fishers and vulnerability of ecosystems were documented and better management practices for sustainable beel fisheries were suggested.

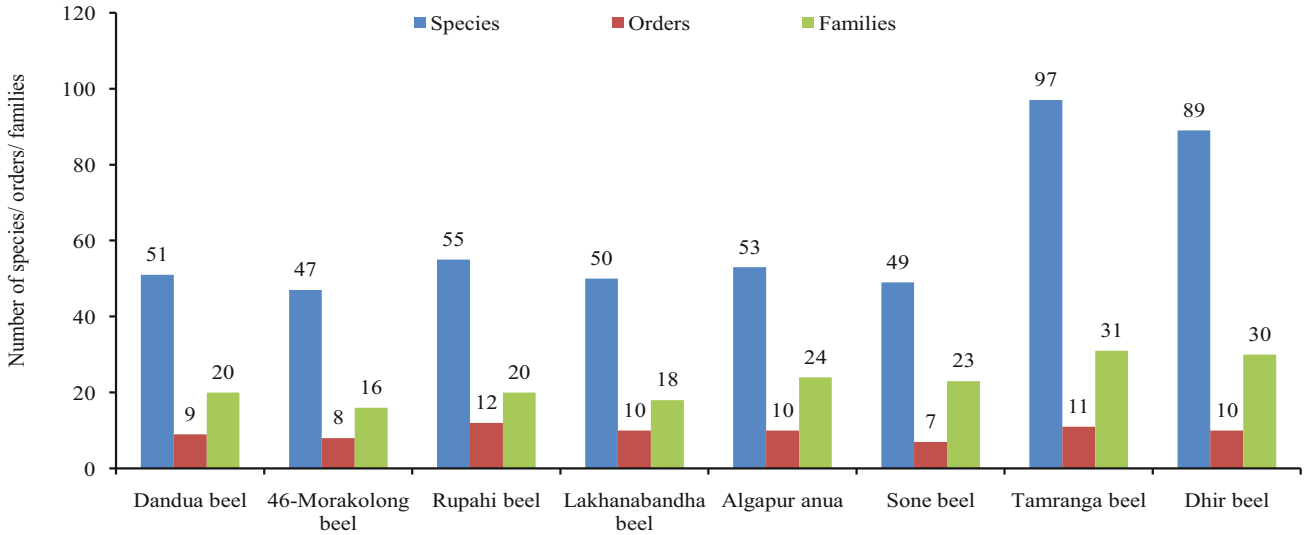
Eight floodplain wetlands (beels) of Assam *viz*. Dandua (50 ha water-spread area; Closed beel) and 46-Morakolong (60 ha; seasonally open) beels of Morigaon; Lakhanabandha (16 ha; closed) and Rupahi (75 ha; seasonally open) beels of Nagaon; Algapur anua (260 ha; Seasonally open) of Cachar district; Sone beel (400 ha; open) of Karimganj; Tamranga beel (400 ha; open) of Bongaigaon and Dhir beel (556 ha; open) of Dhubri were studied for generating data on their fisheries and ecology.

Ecology of studied wetlands

Salient water quality parameters of the eight beels like dissolved oxygen, pH and total alkalinity ranged between 5.10-8.60 mg/l, 5.50-8.30 and 22.00-136.70 mg/l, respectively. Water depth and Sechhi disc transparency ranged between 1.37-9.09 m and 0.33-2.20 m, respectively. Diversity study of phytoplankton in the beels revealed that Bacillariophyceae dominated the plankton diversity in all the beels except in Dhir beel where Chlorophyceae is the dominant plankton group. Maximum number of Classes was reported in Dandua (6) and Lakhanbandha (7) beels (closed ones) with maximum number of genus (15 and 16, respectively). The major types of aquatic macrophytes present in the beels and their extent of coverage was also studied. *Eichhornia crassipes* was the dominant floating macrophyte covering 1-20% of surface area in the beels. The major portion of the beel bottom was covered with submerged macrophytes (*viz*., *Vallisneria*, *Ceratophyllum*, *Hydrilla*, *Potamogeton*, *Myriophyllum*) in Dandua beel (80-90%) as was in Rupahi beel (80-90%).

Fish and fisheries

Fish diversity in terms of number of species, orders and families in the selected beels was recorded and presented in the figure below. The maximum number of fish species and families were recorded in Tamranga beel (97 and 31) and minimum in 46-Morakolong beel (47 and 16). All the beels were reported to have 4-8 number of exotic species.



Fish diversity in selected floodplain wetlands (beels) of Assam

Table: Gross primary productivity (based on phytoplankton) and fish production potential of eight floodplain wetlands (beels) of Assam (range)

Parameters	Dandua beel	46-Morakolong beel	Rupahi beel	Lakhanabandha beel	Algapur anua	Sone beel	Tamranga beel	Dhir beel
Gross primary productivity ($mgC/m^3/hr$)	140.00-160.00	90.22-115.02	220.32-300.40	100.29-135.11	106.66-115.00	100.00-135.00	180.67-193.60	180.00-244.64
Fish production potential (kg/ha/yr)	360.18-420.92	240.25-300.87	300.91-600.14	250.24-350.60	273.408-302.22	256.32-354.78	460.94-500.82	370.68-400.67

Necessary management intervention vis-à-vis sustainable fishery

Dandua beel
(50 ha), Closed

- **Major problem**: Submerged macrophyte especially Vallisneria
- **Major management options**: (i) Pen aquaculture, (ii) Stocking with advanced fingerlings, (iii) Control of floating macrophyte biomass, (iv) Biological control use of *Vallisneria* through stocking grass carp and common carp.

46-Morakolong beel
(60 ha), Seasonally open

- **Major problem**: Frequent flood is both boon and bane
- **Major management options**: (i) Fish aggregating structures (i.e., *jengs* or *katals*) for ease of capture, (ii) Stocking with advanced fingerlings, (iii) Rational fishing/ harvesting, (iv) Removal of silt from connecting channel to maintain river connectivity.

Lakhanabandha beel
(16 ha), Closed

- **Major problem**: Bottom silt/ muck/ mud in the beel
- **Major management options**: (i) Pen aquaculture, (ii) Stocking with advanced fingerlings, (iii) Floating macrophyte clearance and liming, (iv) stocking detritus feeding fishes (i.e., common carp, mrigal, Java puthi) in the beel.

Rupahi beel
(75 ha), Seasonally open

- **Major problem**: Escapement of fish during floods
- **Major management options**: (i) Pen and aquaculture, (ii) Stocking with advanced fingerlings, (iii) Periodic control of floating macrophyte, (iv) Fish aggregating structures (i.e., *jengs* or *katals*) for ease of capture.

Algapur anua
(260 ha), Seasonally open

- **Major problem**: Sustenance fishing without any governance and record keeping
- **Major management options**: (i) Cage and pen aquaculture, (ii) Control of floating macrophytes, (iii) Rational fishing practices in terms of seasons and mesh size regulation, (iv) keeping the connecting river channel clear for fish migration during monsoon.

Sone beel
(400 ha), Open

- **Major problem**: Low water retention during non-monsoon season
- **Major management options**: (i) Pen aquaculture is a boon for large number of beel fishers, (ii) Rational fishing/ harvesting would sustain the capture fisheries, (iii) Aqua-tourism for livelihood improvement of non-fishers, (iv) Keeping a check on pollutants from agriculture and aqua-tourism.

Tamranga beel
(400 ha), Open

- **Major problem**: Siltation of connecting channel
- **Major management options**: (i) Rational fishing/ harvesting to sustain capture fisheries of SIFs, (ii) Pen aquaculture, (iii) Control of floating macrophytes, (iv) Fish aggregating structures (i.e., *jengs* or *katals*) for ease of capture.

Dhir beel
(556 ha), Open

- **Major problem**: Siltation of connecting channel
- **Major management options**: (i) Pen aquaculture, (ii) Rational fishing/ harvesting to sustain capture fisheries of SIFs, (iii) Periodic control of floating macrophyte, (iv) Fish aggregating structures (i.e., *jengs* or *katals*) for ease of capture.

Gross primary productivity (GPP) and fish production potential

Average gross primary productivity (GPP) and fish production potential were estimated in the eight beels over different seasons. GPP was calculated purely based on planktonic production using dark and light bottle method. Considering 1% of this GPP, fish production potential was estimated. Production potential estimated in the present study based on phytoplankton only and hence these values would be higher if macrophyte and detrital food chains were considered. Gross primary productivity (mgC/m^3/hr) of Rupahi and Dhir beels were estimated at 220.32-300.40 and 180.00-244.64, and fish production potential (kg/ha/y) based on phytoplankton were estimated at 300.91-600.14 and 370.68-400.67, respectively.



Boat seine in Sone beel, Karimganj, Assam



Fisher with lift net at Algapur anua, Cachar, Assam

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

Duration: April 2020 to March 2024

Scientific Personnel: A. K. Das (Sub-Project leader), U. K. Sarkar, Asit K. Bera, Md. Aftabuddin, Lianthuamluaia, P. J. Majhi (w.e.f. 01.04.22)

Summary

- Irregular stocking in wetlands of Murshidabad was recorded due to various issues like lease value hike, resulting in drastic decline of major carp production forcing the fishers to thrive on SIFs and other indigenous fish.
- High accumulation of sediment organic carbon (2.1-3.2%) was recorded in wetlands of Murshidabad; restoration of river connectivity for hydrological flushing is needed.
- Considering all the heavy metals, water samples of Rampara and Beloon Beel were found less contaminated as compared to Daserchalk and Magradaha wetlands.

Summary

- 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). Higher value of Shannon–Wiener diversity index (H′) 3.50 and Margalef species richness index (d) 4.30 showed healthy plankton community in seasonally open beel and moderate to high in closed beel.
- In seasonally open wetland, a total of 22 no. of macrobenthos species whereas in closed wetland, 20 no. of species were recorded. The higher Shanon index was recorded in monsoon which depicted better diversity, species richness and abundance in this season.
- Significant spatio-temporal variation of sediment enzyme activities like Acid phosphatase, β glucosidase and dehydrogenase was recorded in studied wetlands
- The most commonly disease affected species in wetlands is *Cirrhinus mrigala* followed by *Laeo rohita and L. catla* during winter season. Environmental degradation due to jute retting triggered the disease occurrence.

Assessment of ecology and fisheries of five wetlands viz. Rampara (14.5 ha), Chhar (30 ha), Beloon (335 ha), Daserchak (42 acre) and Magradaha beel (100 acre) of Murshidabad, West Bengal was carried out during 2023. The Rampara wetland and Chhar wetland is managed by Shaktipur Rampara Fisherman Cooperative Society Ltd having 720 members. Around 40-50 family members are catching fish regularly in both the wetlands. Stocking with relatively larger sized stocking material is the main management practice in both the wetlands. *Hypophthalmichthys molitrix* (Silver carp) was the most dominant in Rampara, whereas Grass carp was the most dominant in Chhar wetland. Stocking in the post-monsoon and harvesting in the late summer is the general practice. Drag net locally called "Ber jal" is the main fishing gear in both the wetlands. Apart from the stocked fish, Small indigenous fish (SIF) and other indigenous species were also contributing the fish catch. Catching of Small indigenous fish (SIF) was mostly done during the rainy seasons. Scoop nets are operated during the rainy seasons by the women for catching SIF in the wetlands. *Salmophasia phulo* was the most dominant among the SIF followed by *Parambassis lala, Puntius sophore* and *Amblypharyngodon mola* in Rampara wetland. *Amblypharyngodon mola* and *Chanda nama* was the most dominant SIF in Chhar wetland. Beloon wetland is the largest among the studied wetlands with an area of 335 ha. Stocking management was not properly followed for the enhancement of fish production here. Fishing was mainly done individually. No drag net was operated due to the macrophytes infestation in the wetland. Gill net is the main fishing gear operated in the wetland. *Eichhornia crassipes*, *Lemna minor*, *Lemna major*, *Pistia* spp., *Azolla* spp., *Chara* spp., and *Hydrilla verticillata* were the important macrophytes in the wetland. Stocking of Grass carp can effectively utilize the macrophytes for the enhancement of fish production in the wetland. An immediate need is to rejuvenate the beel with phase-wise attempt for de-weeding the water body including the excavation for de-silting in littoral areas and restoring the connection of the beel with the adjacent river. SIF and other naturally occurring indigenous fish play an important role in the wetland as there was no proper stocking. *Pethia phutunio, Puntius terio, Puntius sophore* and *Parambasis ranga* were the important species among the SIF.

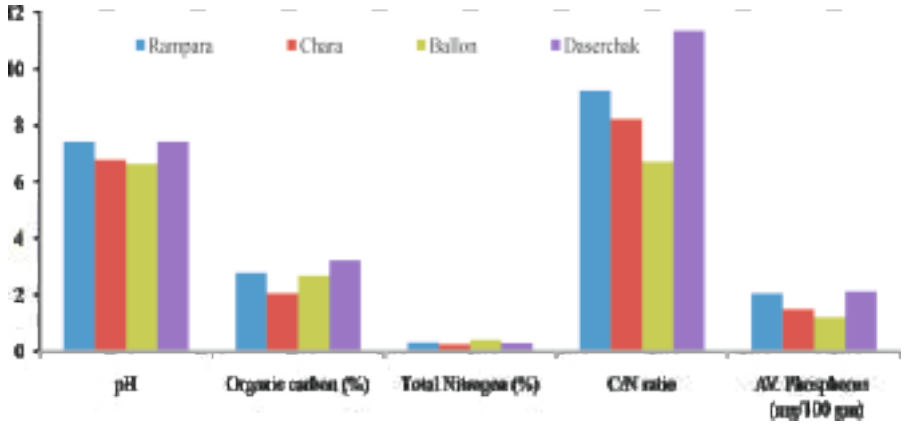
Fisheries management of Daserchak wetland is done by the local fisheries cooperative society, 'Daserchak Matsyajibi Samabay Samiti'. Due to the hike in lease value, there was an issue in managing the fisheries. Big head carp, silver carp, catla, rohu, mrigal and bata dominated the fish catch. As no stocking is being made regularly, major carp production has been drastically reduced forcing the fishers to thrive on SIFs and other indigenous fish. The submerged macrophytes create hindrance in operating fishing gears especially drag nets. In most occasions, gill nets and traps are being used with no mesh size regulation.

Sediment and water quality of selected wetlands of Murshidabad, West Bengal

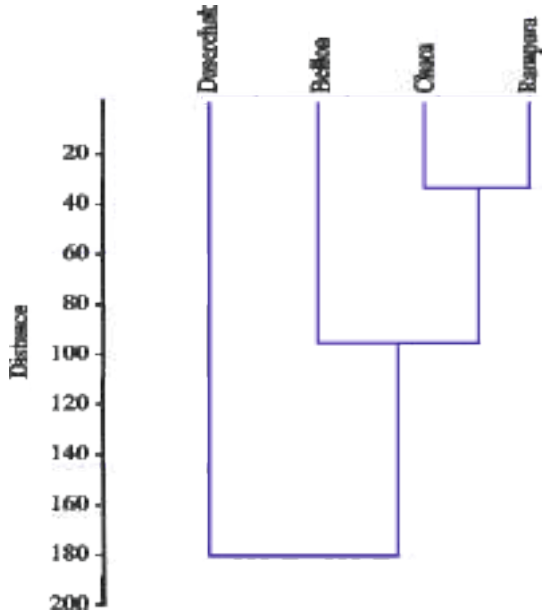
The sediment parameters of the studied wetland indicated that most of the parameters related to fish production were suitable for fish production. The sediment pH (7.4), Organic Carbon (3.2%), C/N ratio (11.35) and available phosphorus (2.11 mg/l) was at the highest in Daserchak wetland indicating the productiveness of the wetland for fish production. The Total nitrogen content of the sediment was at the highest 0.3 mg/l in Rampara wetland. Most of the critical water quality parameters indicated that the wetlands were suitable for fish production. The variation pattern of the water quality parameters using a cluster analysis indicated that Daserchak was distinct from the other wetlands. Specific conductivity (398.5 mg/l), Total Alkalinity (230.75 mg/l), DO (9.8 mg/l), Total phosphorus (0.064 mg/l) and Silicate (5.25 mg/l) were at the highest in Daserchak wetland indicating the productivity of the wetland.

Heavy metal status in wetlands

The water samples of the five wetlands were analyzed for presence of heavy metals during September, 2023. Across the sampling sites of the wetlands, Al concentration varied between 1.66 µg/l (Beloon beel)-3561.904 µg/l (Rampara beel), about 1800 µg/l of Al was also detected in Daserchak and Magradaha sampling sites. Presence of other heavy metals such as Cr, 1.544 µg/l (Rampara)-26.28 µg/l (Chhar beel); Mn, 12.764 µg/l (Beloon) - 91.496 µg/l (Magradaha); Fe, 223.188 µg/l (Rampara) - 11868.584 µg/l (Beloon); Co, 0.1572 µg/l (Beloon beel) - 6.408 µg/l (Magradaha); Ni, 243.904 µg/l (Daserchalk) - 506.416 µg/l (Rampara); Cu, 9.08 µg/l (Rampara) - 79.648 µg/l (Magradaha); Zn, 19.008 (Rampara) -308.532 (Magradaha) µg/l; As, 39.896 µg/l (Beloon beel) - 1627.324 µg/l (Daserchak); Pb, 15.696 µg/l (Daserchak) - 77.280 (Rampara) µg/l; Cd, up to 14.572 µg/l (Beloon beel) were detected in collected water samples. Considering all the heavy metals, water samples of Rampara and Beloon beel were found less contaminated as compared to Daserchalk and Magradaha wetlands.



Sediment parameters of wetlands of Murshidabad

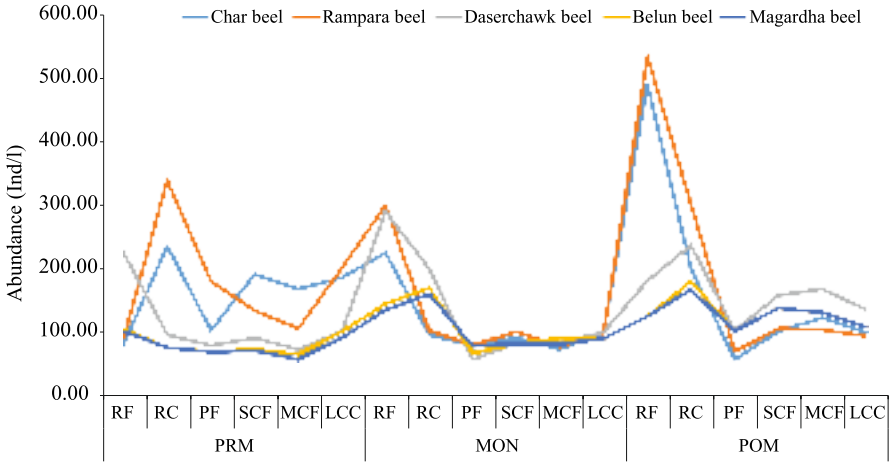


Cluster analysis based on the water quality parameters of the wetlands of Murshidabad

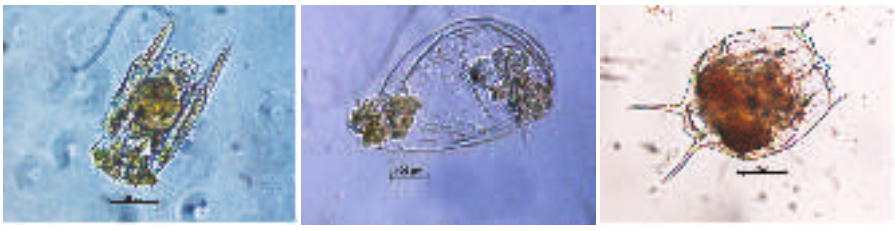
Assemblage patterns and plankton community structure

The present study attempts to assess spatio-temporal dynamics of phytoplankton and zooplankton community composition / assemblage, diversity and eco-hydrological interaction from five wetlands; namely Chhar beel, Rampara beel (seasonally open), Beloon beel, Daserchak beel and Magradaha beel (closed) from Bhagirathi-Hooghly stretch of lower Gangetic basin covering summer (pre-monsoon), rainy (monsoon), winter (post-monsoon) seasons. A total of 58 and 47 zooplankton species were observed from seasonally open and closed beel, which were grouped into 6 functional groups based on their body size/length and mode of feeding, such as rotifer filter feeders (RF), rotifer carnivore (RC), protozoa filter feeders (PF), small copepods and cladocerans filter feeders (SCF), middle copepods and cladocerans filter feeders (MCF), large copepods and cladocerans carnivore (LCC). In seasonally open beel, the functional group "RF" was dominated 50% of total abundance followed by (RC) group 28.45% in post monsoon season. The "RF" was mainly dominated by *Brachionus Caudatus*, *B. forficula*, *F. terminalis*, *Hexarthra* sp. In pre-monsoon, "RC" accounted the highest percentage (33.42%) followed by SCF and LCC. Among the "RC", *Polyarthra* sp. and *Trichocerca* sp. were dominated. However, in closed beel "RF" was dominated (29.56%) in pre-monsoon followed by RC and LCC. The functional group "RF" was mainly dominated by *Brachionus calyciflorus*, *B. falcatus, B. angularis*, *Keratella* sp., whereas, in post-monsoon season "RC" accounted highest percentage (33.42%) followed by RF, SCF and MCF. The functional group "RC" was dominated by mainly *Asplanchna* sp. The mean zooplankton abundance was maximum in Rampara beel (995.14 ±102.42 ind./l) and minimum in

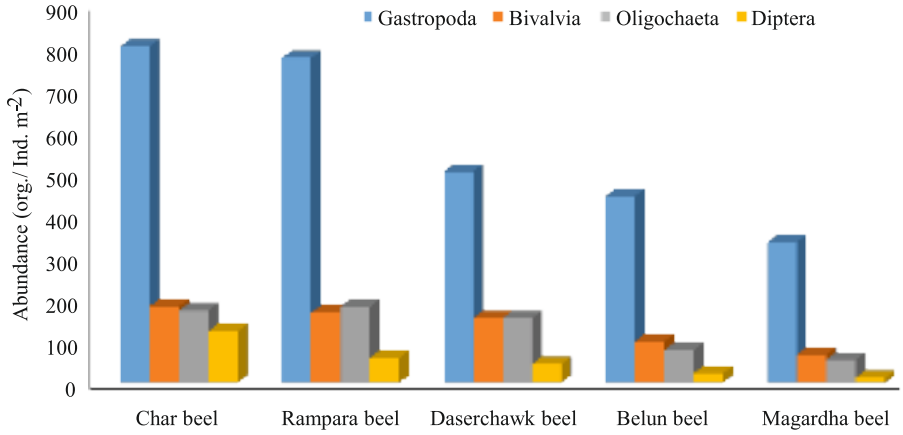
Magradaha beel (608.33 ±92.36 ind./l). The studied beels were mainly dominated by "RF" and "RC" functional groups. An IndVal test showed that the high *IndVal* (⩾40%) was documented for *B. calcyflorus, B. fulcatus, B. diversicornis, K. tropica, Asplanchna* sp., *Testudinella, Diaphanosoma,* and the taxa of calanoid and cyclopoid copepods in all five beels environment which were potential bioindicator of environmental quality in the studied wetlands. 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 (3.26×10^4 cells l^{-1}) and minimum in monsoon (2.13×10^4 cells l^{-1}). However, in the closed wetland, the mean abundance was maximum during post-monsoon (2.17×10^4 cells l^{-1}) followed by monsoon (1.96×10^4 cells l^{-1}). Beloon beel was found with dominance of Cyanophyceae, while Chhar beel with Bacillariophyceae and Rampara beel with Chlorophyceae. Higher value of Shannon – Wiener diversity index (H′) 3.50 and Margalef species richness index (d) 4.30 showed healthy plankton community in seasonally open beel and moderate to high range in closed beel.



Seasonal abundance of zooplankton functional group in five wetlands



Polyarthra sp. *Asplanchna* sp. *B. caudatus*

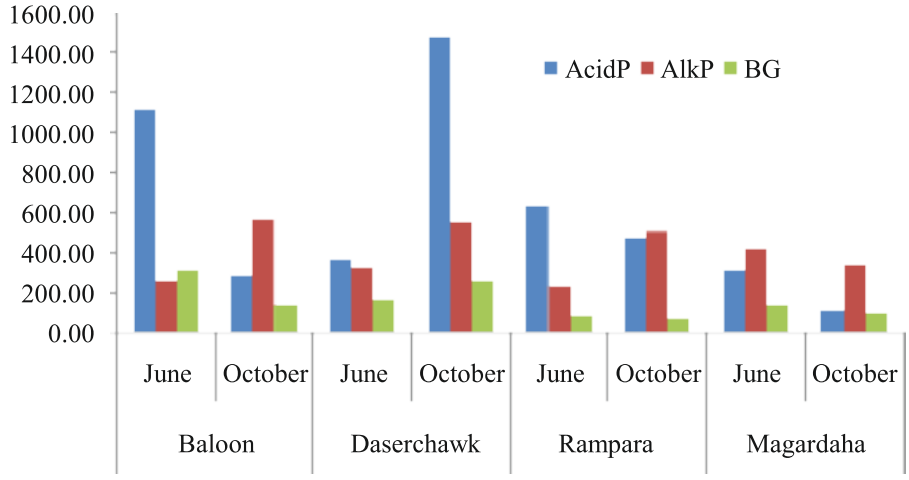


Abundance of macro-zoobenthic community of five wetlands

Benthic community

Spatio-temporal dynamics of assemblage patterns and community structure of macro-zoobenthos were studied from five wetlands, *viz.* Chhar beel, Rampara beel (seasonally open), Beloon beel, Daserchak beel and Magradaha beel (closed) from Bhagirathi-Hooghly stretch of lower Gangetic basin. In seasonally open wetland, a total of 22 no. of species, whereas in closed wetland, 20 no. of species were recorded. The community structure of macro-zoobenthos in seasonally open beel showed the dominance of gastropoda (95%), followed by bivalvia (0.68%), oligochaeta (0.26%) and diptera (0.10%). Similarly, in closed beel also showed dominance of gastropoda (47.38%) followed by oligochaeta (41.36%), diptera (10.02%) and bivalvia (1.24%). The most dominant species among gastropod in seasonally open and closed beel were *Gabbia orcula* (663 ± 228) and (566 ± 247) followed by *Gyraulus convexiusculus, Thiara granifera,* and *Thiara lineata.* The

result of diversity indices revealed that in seasonally open wetland, the average Simpson index was 0.7, with maximum value in monsoon (0.8) as compared to other seasons that indicated the better distribution pattern in monsoon season. Similarly, average Shannon indices was 1.7 and the higher value in the monsoon and winter season indicated the better diversity, species richness and abundance in these seasons. In closed wetland, average Simpson index was 0.8 and higher value of 0.9 was recorded in monsoon which revealed better distribution pattern in this season. The average Shannon index recorded was 1.9 and higher value observed in monsoon which depicted better diversity, species richness and abundance in this season.



Seasonal and wetland-wise variation of sediment enzyme activities

Spatio-temporal variation in sediment enzyme activities of wetlands

Wetland health and productivity using sediment associated enzyme activities were assessed in four wetlands of Murshidabad district, West Bengal during June (summer) and October (monsoon), 2023. Acid phosphatase activity was higher in summer than monsoon except Daserchak while alkaline phosphatase showed opposite trends in magnitude of activities except Magradaha. Pooled average data of two season revealed significant variation (211.45 -921.19 µg p NP/g dry soil /h) in acid phosphatase activities among wetlands and was in the order of Daserchak > Beloon > Rampara > Magradaha. Variation of alkaline phophatase activities among wetlands is marginal (365.41-433.66 µg p NP/g dry soil/h). Notable variation was also observed in β glucosidase (78.99-225.63 µg p NP/g dry soil /h) and dehydrogenase (µg TPF/ g dry soil /h) activities among the studied wetlands. The hierarchy of glucosidase and dehydrogenase activities were Beloon> Daserchak> Magradaha > Rampara and Daserchak> Rampara> Beloon> Magradaha respectively. Dehydogenase activities markedly decreased from summer to monsoon for all wetlands. β-Glucosidase activities showed varied seasonal change with marked decreased activities in Beloon and Magradaha, marginal decrease activity in Rampara and increased activities in Daserchak.

Participatory approach to prevent disease occurrence in floodplain wetlands

Data on fish disease occurrence pattern and mortality history was collected in the month of October from wetlands namely Daserchak beel, Beloon beel, Magradaha beel, Rampara beel and Chhar beel. Collected fish samples from catch of local fishermen from the wetland were examined. Based on data provided by the society, it is revealed that disease occurs due to seasonal impact along with jute retting. These factors further aggravate with infectious disease mostly caused by bacteria. The most commonly affected species is *Cirrhinus mrigala* followed by *Laeo rohita* and *L. catla* during winter season. Due to severe alteration in the sediment and water quality, small indigenous fishes are also affected. Detailed discussion was made with the society members about the disease problem in fish farming. The society members were suggested to take precautionary measures for prevention of fish diseases and treatment during early stage of fish diseases.

Table: Pollution monitoring of wetlands of Murshidabad, West Bengal by sediment enzyme activities (Average and Range)

Wetlands	Dehydrogenase: (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)
Katiganga	52.84(10.84)	327.99(16.6)	485.38(85.1)	106.86(42.6)
Bishnupur	121.24(59.00)	231.78(149.3)	511.88(275.0)	152.74(135.0)
Chaltia	76.1	148.4	358.37	92.6

Sampling of wetlands sediments was conducted in 3 wetlands in Murshidabad district of West Bengal comprising two wetlands resceiving waste materials of Berhampore city and one with natural wetland with agriculture land as catchments. Variation of all four sediment enzyme activities among sectors is more in Bishnupur(sewage fed) than Katiganga (natural) wetlands and that for alkaline phosphatase than dehydrogenase. With respect to wetlands higher activities of dehydrogenase and glucosudase in sewage fed than natural while opposite for acid phophatase. The data indicates scope for using dehydrogenase, acid phophatase and glucosidase as indicator for comparative assessment of wetland ecosystem with respect to sewage intrusion.

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

Duration: April 2020 to March 2024

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

Summary

- Institutional mechanism was identified as major factor for sustainable fisheries in wetlands of Bihar, where lack of proper ownership in Bhusra wetland made it near defunct with almost fully choked with floating macrophytes; whereas Manika and Simra maun observed better fishery with newly leased owners.
- The total fish production of the Manika maun was approximately 36000 kg with average yield of 342 kg/ha/year, whereas that in the Simra maun was recorded at 14000 kg with an average yield of 213 kg/ha/year.
- Impact of management was evident in water quality where very low dissolved oxygen (2.6 ± 0.22 mg/l) was recorded in floating weed choked Bhusra maun, as compared to moderate value (4.2 ± 0.85 mg/l) in Manika maun and good oxygen level (7.90 ± 0.14 mg/l) in Simra maun.

The ecology of three floodplain wetlands (mauns) of Bihar namely Manika, Simra and Bhusra were studied in 2023. In Bihar, the ownership of wetlands lies with the state fishery department, the fishing right is leased to the Primary fisheries cooperative society of the three blocks. New lease of five years has been initiated in the three blocks with the election of cooperative executive committee. The new committee has overtaken the fishing rights in Manika and Semra maun. In Bhusra maun, the cooperative election was challenged in court and hence, the new lease is not yet initiated. The fishing operation has been halted since September 2023 due to court case. The fisheries management in Manika and Siemra maun lease has been initiated by the newly elected cooperative members team.

Manika maun is a seasonally opened wetland; during monsoon it is connected to Burhi Gandak river through a narrow channel. This maun is located Mushari block of Muzaffarpur district of Bihar with an average water area of 120 ha and average depth of 3 meter. A total of 270 fishing families are dependent on this maun. The recorded fish samples of this maun during experimental fishing were *Cirrhinus reba, Labeo rohita, Hypophthalmichthys nobilis,*

Table: Property regimes of three selected wetlands

Wetlands	Size (ha)	Ownership	Lease		Fishing regime	Type of Wetland	Connecting River
			Rent/Yr (Rs.)	Period (Years)			
Simra	80	DOF, Bihar	2,00,000	5	Cooperative	Semi Open	Budhi Gandak
Bhusra	70	DOF, Bihar	Under dispute	5	Cooperative	Semi open	Baghmati
Manika	120	DOF, Bihar	2,75,000	5	Cooperative	Semi open	Budhi Gandak

Glossogobius giuris, Channa striata, Trichogaster fasciata, Chanda ranga, Mastacembelus pancalus, Nandus nandus, Prawn. Among the benthos samples, gastropods are the dominant groups with *Filopaludina bengalensis* and *Lymnaea acuminate* being two major contributors. In last year, the maun was stocked with 2000 fingerlings of *Labeo rohita, Catla catla, Cirrhinus mrigala, Hypophthalmichthys nobilis* and *Cyprinus carpio* per hectare in the month of September-October. The fishing here was mainly carried out with a drag net by a group of five to six fishers five days a week. The average daily catch was 50 kg/day/dragnet. The total fish production of the maun was approximately 36000 kg in with average yield of 342 kg/ha/year, despite loss of fishes during rapid flood when 4-5-month-old juvenile fishes were caught by the nearby villagers. In northern area of the maun, some mortality of fishes was visible during winter sampling.

Simra *maun* is also a seasonally open wetland having a connection to Burhi Gandak river during the monsoon period. This waterbody has a water area of 80 ha with an average depth of 3.5 meter located in Bandara block of Muzaffarpur district. A total of 160 fishers' families of the surrounding villages were dependent on it. 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, Puntius ticto, Puntius terio, Nandus nandus, Anabas testudineus, Parambassis lala, Xenetodon cancila, Amblypharyngodon mola, Mystus tengara, Chanda nama, Chanda ranga, Colisa fasciata, Colisa lalia, Osteobrama cotio, Salmostoma bacaila, Laubuca laubuca, Gudussia chapra and Neotropius atherinoides, Channa straitus*. The stocking in this wetland was carried out in October last year with 1500 fingerlings per hectare. The fishing was started from January onwards and carried out three to four days in a week. Fishers are generally using drag nets to catch the fishes and the average catch is 20-30 kg/day/dragnet. The total fish production of the wetland was recorded 14000 kg with an average yield of 213 kg/ha/year. The stocking this year was delayed due to flood situation in the wetland.



Bhusara maun, presently choked with floating weed due to ownership conflict (winter, 2023)

Bhusra maun a seasonally open maun 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 meters. The fisheries management of this wetland has not been decided this year due to court cases filed by the rival cooperative faction over management control of the wetland. This has led to complete stop of fishing activities since September, 2023. 80% of the waterbody is completely chocked with floating weeds and no water is visible in that area.

Table: Water Quality Parameters of Bhusra, Semra and Manika maun during post-monsoon period

Parameters	Bhusra	Simra	Manika
Air (°C)	17.0± 0.1	16.1±0.14	21.35 ± 0.21
Water (°C)	17.9 ± 0.32	20.15 ± 0.49	19.15 ± 0.50
Depth (cm)	264.0 ± 51.20	490.50 ± 225	231.0 ± 70.7
Transparency (cm)	201.2 ± 5.6	192.5 ± 9.2	Bottom visible
Dissolved oxygen (mg/l)	2.6 ± 0.22	7.90 ± 0.14	4.2 ± 0.85
pH	7.08 ± 0.2	7.92 ± 0.01	7.54 ± 0.11
Conductivity (µS/cm)	416.0 ± 2.5	197.2 ± 1.4	541.0 ± 1.4
Total Alkalinity (ppm)	158.0 ± 2.6	81.0 ± 2.4	217.0 ± 1.4
Total Hardness (ppm)	260 ± 6.6	131 ± 7.1	311 ± 12.7
Total Dissolved Solids (ppm)	295 ± 0.8	140 ± 1.4	384 ± 0.6



Potamogeton sp.



Ludiwigia sp.



Marsilea sp.

Macrophytes diversity in Manika Maun

Water quality

Macrophytes diversity in Manika Maun

A flourished diversity of macrophyte resources has been observed in Manika maun. Species like *Marsilea* sp., *Eichhornia* sp., *Datura* sp., *Ludiwigia* sp. and *Potamogeton* sp. were found in Manika maun. Moreover, most of the mauns were weed choked and particularly the Bhusra maun was about 75-80% weed chocked mainly by *Eichhornia* sp.

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

Duration: April 2020 to March 2023

Scientific Personnel: A. Alam (Sub-Project leader), Monika Gupta (upto 08.10.21), Venkatesh Thakur, Jeetendra Kumar, Shravan K. Sharma (w.e.f. 01.04.22) and Vikas Kumar (w.e.f. 01.04.22)

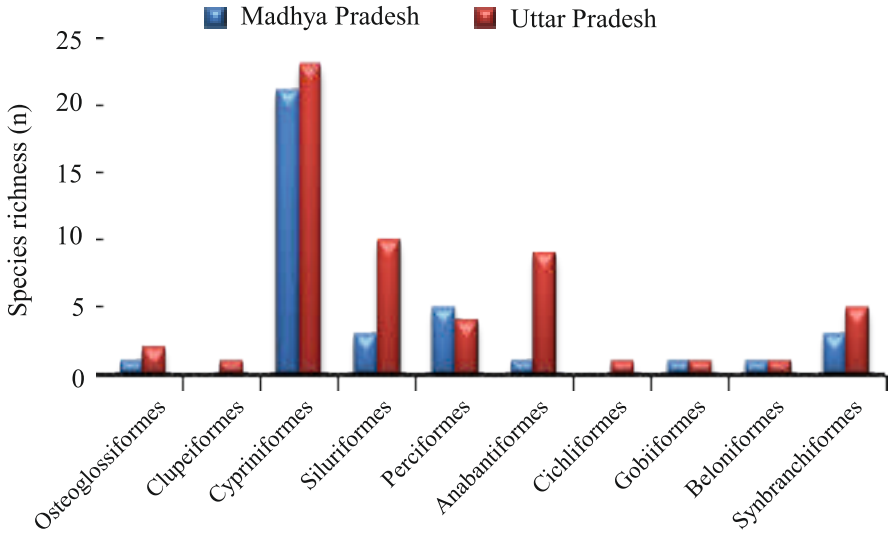
Summary

- A total of 57 fish species belonging to 38 genera, 22 Families and 10 orders were recorded from the four selected wetlands in Uttar Pradesh. The four wetlands of Madhya Pradesh (MP) documented a total of 36 fish species belonging to 31 genera, 18 families and 8 orders.
- In Ramgarh tal, Gorakhpur, Uttar Pradesh, water quality parameters were found to be higher than all other studied wetlands. This could be attributed to the higher pollution load in the Ramgarh which is situated in the heart of the city. As evidence, highest plankton density (5.4 x 10^6 u/l) with dominant Blue-green algae were recorded in Ramgarh tal among all the studied wetlands.
- A total of 98 periphyton species were recorded in four wetlands of Uttar Pradesh. In case of Madhya Pradesh wetlnads, it was only 27 genera.
- The average monthly family income of fishermen dependent on wetlands varied from ₹3043 (Lokpal Sagar) to ₹9818 with maximum being from Man Sagar, Madhya Pradesh followed by Kitaman tal (₹9525) and Ramgarh tal (₹8312), Uttar Pradesh.

During post-monsoon season of 2023, four wetlands each in Uttar Pradesh and Madhya Pradesh were investigated for the ecology and fisheries. These were Kitaman tal (150 ha) in the Kushinagar, Jatiya tal (83 ha), Bakwa tal (40 ha) and Ramgarh tal (678 ha) in Gorakhpur districts of Uttar Pradesh. In Madhya Pradesh, four wetlands were Govindgarh lake (307 ha) in Rewa district, Devendra Nagar (190 ha), Lokpal Sagar (240 ha) and Man Sagar (185 ha) lakes from the Panna district. The fisheries in all these wetlands are managed by the co-operative societies except Kitaman tal in Kushinagar. Supplementary stocking was done @ 3000-4000 fingerlings/ha in wetlands of Uttar Pradesh with major carps and exotics (Grass carp, Silver carp, Chinese carp and Big head), and arbitrarily @ 2-3 lakh fingerlings/year in wetlands of MP. The catch composition showed the dominance of catfish (50%) at Govindgarh whereas in other wetlands, major carps dominated (65-70%).

Ichthyofaunal diversity

A total of 57 fish species belonging to 38 genera, 22 Families and 10 orders were recorded from the selected wetlands in Uttar Pradesh. The most



Order wise fish species richness in selected wetlands of Madhya Pradesh and Uttar Pradesh

species rich order was Cypriniformes (24) followed by Siluriformes (10), and Anabantiformes (9), respectively. The most species rich family was Cyprinidae (13), followed by Danionidae (8), Ambassidae (4), and Channidae (4), respectively. The wetlands of Madhya Pradesh (MP) documented a total of 36 fish species belonging to 31 genera, 18 families and 8 orders.

Water and soil quality

The analysis of water quality parameters in wetland of Uttar Pradesh and Madhya Pradesh revealed alkaline nature of their water with pH and total alkalinity ranging from 7.2-10.62, and 42-154 mgl^{-1}. The dissolved oxygen, total hardness and transparency varied from 6.5-12.0 mgl^{-1}, 44-314.6 mgl^{-1}, and 23-148 cm. The other important water quality parameters, specific conductivity, total dissolved solids, chloride, dissolved organic matter ranges were 33-676 µS/cm, 17-480 mgl^{-1}, 19-66 mgl^{-1}, and 0.5-7.2 mgl^{-1}. The nutrient status of water of silicate, nitrate-N, Phosphate-P ranged from 2.3 - 24.45 mgl^{-1}, 0.05-0.5 mgl^{-1} and 0.02-1.98 mgl^{-1}, respectively. The gross and net productivity in these wetlands varied from 49 to 250 $mgC/m^3/hr$, and 24 to 167 $mgC/m^3/hr$. In Ramgarh tal, water quality parameters were found to be higher than all other studied wetlands. This could be attributed to the higher pollution load in the Ramgarh which is situated in the heart of the city.

The soil analysis indicated the alkaline character of the sediment with pH ranging from 7.0 to 8.0 being highest in Ramgarh wetland (8.0). The texture of soil had sand as major component ranging from 78 to 97% suggested that the soil was sandy loam. The mean values of nutrients in terms of available-N and available-P in the soil of wetlands of Madhya Pradesh were 18.6, 17. 3, 17.4 and 33.4 mg N g^{-1} & 13.01, 5.72, 18.7 and 19.3 mg P g^{-1} in Govindgarh, Devendra Nagar, Lokpal Sagar and Man Sagar, respectively; and Uttar Prdesh were 16.56, 21.79, 33.58 and 13.54 mg N g^{-1} & 22.11, 16.57, 15.10 and 16.13 mg P g^{-1} in Jatiya, Kitaman, Bakwa and Ramgarh tals, respectively.

Plankton

A total of 59 phytoplankton species belonging to four phyla viz., Heterokontophyta (diatoms), Chlorophyta (Green algae), Cyanobacteriota (Blue-green algae) and Euglenophyta (Euglenoids) were recorded in four wetlands of Uttar Pradesh in post-monsoon season. While only 24 plankton species were recorded from selected wetlands of Madhya Pradesh. The highest phytoplankton species was recorded in Bakwa tal (32 sp.) followed by Kitaman tal (31 sp.). Phytoplankton abundance ranged from 2.2 x 10^4 to 5.4 x 10^6 u/l. The highest density was recorded in Ramgarh tal while lowest density was recorded in Govindsagar. Blue-green algae were highly dominant in Ramgarh tal.

Periphyton

A total of 98 periphyton species belonging to Heterokontophyta (Diatoms), Chlorophyta (Green algae), Cyanobacteriota (Blue green algae) and Euglenophyta (Euglenoids) were recorded in wetlands of Uttar Pradesh. The highest species was recorded in Kitaman tal (49 sp.) followed by Bakwa (35 sp.), Ramgarh (34 sp.) and Jatiya tal (28 sp.), respectively. Species density ranged from 7.8 x 10^5 to 4.9 x 10^6 ucm^{-2}. The highest density was recorded in Kitaman tal (4.9 x 10^6 ucm^{-2}) followed by Ramgarh tal (1.4 x 10^6 ucm^{-2}), Bakwa tal (1 x 10^6 ucm^{-2}) and Jatiya tal (7.8 x 10^5 ucm^{-2}), respectively.

A total 27 genera of periphyton 10 belonging to Heterokontophyta (Diatoms), 12 to Chlorophyta, 04 to Cyanobacteriota, and 01 to Charophyta were recorded from the selected wetlands of Madhya Pradesh. The periphytic abundance ranged from 4.6 x 10^4 to 7.1 x 10^5 ucm^{-2} with maximum being at Lokpal Sagar.

Socio-Economics

The socio-economic study was conducted among the fisher households in four wetlands each in Uttar Pradesh and Madhya Pradesh. The literacy rate ranged between 40 and 70% being the highest in Kitaman tal and the lowest in Devendra Nagar tal. The mean family size ranged between 3.9 to 6.9 with

Table: Socio-economic profile of the fishermen of the selected wetlands in Uttar Pradesh and Madhya Pradesh

Parameters	Literacy rate %	Mean Family size	Males per female	Fishing as main occupation (%)	Kaccha House (%)	Landless fishermen (%)	Incomes (₹/family/month)
Ramgarh tal	66	6.4	1	90	25	90	8312
Kitaman tal	70	5.75	1.8	70	30	40.4	9525
Bakwa tal	63	5.1	1.2	30	30	56.5	7250
Jatiya tal	55	6.8	1.2	10	80	91.2	5022
Govindgarh	53.3	3.8	0.71	100	97	93.3	3843
Devendra Nagar	40	4.5	0.83	100	50	80	3850
Lokpal Sagar	57	3.6	0.5	80	60	40	3043
Man Sagar	82	3.9	0.71	50	40	50	9818

the highest in Jatiya tal and the lowest in Lokpal Sagar. The number of males per female ranged from 0.5 to 1.8 showing higher number of males in families of Uttar Pradesh and higher number of females in the families of Madhya Pradesh. The main occupation of the fishermen was fishing in almost all wetlands except in the Bakwa where only 30% of them had it as their main source of livelihood. The possession of Kaccha house ranged from 30 to 97%, being maximum in Govindgarh (97%), followed by Jatiya. The percentage of landless fishermen varied between 40 and 93.3%, being highest in Govindgarh tal followed by Jatiya (91.2%), Ramgarh tal (90%), etc. The highest percentage fishermen possessing land were from the Lokpal Sagar (60%). The average monthly family income of fishermen dependent on wetlands varied from ₹3043 (Lokpal Sagar) to ₹ 9818 with maximum being from Man Sagar followed by Kitaman tal (₹9525), Ramgarh tal (₹8312)

Project Title: Exploration of ecosystem dynamics and fisheries of Kanva (Karnataka), Sathanur (Tamil Nadu) and Banasurasagar (Kerala) reservoirs for sustainability and conservation

Project Code: RWF/23-26/15

Duration : April 2023 to March 2026

Principal Investigator: Preetha Panikkar

Scientific Personnel : Ramya V.L., Jesna P.K., Sonalika Sahoo

Summary

- Data collected for monsoon sampling, recorded a total of 33 Species belonging to 10 families and 7 orders in Sathanur reservoir. The mullet, *Rhinomugil corsula* dominated in this reservoir, accounted for 37.5% of the catch. Species richness was maximum in riverine zone (28) of the reservoir followed by transitional (25) and riverine (21) zones.
- The average net primary productivity of Sathanur reservoir was 144 mgC/m^3/hr. The production potential of the reservoir was 2190 kg/ha/yr.
- The commercial catch of the Kanva reservoir was dominated by IMCs and experimental fishing recorded 22 species belonging to seven order and ten families. The fish abundance and species richness was maximum in Cyprinidae family.
- The average net primary productivity of Kanva reservoir was 48 mgC/m^3/hr. The production potential of the reservoir was 730 kg/ha/yr.

Sathanur Reservoir, Tamil Nadu

Sathanur Reservoir is located in Tamil Nadu, Southern India at the latitude of 12.2064°N and longitude of 78.8567°E. It is a masonry dam, which spans the South Thenpennai river with the capacity of 7,321,000,000 cubic feet and a depth of 119 feet at full reservoir level. The purpose of the reservoir was primarily for irrigation. The morphometric detail of the Sathanur dam is given here. This reservoir is under the control of Tamil Nadu Fisheries Development Corporation Limited (TNFDC). The complete management protocols such as stocking, fish catch and fishing regulations are controlled by TNFDC. Around 40 fisher folk families are dependent on this reservoir for their livelihood. The reservoir provides habitat for a diversity of life including the edible species of fish, aquatic macrophytes, benthos, nekton and plankton.

The collections of samples for biotic and abiotic parameters were carried out in a spatio-temporal scale. In the temporal scale, four seasons (Pre-monsoon, monsoon, post-monsoon, and summer) were decided based on the local climatic conditions of the reservoir. In spatial scale, different zones such as Lentic, Intermediate and Lotic zones were selected for sampling. For deriving fish assemblage pattern, the fish abundance data from the experimental catch using multi-layered gill nets and commercial catch were assessed.

Table : Morphometric details of Sathanur Dam, Tamil Nadu

Maximum height	72 ft
Top width of the dam	20 ft
Top of dam (Road)	130'3" ft
Top of the parapet wall	133'6" ft
Length of the earth dam	1185 ft
Earth dam type	Zone (Impervious & Semipervious)
U/S Relevant thickness	0.9 m, 0.6 m & 0.4 m
U/S slope	3.1 & 2.5:1
D/S slope	2.5 & 2:1
Maximum Depth (Water level)	119 ft



Sampling at Sathanur reservoir, Tamil Nadu

Fish composition

A total of 33 Species belonging to 10 families and 7 orders were reported from the Sathanur reservoir. Species richness and abundance was high in the Cyprinidae family followed by Cichlidae and Mugilidae. The commercial catch was dominated by Indian Major Carps (IMCs). The experimental catch recorded *Rhinomugil corsula*, *Dawkinsia filamentosa*, and *Etroplus suratensis* as the most abundant species. The mullet, *Rhinomugil corsula* dominated in the catch (37.5% of the total catch) and the highest abundance was recorded at the intermediate site. The average length of the species was 27.5 ± 2.8 cm and weight 210.8 ± 15.6 g. Species richness was maximum in lotic zone (28) of the reservoir followed by intermediate (25) and lotic (21) zones.

Physico-chemical properties of Sathanur reservoir water

The reservoir water depth varied from 9.6-29 m and Secchi disc depth ranged from 75 -160 cm. The monsoon water samples were alkaline in nature, ranging from 8.1-9.01 (avg. pH 8.33) and the specific conductivity varied from 1149 to 1172 µS/cm. The average total alkalinity was 75 mg/l and DO varied between 8.11-11.33 mg/l. The TDS



Sathanur reservoir, Tamil Nadu



Sampling at Kanva reservoir, Karnataka

and total hardness varied between 320- 560 mg/l and 148-228 mg/l. The nitrate, phosphate and silicate concentration varied between 0.11 - 0.21 mg/l, 0.38-0.51 mg/l and 5.49-5.81 mg/l respectively. Higher turbidity, TDS, hardness, nitrate, chloride and phosphate concentrations were observed in both the lotic sites. The nitrate and phosphate concentration of the reservoir indicate moderate to high productivity. The average net primary productivity of Sathanur reservoir was 144 mgC/m^3/hr. The production potential of the reservoir was 2190 kg/ha/yr.

Kanva reservoir, Karnataka

Kanva Dam was built in 1946 across the Kanva River for irrigation, located in the Ramanagara District, Karnataka at the latitude of 12°43′45.36″N and Longitude 77°11′53.45″E. The total area of the reservoir is 776 ha at FRL. The maximum height of the dam is 22.57 m. Around 10-15 fishermen are involved in the fishing activity. In the catchment area, the granite suite is represented by granite Porphyries with huge phenocrysts of potash feldspar. Apart from granite porphyries, the area is well represented by coarse grained grey and pink granites too.

Fish composition

IMCs dominated in the commercial catch at Kanva reservoir. The experimental fishing showed the occurrence of 22 species belonging to seven order and ten families. The fish abundance and species richness were maximum in Cyprinidae family. Species richness was high in lotic zone (22) followed by lentic (18) and intermediate (17) zones. The species belonging to the family Heteropneustidae and Mastacembalidae were recorded only in the lotic zone of the reservoir. *Salmostoma* spp. dominated at all the zones of the reservoir with more than 85% abundance.

Physico-chemical properties of Kanva reservoir water

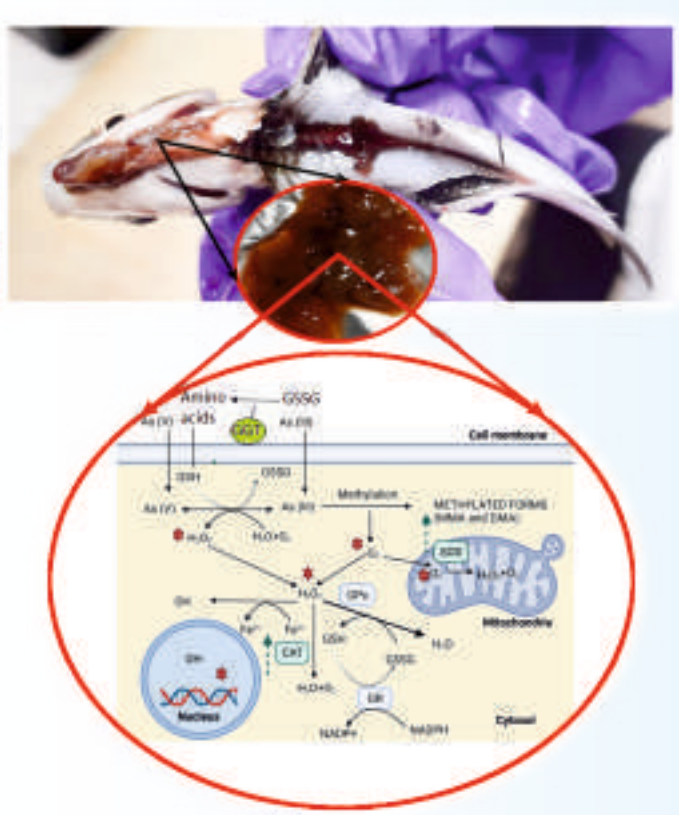
During the study period (September to November) the water was alkaline in nature and the water pH varied from 7.5 to 8.1. The average specific conductivity varied from 587 to 605 µS/cm. The TDS was slightly higher in September (293 mg/l) than that in November month samples (248 mg/l). The average DO values ranged from 5.80 to 8.11 mg/l. The average total alkalinity was lower in September. The nitrate, phosphate and total phosphate content was higher in September due to nutrient input by runoff water from adjacent agricultural field. Silicate concentration did not vary significantly across the three months. The nitrate and available phosphate data indicate low productivity of the reservoir. The average net primary productivity of Kanva reservoir was 48 $mgC/m^3/hr$. The production potential of the reservoir was 730 kg/ha/yr.



Abundance of *Salmostoma* spp. in Kanva reservoir, Karnataka



Fisheries Resource Assessment and Informatics



वार्षिक प्रतिवेदन

Annual Report

2023

Fisheries Resource Assessment and Informatics

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

Project Code : FREM/20-23/16

Principal Investigator : S. K. Nag

Sub-project 1: Monitoring of targeted pesticides and emerging contaminants in selected water bodies

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

Sub-project 1: Monitoring of targeted pesticides and emerging contaminants in selected water bodies

Duration : April 2020 to September 2023

Scientific Personnel : S. K. Nag (Sub-project leader), S. K. Manna, Soma Das Sarkar, Md. Aftabuddin, Kavita Kumari (on leave 22.08.22-30.03.23), Ajoy Saha

Summary

- Residues of few pesticides were detected in water at very low concentration in the middle and upper stretch of River Cauvery in Karnataka and Tamil Nadu. Emerging contaminants Triclosan, Triclocarban, BPA, and Phthalates were detected in few fishes collected from different sites along the river.
- Residues of metabolites of DDT like DDE and DDD were recorded in water albeit at a very low concentration in three freshwater wetlands of Murshidabad district of West Bengal. Accumulation of residues of synthetic pyrethroids was noticed in sediments of these wetlands.

Chaltia beel (24°04′2″N to 24°04′45″N, 88°14′33″E to 88°15′43″E) is located in Bhakuri Gram Panchayat adjacent to Berhampore municipality in Murshidabad district of West Bengal. It has a total water area of 59 ha. The beel is under stress due to sustained release of untreated sewage water by the adjacent municipality, sometimes causing mass mortality of fishes and thus causing economic loss and threat to the livelihood of fishers.

Bisnupur beel (24° 06′ 25″ N to 24° 04′ 59″ N, 88° 15′ 51″ E to 88° 16′ 2″ E) is located in the Berhampur municipality area of Murshidabad district of West Bengal. It is a natural horse shoe lake derived from the River Ganga having a water spread area of around 150-175 ha.

Katiganga beel (24° 07′ 21″ N to 24° 07′ 36″ N, 88° 16′ 51″ E to 88° 16′ 57″ E), a flood plain wetland with an approx area of 33 ha is an open wetland of Murshidabad district of West Bengal connected with River Ganga.

The physico-chemical properties of water and soil was measured. The pH of water of Chaltia was slightly acidic to alkaline while in other two wetlands, water was alkaline in reaction. Dissolved oxygen (DO) was below optimum 5 mg/l^{1} level on many occasions, particularly in Chaltia where it even measured around 2-3 mg/l^{1} in the early morning hours. The specific conductance was on a higher side at Chaltia and Bisnupur (870-1030 µS/cm^{1}) than at Katiganga (500-590 µS/cm^{1}). The total alkalinity (150-420 mg/l^{1}) and hardness (190-310 mg/l^{1}) was also very high at Chaltia and Bisnupur than at Katiganga (90-180 mg/l^{1} and 131-135 mg/l^{1} respectively). The BOD was around 6 mg/l^{1} in chaltia, 3 mg/l^{1} in Bisnupur and 2 mg/l^{1} in Katiganga. Similarly, COD was also higher in Chaltia and Bisnupur than at Katiganga. In terms of water quality parameters, water at Katiganga was better than that of Chaltia and Bisnupur.

The pH range of soils of Chaltia (6.63-7.03), Bisnupur (6.85-6.99) and Katiganga (7.05-7.51) indicate slightly acidic soil of the former two wetlands and slightly alkaline soils of Katiganga. Soluble salt concentrations were quite high in Chaltia and Bisnupur soil as indicated by specific conductance (1830-1920 µS/cm^{1}) as compared to Katiganga (1110-1324 µS/cm^{1}). The organic carbon content of soil of Bisnupur beel was higher (6%) than Chaltia (4.6%) and Katiganga (4.4%). Texturally, the soils were sandy with 90-96% sand, 1-6% silt and 1.5-6% clay.

Pesticide residues in water, soil and fish samples of the wetlands

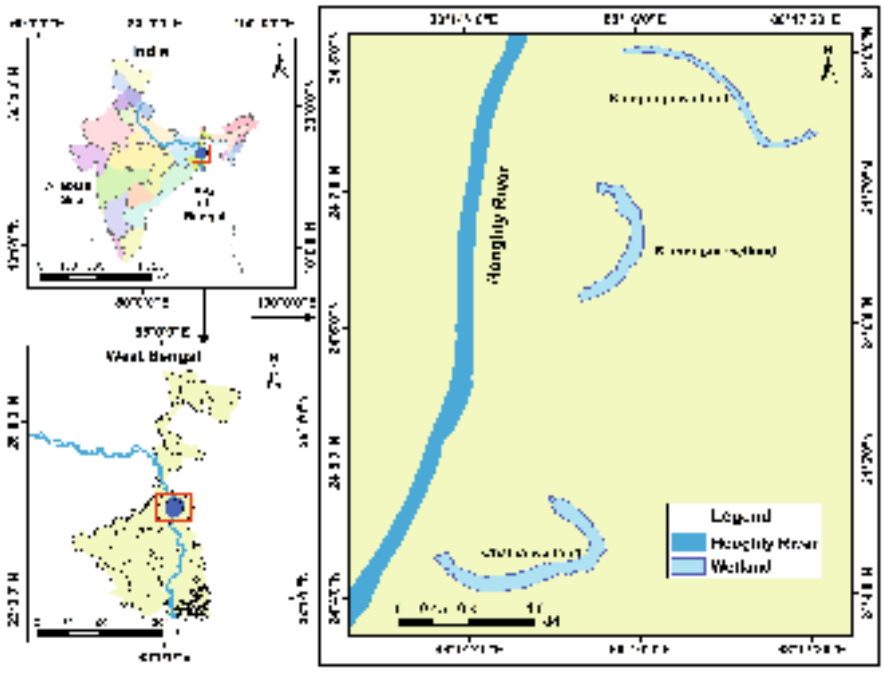
Water and soil samples from all the three wetlands and fish samples from Chaltia and Katiganga were analysed for targeted 34 compounds including pesticides and their metabolites belonging to three groups *viz.*, Organochlorines (OC), Organophosphates (OP) and Synthetic pyrethroids (SP).

In water, residues of OCs were almost absent. Only pp DDE was identified in water of Bisnupur and Chaltia but at below the detectable level. Among the soils, only pp DDE (0.002 µg/g) was detected in soil of Bisnupur. Accumulation of OCs could not be found in any fish sample.

Residue of OPs could not be detected in water or soil samples. However, chlorpyrifos in gill of *Catla catla* and *Systomas sarana* (0.009-0.157 µg/g) and malathion (0.692 µg/g) in gill of *S. sarana* was recorded in fishes collected from Chaltia.

Synthetic pyrethroids were not found in water samples. In soils of Chaltia and Katiganga, cypermethrin (0.01-0.124 µg/g) and also deltamethrin (0.1-0.2 µg/g) in Chaltia were recorded. In regard to fish, cypermethrin in flesh (0.101 µg/g) and gill (0.042 µg/g) of *Oreochromis niloticus* collected from Chatia could be detected.

Sampling of wetlands sediments was conducted in 3 wetlands in Murshidabad district of West Bengal comprising two wetlands receiving waste materials of Berhampore city and one with natural wetland with agriculture land as catchments. Variation of all four sediment enzyme activities among sectors is more in Bishnupur (sewage fed) than Katiganga (natural) wetlands and that for alkaline phosphatase than dehydrogenase. With respect to wetlands, higher activities of dehydrogenase and glucosidase in sewage fed than natural while opposite for acid phosphatase. The data indicates scope for using dehydrogenase, acid phosphatase and glucosidase as indicator for comparative assessment of wetland ecosystem with respect to sewage intrusion.



Selected wetlands of Murshidabad, West Bengal

River Cauvery

The river Cauvery is one of the major rivers of the Peninsula flowing through the states of Karnataka and Tamilnadu. 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 like steel, textiles, and other engineering aspects. There are coffee and other plantations crops on the upper part of the river basin in the Coorge district of Karnataka. Different reports point out about pollution of the river with metals and a range of different emerging contaminants.

Sampling points

Four locations along the middle and upper stretch of the river *viz*., Mettur dam, Shivanasamudra, Meenakshipuram (KRS), and Kudige, (N 11° 48′ 35.6″ – N 12° 33′ 43.7″ and E 77° 47′ 56″ – E 75° 59′ 53.1″, Elevation 243 – 818 m) were selected for sampling in the reporting period. The middle to lower stretch of the river (Mettur dam to Kollidam) was explored in the previous years.

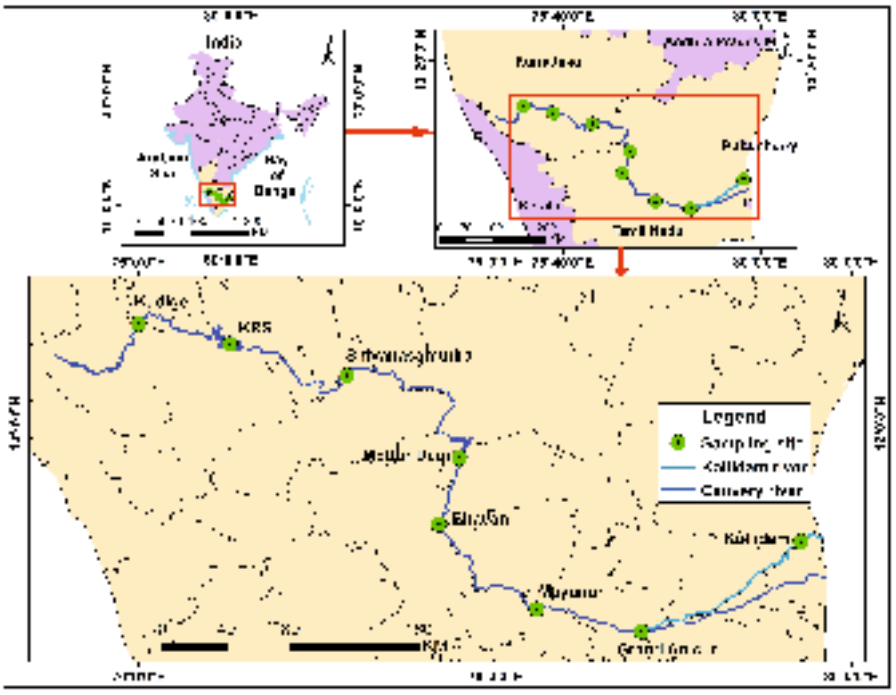
Characterization of water and sediment quality of Cauvery River, South India

Temperature in Cauvery River ranged from 25.63 to 28.17°C, and little low temperature at upper stretches may be due to altitude and latitudinal differences. The pH varied from 8.34 at the KRS station to 8.86 at the Metter station, with an average

Table: Pollution monitoring of wetlands of Murshidabad , West Bengal quantified through sediment enzyme activities (Average and Range)

Wetlands	Dehydrogenase: (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)
Katiganga	52.84(10.84)	327.99(16.6)	485.38(85.1)	106.86(42.6)
Bishnupur	121.24(59.00)	231.78(149.3)	511.88(275.0)	152.74(135.0)
Chaltia	76.1	148.4	358.37	92.6

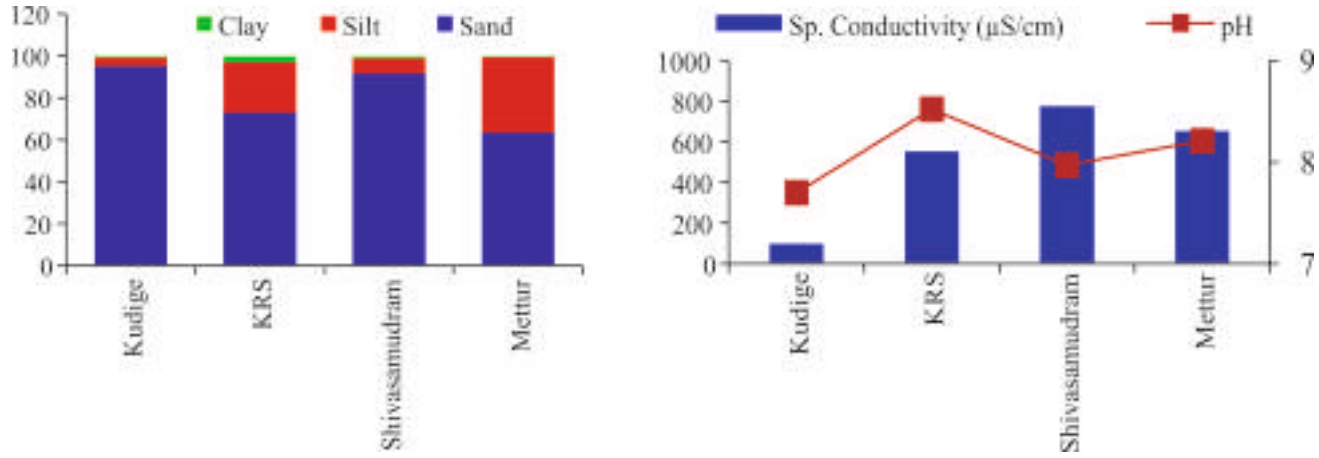
of 8.53 ±0.24. So, Cauvery waters were alkaline in nature. Overall, the alkaline pH during the present study can be attributed to the amount of buffering substances (carbonates of calcium and magnesium) due to significant amount of anthropogenic burden in the riparian area. The observed DO values range from 3.0 to 6.53 mg l^{-1}, and the average values recorded were comparatively higher in upstream stretches. Submerged macrophytes lead to higher transparency at Shivanasamudra station. During the present study, EC was found to be minimum (mean value of 96.53±0.153 µS cm^{-1}) at Kudige and maximum (mean value of 493.7±2.5 µS cm^{-1}) at downstream Mettur which can be due to various factors such as agricultural runoff as well as increased bank erosion during floods in the downstream regions, increase in total dissolved solids, and increasing temperature. TDS also followed the similar trend. Total alkalinity, total hardness, Ca and Mg was minimum at Kudige, and higher at downstream stations. The minimum value (mean value of 14.7±3.1 mg l^{-1}) of chloride was found at Kudige and its increasing trend towards downstream with the recorded maximum mean value at Mettur as 119.3±1.2 mg l^{-1} which may be attributed to the influx of domestic sewage. All the nutrients (TP, NO_3-N, and silicate) were found to be in higher concentration at downstream Mettur station as compared to midstream and upstream stations attributing to the anthropogenic inputs. Bottom soil was alkaline in nature with pH value ranged from 7.7-8.52. Specific conductivity (EC) of river bottom sediment varied from 97.8 to 776 µS cm^{-1}. Organic carbon content varied from 0.15-2.1%. Bottom soil is sandy in nature in Kudige and Shivanasamudra while considerable amount of silt was present at KRS and Mettur sediment.



Sampling sites along the river Cauvery

Table: Overall trend of physicochemical parameters (Mean ± SD) of Cauvery river

Parameters	Kudige	KRS	Shivanasamudra	Mettur
Water (°C)	26.97±0.31	25.63±0.25	26.90±0.10	28.17±2.31
Transp.(cm)	111 ±3.61	118 ±2	228.00±2.00	97.17±0.96
pH	8.55±0.17	8.34±0.02	8.37±0.01	8.86±0.08
Sp. cond (µS/cm)	96.53±0.15	356.33±0.58	438.00±2.65	493.67±2.52
D.O. (mg/l)	6.53±0.61	5.27±0.12	5.80±0.20	3.00±1.22
TDS (mg/l)	68.30±0.10	249.67±2.52	311.33±3.79	353.67±1.53
Total Alkalinity (mg/l)	28.33±2.52	136.67±1.15	158.33±1.53	151.00±2.65
Total hardness (mg/l)	52.67±1.15	135.33±4.16	152.67±1.15	142.00±2.00
Ca^{++} (mg/l)	10.40±0.80	27.83±0.92	31.27±0.80	21.60±0.80
Mg^{++}(mg/l)	6.47±0.58	16.00±0.50	17.93±0.45	21.40±1.00
Chloride (mg/l)	14.67±3.06	78.00±2.00	100.00±2.00	119.33±1.15
Nitrate-N (mg/l)	0.03±0.00	0.02±0.01	0.03±0.01	0.02±0.00
Silicate-Si (mg/l)	12.20±3.17	13.87±4.10	17.50±3.17	19.07±4.25
AV. Phosphorus (mg/l)	0.02±0.01	0.03±0.01	0.08±0.01	0.10±0.12
Total Phosphorus (mg/l)	0.14±0.03	0.18±0.06	0.29±0.07	0.23±0.22



Texture (a), pH and specific conductivity of Cauvery River sediment

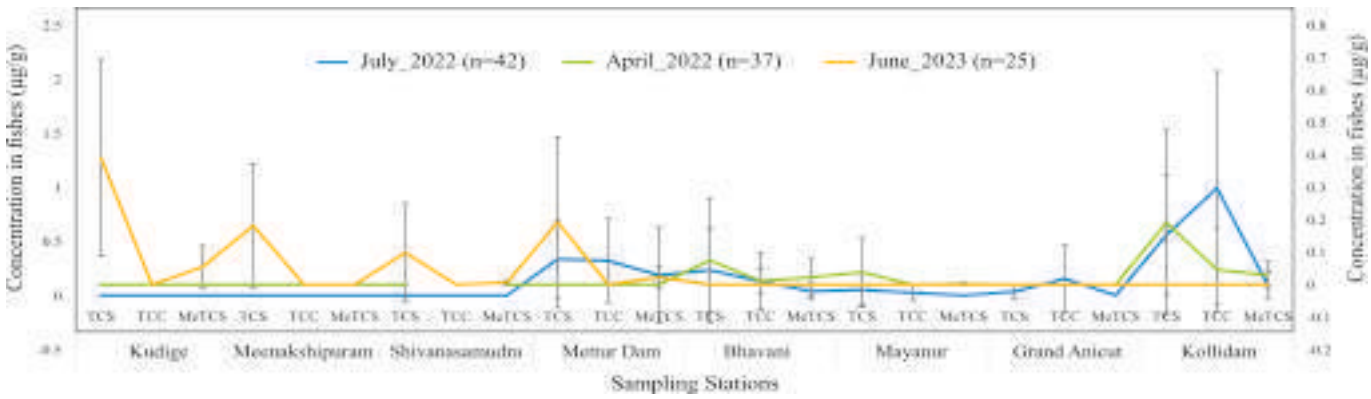
Traces of phenolic antibacterial compounds Triclosan and Triclocarban in fishes of river Cauvery

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.

Exploration on source apportionment of antibacterial PCPs in the edible fish tissues of river Cauvery from April 2022 to June 2023 encompassing a longitudinal course of 683 km at eight sampling sites namely Kudige, Meenakshipuram, Shivanasamudra, Mettur Dam, Bhavani, Mayanur, Grand Anicut and the estuarine site at Kollidam have shown that about 42.30% (n=104) of the studied fishes were contaminated with the triclosan (TCS), triclocarban (TCC) and methylated metabolites of triclosan (MeTCS) with a higher contamination during the monsoon season (62%) which might be attributed to the exclusive monsoon run off from river catchment. Fishes caught at river landing sites showed a higher load of TCC (0.296±0.581 µg/g) followed by TCS (0.256±0.388 µg/g) and MeTCS (0.068±0.217 µg/g) during monsoon, whereas the pollutants load was reduced during pre-monsoon with TCS (0.2±0.244 µg/g) and MeTCS (0.020±0.037 µg/g) followed by lean season samples with TCS (0.077±0.189 µg /g), TCC (0.014±0.064 µg/g) and MeTCS (0.015±0.041 µg/g). A comparative seasonal occurrence of the compounds in fishes has been presented below.

The estuarine fishes such as *Mugil cephalas* (mullet), *Chanos chanos* (milk fish) and *Caranx* sp. (Carangid) at Kollidam have shown high concentration of the targeted compounds. The mullets were reported with TCS (1.019 µg/g), TCC (0.766 µg/g) and MeTCS (0.184 µg/g). Similarly, the milk fishes also have shown large concentration of TCS (1.124 µg/g), TCC (0.805 µg/g), MeTCS (0.296 µg/g). However, the present study also has reported residues of the phenolic compound TCS (0.389±0.302 µg/g) and MeTCS (0.05±0.064 µg/g) in *Channa punctata*, *Cirrhinus mrigala,* and *Notopterus notopterus* from Kudige.

A seasonal analysis of fish tissue for the presence of Bisphenol A, a plasticizing compound mostly reported from canned food industries, has revealed that during pre-monsoon season 21.42% (n=28) of the fishes have shown the presence of BPA in the fish tissues. Although, the compound has not been detected in fish samples (n=109) during lean and monsoon season. The concentration of BPA in *Pangasianodon hypophthalmus* (0.19 µg/g), *Oreochromis niloticus* (0.0144-1.276 µg/g), collected from Mettur dam. A



Distribution of TCS and TCC in fishes of River Cauvery

high concentration of BPA in *Cirrhinus mrigala* (1.218 µg/g) and *Channa punctata* (1.324 µg/g) has also been reported from Kudige region due to the excessive run off from coffee plantation areas. The compound has also been traced in *Rita rita* with (1.255 µg/g) from Shivanasamudra. However, the present study did not find the residues of the target compound in water across season.

Pollution monitoring of Karnataka stretch of river Cauvery by sediment enzyme activities

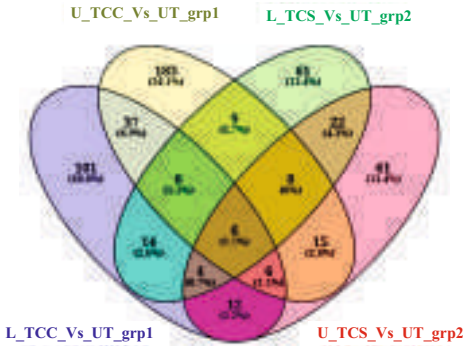
Sediment microbial enzyme activity assessed for four sites comprising two reservoirs and two river stretches in the upper stretches (Karnataka) of Cauvery river revealed higher carbon cycling (glucosidase), phosphorous mineralizing (phosphatase) and general microbial activity in reservoir sites of Mettur and KRS than river sites at Kudegi and Shivanasamudra. Among the river site activities are markedly higher in Shivanasamudra than Kudegi for all enzyme except alkaline phosphatase. In case of reservoir, sectoral variation is wide in Mettur than KRS. This showed potential of using sediment enzyme activity as parameters for impact assessment of construction of dam and barrages in a river stretch as well as impact of anthropogenic pollution in sediment biological activities.

Study of effect of biotic and abiotic stress on gonadal transcriptome

The experiment has been set up to study the effect of abiotic factor on zebra fish female. The experiment with Bisphenol A (BPA) and Nonylphenol (NP) has been done in total 6 tanks, with 04 no. of fish/tank; along with negative controls (UT). Afterwards, the gonad were collected at 96 hour for analysis. Treatment was done at 1/10th and 1/100th of LC50. The effect of BPA and NP on Gonadal transcriptome has been studied. The various genes were upregulated and downregulated in lower (L) and higher dose (U) of BPA and NP. The common upregulated and dowregulated genes were shown below.

Table: Upregulated and downregulated genes in various treatments

Treatment	Upregulated	Downregulated
LTCC_Vs_UT	108	75
UTCC_Vs_UT	100	160
LTCS_Vs_UT	79	40
UTCS_Vs_UT	56	67



Common genes upregulated in various pathways

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

Duration: April 2020 to September 2023

Scientific Personnel : D. J. Sarkar (Sub-project leader), S. K. Manna, Santhana Kumar V., Prajna R. Behera, Tanushri Bera, S. Samanta, Soma Das Sarkar, A. K. Bera (w.e.f. 01.04.2021)

Summary

- The level of the toxic metals like Cd, Pb, Cr exceeded the USEPA prescribed limit for aquatic community in the middle and upper stretch of River Cauvery in Karnataka and Tamil Nadu. Whereas in three beels of Murshidabad district of West Bengal the contents of metals like Pb, Cd, Cr, Cu, Zn were at levels higher than the USEPA prescribed limit for aquatic community in water phase in. The accumulation of toxic metals like Cr, Cd, Pb in fish flesh was at very low level.
- Investigation of metal contamination in fishes of Loktak Lake revealed that fishes within the FAD (fish aggregating device) contained less metals and thus safer for consumption than the fishes from outside the FAD.
- Microalgae biofilm incorporation improved (p<0.05) the As (III) induced damage in *Labeo rohita* liver which facilitate more biotransformation of toxic As into less toxic and excretory forms.

Metal pollution status in River Cauvery

Water, sediment and fish samples collected from the River Cauvery were analysed in ICPMS for assessing the pollution of the river ecosystem with heavy metals like Fe, Mn, Zn, Cu, Cr, Cd and Pb. In water phase, the level of Cd, Pb and in few places Cr concentration exceeded the USEPA prescribed limit for aquatic community. Load of different metals in water phase was comparatively higher at KRS-Meenakshipuram and Mettur than the other sites. In sediments, Cr level indicated moderate pollution in KRS-Meenakshipuram and Kudige. Overall, load of different metals in sediments of KRS-Meenakshipuram site was highest. Deposition of metals like Cr (1.13-3.07 µg/g), Cd (0.001-0.003 µg/g) and Pb (0.096-0.563 µg/g) were also found in fish tissue but their levels were low, which apparently would not pose any health risk to the consumers.

Metal pollution status wetlands in Murshidabad

Water and soil samples from all the three wetlands *viz*., Chaltia, Bisnupur and Katiganga, and fish samples from Chaltia and Katiganga were analysed in ICP-MS for assessing metal pollution. In water phase, the contents of metals like Pb, Cd, Cr, Cu, Zn were at levels higher than the USEPA prescribed limit for aquatic community. However, in soils accumulation of these metals indicate 'Not Polluted' status excepting Cu which was detected at levels indicating moderate to heavy pollution. The concentration of metals in water and soil was highest in Bisnupur wetlands followed by Chaltia and Katiganga. The accumulation of toxic metals like Cr, Cd, Pb in fish flesh was at very low level (below 0.5 µg/g for Pb and Cr, and 0.01 µg/g for Cd). So there is not much concern about food safety from the fishes of the wetlands in regard to metal pollution.

Metals contamination status in fishes of Loktak lake

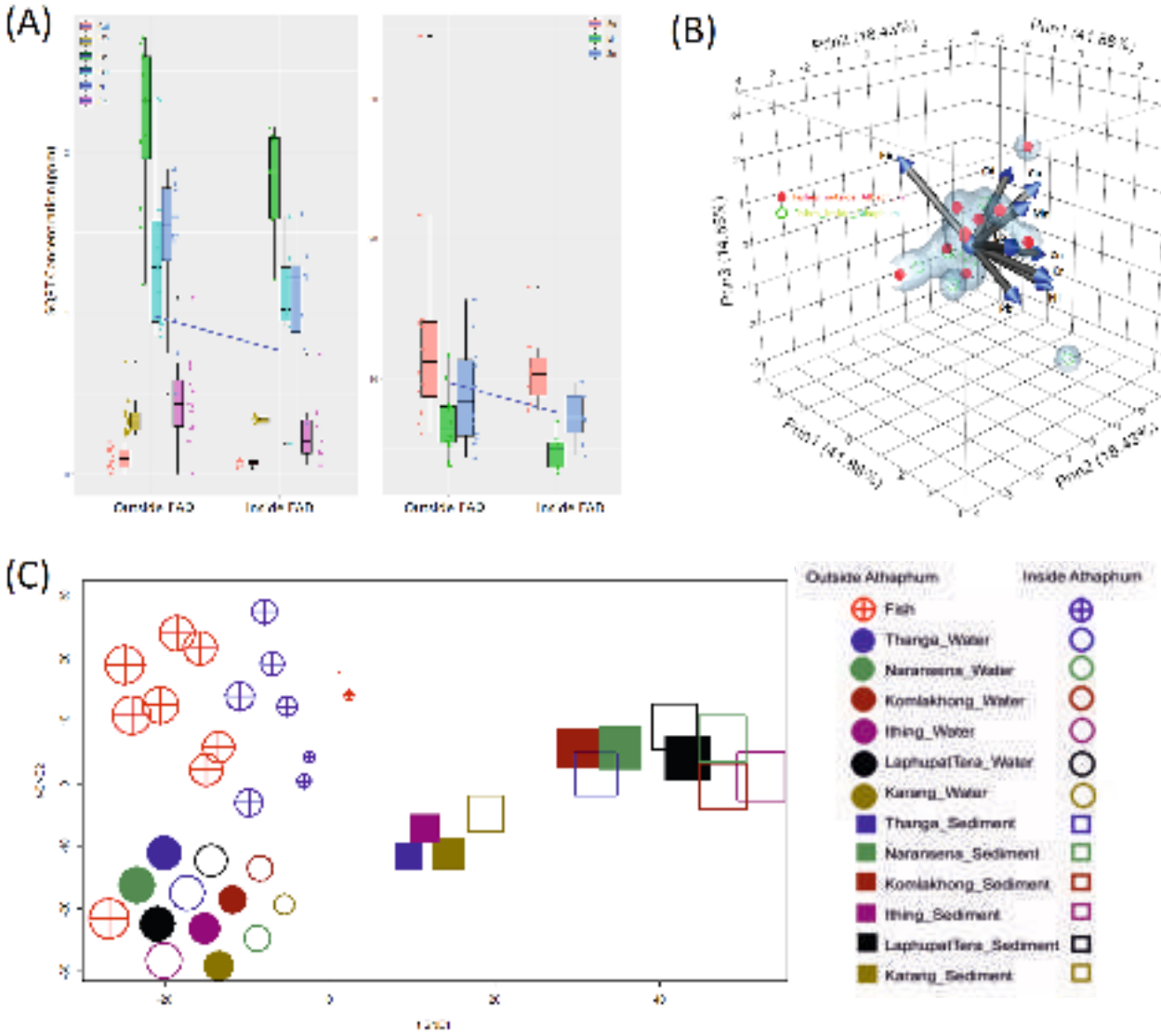
The heavy metal content (dry weight basis) in the fishes collected from the Loktak lake, Manipur is presented in the Table. The mean concentration of heavy metals in the fishes were 0.01±0.01 µg/g (Cd), 0.13±0.09 µg/g (Co), 4.38±1.89 µg/g (Cr), 1.81±1.44 µg/g (Cu), 192.82±262.37 µg/g (Fe), 1.89±1.11 µg/g (Ni), 0.23±0.29 µg/g (Pb), 79.03±60.72 µg/g (Zn) and 41.49±32.54 µg/g (Mn). The heavy metal content of Cd, Cu, Cr, Ni, Zn and Mn were found well below than the critical limit set by WHO and FAO. The comparison of heavy metal content in fishes from outside and inside of the FAD is made, which clearly depicts those fishes inside the fish aggregating device (FADs) contained lower heavy metals as compared to fishes outside the FADs. A reduction of 24.07 to 25.07 % was observed in case of Cd, Cu and Ni, and in case of Co, Fe, Mn, Pb, Zn the percent reduction was 5.3, 19.48, 30.49, 40.19 and 18.76 %, respectively. This is one of the first kinds of study which highlights that FADs constructed using floating weed biomasses in a wetland led to lower accumulation of metals in fish tissue.

PCA was conducted to observe the correlation of heavy metal content with fishes of different habitat (*viz*. outside and inside of FADs). Three principal components encompassed a major variability (75.16 %) and depict that major heavy metals were positively correlated with PC1 and fishes outside the FADs. Whereas, fishes inside the FADs showed a negative correlation with the majority of the heavy metals. To understand the any nonlinear relation between heavy metal contents in fish, water and sediment a machine learning algorithm t-distributed Stochastic Neighbor Embedding (t-

Table: Heavy metal concentrations in collected fishes

Location	Fish	Cd (µg g^{-1} d.w.)	Co (µg g^{-1} d.w.)	Cr (µg g^{-1} d.w.)	Cu (µg g^{-1} d.w.)	Fe (µg g^{-1} d.w.)	Ni (µg g^{-1} d.w.)	Pb (µg g^{-1} d.w.)	Zn (µg g^{-1} d.w.)	Mn (µg g^{-1} d.w.)
Thanga (inside fish aggregating device)	*Macrobrachium* sp.	0.02	0.13	6.8	2.0	144	3.2	0.48	88	30
	Amblypharyngodon mola	0.02	0.08	5.4	0.9	45	2.6	0.31	54	14
	Chanda nama	0.01	0.07	2.4	0.8	195	0.3	0.04	126	64
Mayang (inside fish aggregating device)	*Chanda nama*	0.00	0.14	6.7	1.7	82	3.1	0.43	28	47
	Puntius sophore	0.00	0.07	5.3	0.7	36	2.2	0.20	18	16
	*Trichogaster fasciata**	0.04	0.21	7.4	5.4	470	3.6	0.18	244	101
	*Channa punctata**	0.01	0.08	1.4	5.4	202	0.6	0.00	188	60
	*Anabas testudineus**	0.02	0.12	4.3	2.4	189	2.1	0.27	133	66
	Pethia ticto	0.03	0.49	7.1	2.7	1192	3.6	1.20	118	136
Karang (inside fish aggregating device)	*Amblypharyngodon mola*	0.01	0.14	2.5	1.5	149	1.8	0.09	94	31
Naransena (inside fish aggregating device)	*Amblypharyngodon mola*	0.01	0.12	4.6	1.0	106	2.6	0.00	51	28
	Pethia ticto	0.01	0.11	4.4	1.0	272	1.0	0.15	76	47

W.W. - Wet weight; D.W. - Dry weight; * - Flesh



The total heavy metal content (µg/g) (A) and PCA (B) of heavy metals distribution in fishes collected from outside and inside of FADs; (B); t -SNE cluster analysis heavy metals content in fish, sediment and water collected from inside and outside of FADs (C)

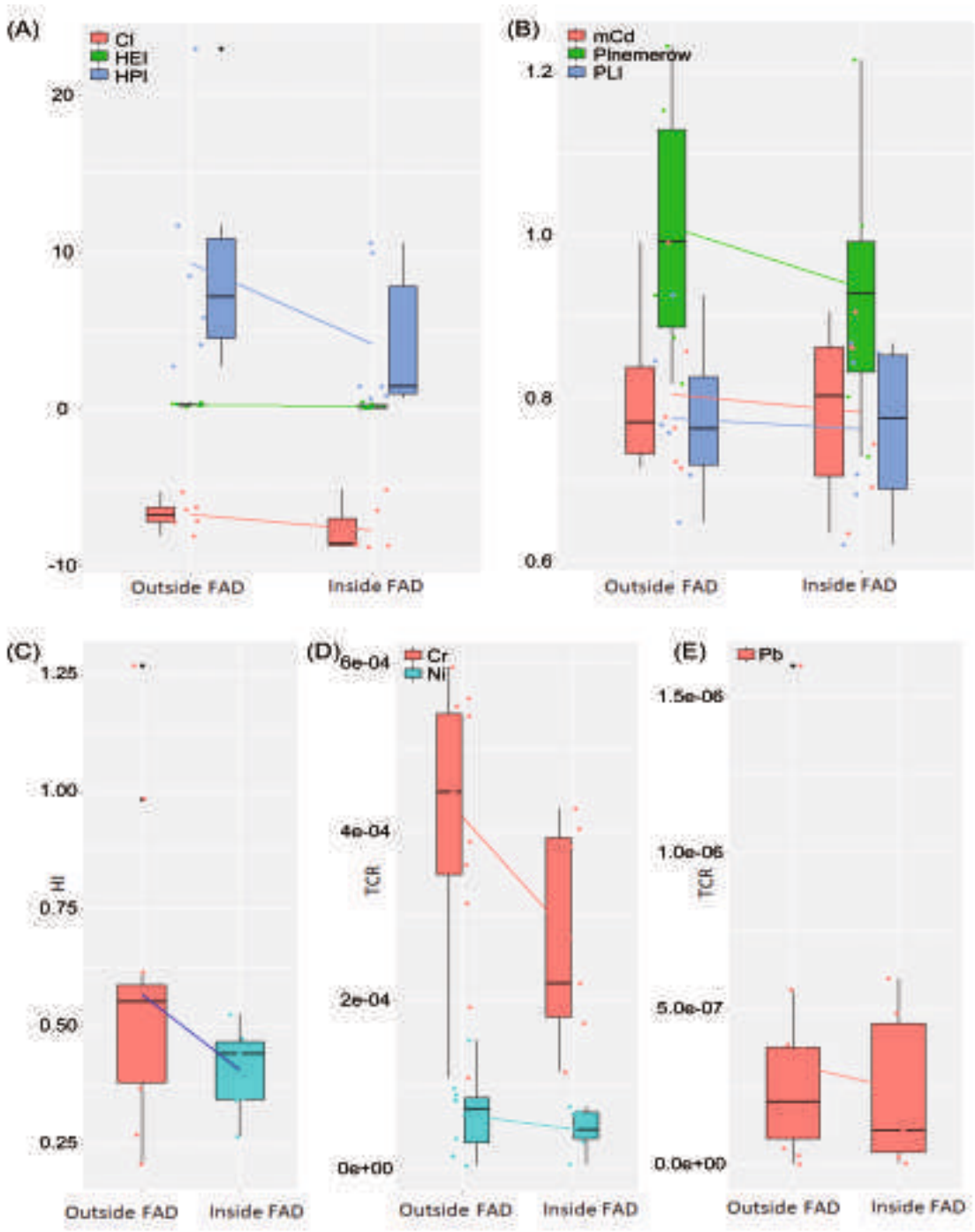
SNE) cluster analysis was done. In the present study the t-SNE cluster analysis reveal that heavy metal contents in fish, water and sediment formed three major cluster distinct to each other. However, the analysis also revealed that t-SNE analysis do not recognize the effect of FADs on the heavy metal distribution in fish, water and sediment. Further, it could be also postulated that heavy metal content in the fishes was more associated with heavy metal content in the water. The heavy metals content in the sediment form two separate sub cluster which may be due to proximity of sampling station and effect of FADs.

Environmental and human health risk assessment due to heavy metals in Loktak lake

The contamination index (CI) values of river samples associated with Loktak lake ranged from -2.645 to 0.196 whereas the same ranged between -5.842 to -5.789 for Loktak lake samples which indicates that heavy metal contamination level is much lower in wetland samples as compared to river samples. Like CI, Heavy metal Evaluation Index (HEI) also showed that river samples have higher index values (HEI = 0.861 to 1.022) as compared to wetland samples (HEI= 0.130 to 0.357). The Heavy Metal Pollution Index (HPI) value ranged from 6.22 to 19.96 in case of river samples and for wetland samples it was ranged between 1.58 to 31.67. The average CI, HEI and HPI values inside and outside FADs is presented here. Due to FAD barrier, a reduction of 14.72, 55.39 and 44.16 % was observed in case of CI, HPI and HEI indices values, respectively.

The average calculated CF values of target heavy metals in the sampling sites of Loktak lake were found to be in the order of Fe (0.67, 0.32-1.04) <Cd (0.75, 0.3-2.05) ~ Co (0.75, 0.34 -1.09) ~ Zn (0.75, 0.38-1.5) ~ Mn (0.78, 0.22-1.54) < Ni (0.79, 0.35-0.99)< Pb (0.81, 0.43-1.58)< Cr (0.83, 0.35-1.14) < Cu (0.84, 0.34-

1.2). Since in all the test sampling location the CF value is less than 2, it can be postulated that the sites were unpolluted. To understand the comparative heavy metal contamination level inside and outside FADs, CF values for each heavy metal was generated for inside and outside of the FADs. However, from the data it can be stated that there was no significant difference between CF values for inside and outside FADs. Similarly, the I_{geo} and EF values of the heavy metals in the sediment were calculated and found to be unpolluted with values less than the critical. To estimate the overall contamination level brought on by a set of heavy metals, several indices *viz*. C*d*, *mCd,* RI, $PI_{Nemerow}$ and MPI were calculated. In case of the C*d*, the value ranges between 3.65 to 11.43 indicating low to moderate level of heavy metal pollution. However, all the mCd values are ranged below 1.5 indicating extremely low pollution level. This is supported by the potential ecological Risk Index (RI) values which were below 150 (low potential ecological danger).

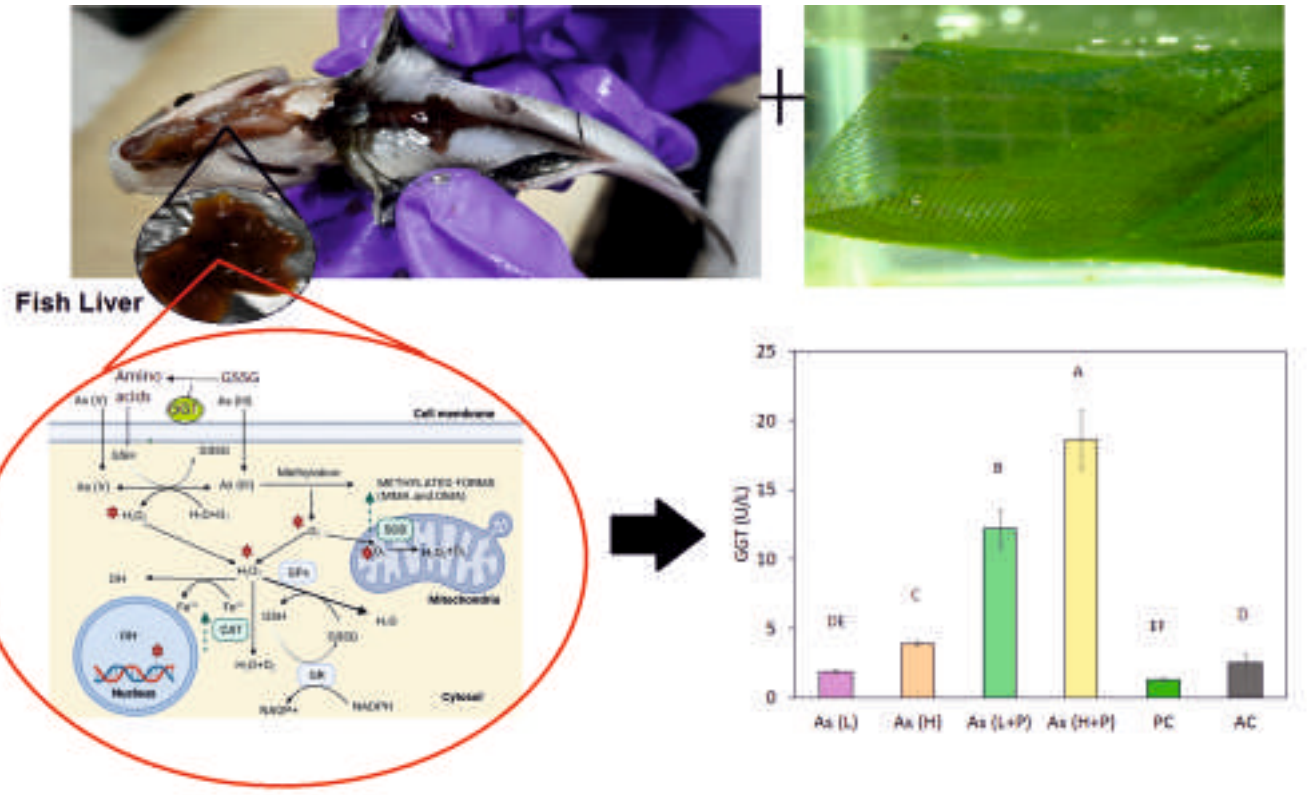


Water pollution indices (CI, HEI and HPI) (A) and sediment pollution indices (mCd, $PI_{nemerow}$, PLI) (B) of water and sediment collected from outside and inside of FADs; The calculated Hazard index (HI) (C) and Total Cancer Risk (TCR) (D, E) associated with human consumption of fishes collected from outside and inside of FADs

However, as per the Nemerow Pollution Index ($PI_{Nemerow}$) and Modified Pollution Index (MPI) the sediments were in the slightly polluted domain and moderately polluted, respectively. The average mCd, PLI and $PI_{Nemerow}$ values inside and outside FADs is presented in the figure and it shows that due to FAD barrier 2.6, 1.62 and 7.39 % reduction was observed, respectively. The consumption induced THQ values of fishes obtained from the wetland were having values way below 1 which indicates that that exposed population is less likely prone to adverse effect associated with heavy metals. Further, it was observed that average HI value of the fishes inside FADs (0.407) was less as compared to average value indicated for fishes outside the FADs (0.568). Similarly, the risk of cancer (TCR) associated with the concentration of heavy metals (Cr, Ni and Pb) in the local fishes indicated that the fishes from inside the FADs is safer than the fishes from outside the FADs.

Microalgae biofilm improved arsenic biotransformation and immune response in fish *Labeo rohita*

Arsenic (As) contamination in aquaculture systems is a global concern that affects the food safety, fish and human health. There is a tremendous need for sustainable remediation technology to curb hazards associated with As induced toxicity in aquaculture systems. The present study explored the possibility of use of microalgae biofilm grown on nylon mesh to ameliorate toxic properties of As (III) to a model fish *i.e. Labeo rohita*. Fishes were introduced to As (III) contaminated water (0.3 and 3 ppm) along with microalgae biofilm and fish immunological parameters including gene expression of Immunoglobulin M (IgM), Complement C3 (CC3) and Lysozyme activity (LyZ) was assessed after 30 days of exposure. Further, As bioaccumulation and their biotransformation in fish and microalgae biofilm were analyzed through speciation studies using LC-ICP-MS. Microalgae biofilm incorporation improved (p<0.05) the As (III) induced damage in liver which facilitate more biotransformation of toxic As into less toxic and excretory forms. Speciation studies confirmed high accumulation of As (V) by the biofilm (5-31.9 $mg.g^{-1}$). The immune response analysis revealed that low As (III) exposure increased the IgM concentration, CC3 and Lysozyme activity of fish but high concentration exposure decreased the immunological response. The presence of microalgae biofilm in high As (III) exposed group significantly improved the IgM concentration and CC3 activity of fishes when compared to only As (III) exposed individuals. The gene expression study also revealed that presence of microalgae biofilm significantly upregulated the *CC3* gene. This study concludes that the presence of microalgae biofilm in arsenic contaminated waters significantly improved the arsenic biotransformation by reducing the liver damage which in turn improved the immune response of the fish.



The As biotransformation in fish liver with the presence of microalgae biofilm and the involvement of GGT enzyme for glutathione homeostasis process. The cell image representation has been referred from Byeon et al. (2021)

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 to March 2023

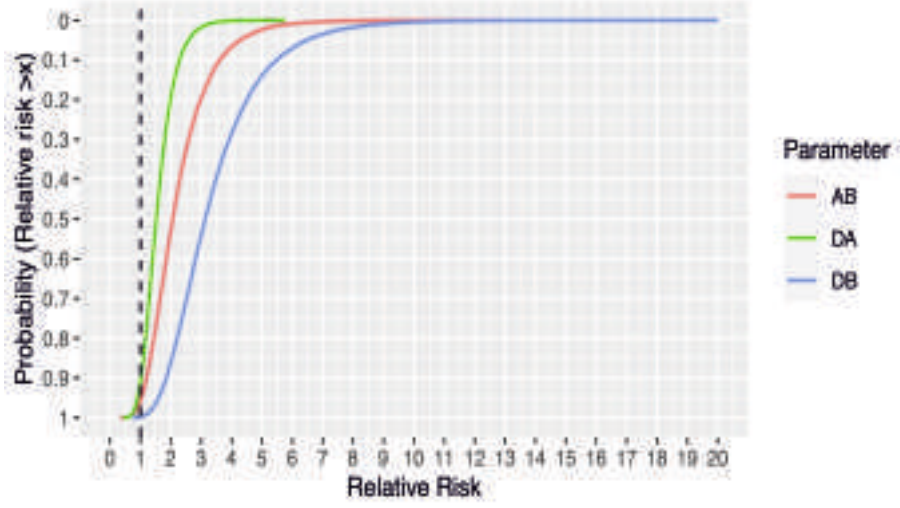
Scientific Personnel: Malay Naskar (PI), B. K. Das, S. K. Sahu, Chayna Jana, T. N. Chanu, Arun Pandit, A. K. Das, N. S. Singh (upto 30.04.22), D. Das

Summary

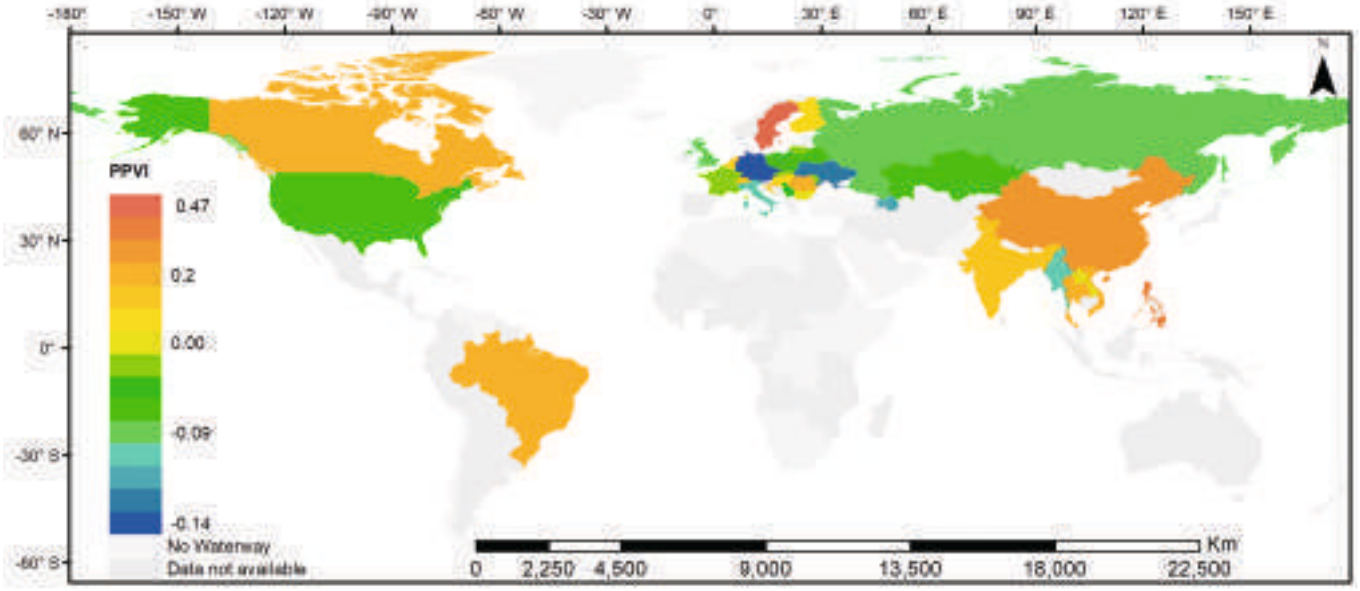
- A bigdata analytics framework has been used to generate a database of Asian fish species' occurrence at the country level, comparison of taxonomic diversity and threatened status among 48 Asian countries. The key to the analytics is a pyhton program that has been developed to retrieve country-specific fish species directly and dynamically from Catalogue of fishes and Fishbase, using web-scraping technique.
- Inland waterways navigation contemplatively induces risk of phytoplankton cell damage. After conceptualising the risk of phytoplankton cell damage, an innovative Bayesian GLMM hierarchical modelling has been applied to decouple the phytoplankton cell damage risk from other potential factors. The Bhagirathi-Hooghly River, the busiest waterway of the lower part of the Ganga River, is the selected study area. The model outputs are then used to develop a global-level prospective phytoplankton vulnerability map for regional level decision-making.
- We modelled the As mobilisation pathways in two compartments: (1) the trophic level food-web compartment comprising sediment, water, phytoplankton, zooplankton and fish; and (2) the organisms' coexistence compartment—where organisms coexist by sharing common habitat without competing for food—comprising sediment, periphyton and gastropods. The developed model has successfully quantified the As transfer rate along the conceptualised pathway, which is non-existent for the lentic aquatic ecosystem.

Navigation-induced risk of phytoplankton cell damage

Inland waterways navigation has adverse effects on aquatic systems that are of global concern. Among others, the phytoplankton community is the most vulnerable to getting damaged or disappeared. Quantifying their cell damage risk to navigation is significantly important and challenging, particularly using *in situ* field observation. Furthermore, extra heterogeneity influences the cell damage risk due to other drivers like watercraft's activities, fishing activities, flow-induced drift of phytoplankton, which exacerbate the challenge. Thus, decoupling the IWT-induced risk to phytoplankton cell damage from the entangled extra heterogeneity is significantly important. A Bayesian GLMM hierarchical modelling was proposed



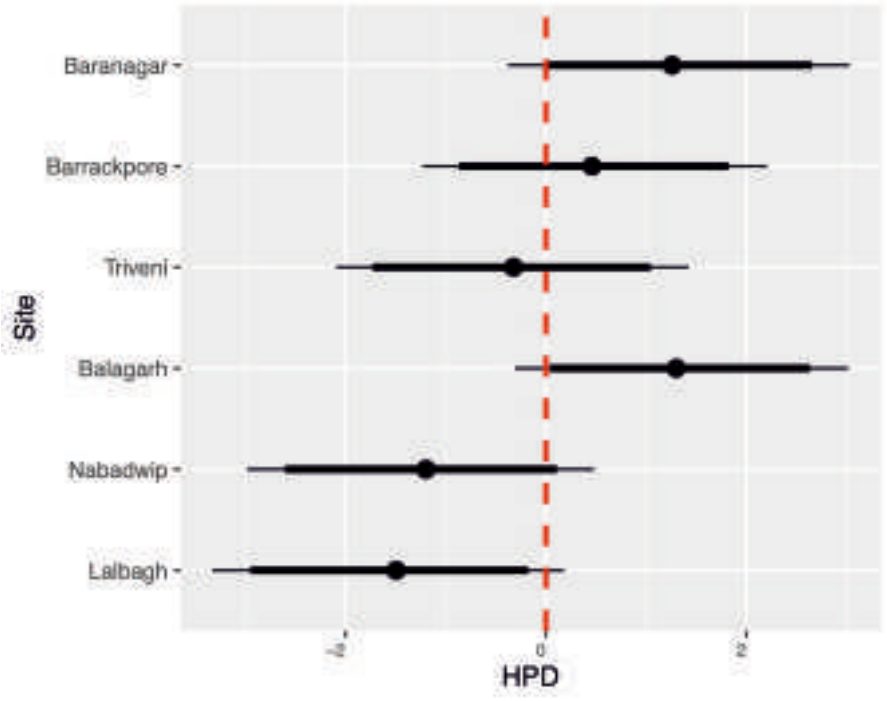
Probabilistic paired comparisons of relative phytoplankton cell damage risk. AB: After relative to before; DB: During relative to Before; and DA: During relative to After. Dashed line represents the threshold value (=1). Filled circles represent the median



Global-scale prospective phytoplankton vulnerability due to IWT. PPVI: the slope of linear trend of IWT freight (standardized)

to predict the phytoplankton cell damage risk. The Bhagirathi-Hooghly River, the busiest waterway of the lower part of the Ganga River, is the selected study area, and secondary data for a completed project on this area was used for the investigation. For excess risk characterization, four types of hierarchical priors-independent normal prior, multivariate normal prior, conditional autoregressive prior and diminishing correlation prior-were used, and four models corresponding to each prior selection were compared. The results established the effectiveness of Bayesian inference with reasonably good accuracy (Bayesian R^2= 0.83) even for a small sample size. The model accounting for excess risk accommodated through conditional autoregressive prior was the best performer among the four competitive models. The best model predicted an average 200% and 100% cell damage during and after 30 minutes of barge movement, respectively, relative to control. The excess risk in cell damage and loss revealed a downstream trend-from low to high-capturing a significant correlation strength (= 0.45) between nearby sites.

It can very well be contemplated that IWT-induced phytoplankton damage risk is directly proportional to IWT intensity. So, the prospective phytoplankton vulnerability is presumably proportional to the future IWT intensity. Thus, the future trend of IWT freight-a proxy for IWT intensity-indirectly serves as the indicator of the prospective phytoplankton cell damage vulnerability. The simple linear growth parameter-the regression coefficient-was chosen as the indicator of future growth of plankton vulnerability to IWT and conceptualized as the Prospective Phytoplankton Vulnerability Indicator (PPVI). The country-



Caterpillar plot for the site-specific excess relative risk of phytoplankton cell damage. Dots represent median, and thick and thin lines represent 90% and 95% Highest Posterior Density (HPD) regions, respectively. The dashed red line demarcates the threshold of null excess risk

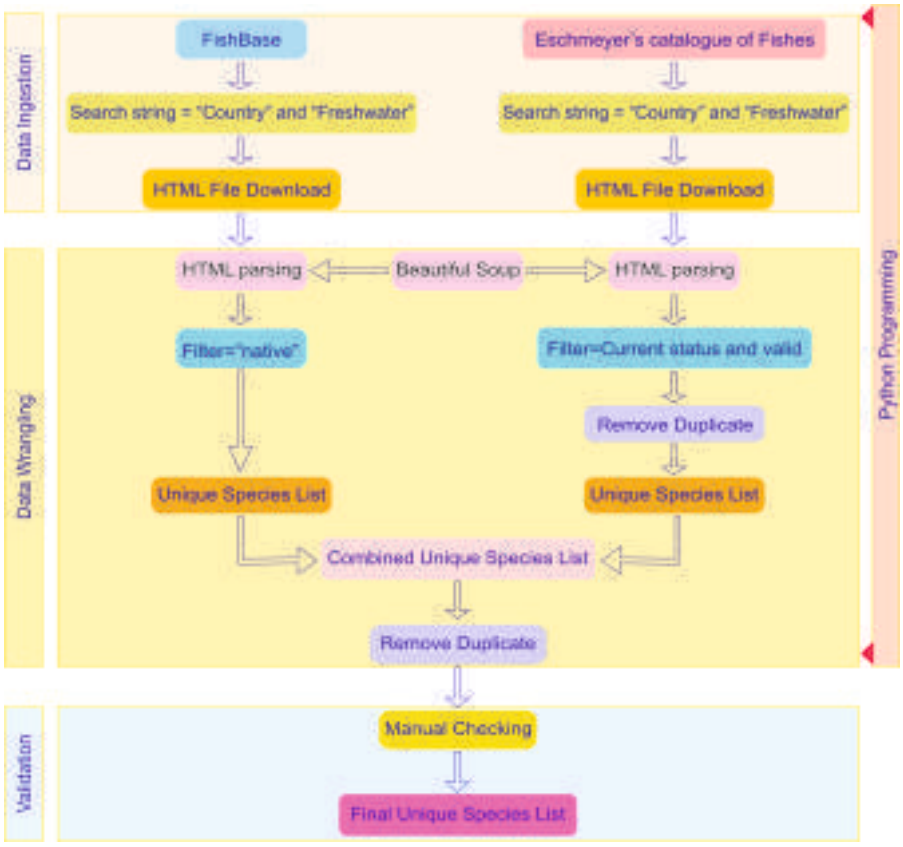
specific trend analysis has revealed both positive and negative growth of varying magnitude. The top ten countries having decreasing trend are Luxembourg (-0.136) < Austria (-0.134) < Germany (-0.134) < Czech Republic (-0.132) < Ukraine (-0.129) < Azerbaijan (-0.120) < Myanmar (-0.104) < Switzerland (-0.100) < Italy (-0.097) < United Kingdom (-0.096); noticeably, all belong to Europe except Myanmar. And the top ten countries having increasing trend are Sweden (0.466) > Philippines (0.307) > Canada (0.198) > China (0.152) > Vietnam (0.151) > Thailand (0.136) > Romania (0.136) > Brazil (0.132) > Croatia (0.130) > India (0.127) > Bangladesh (0.125), of which six are from Asia.

Freshwater native fish species diversity and threatened status comparison among Asian countries

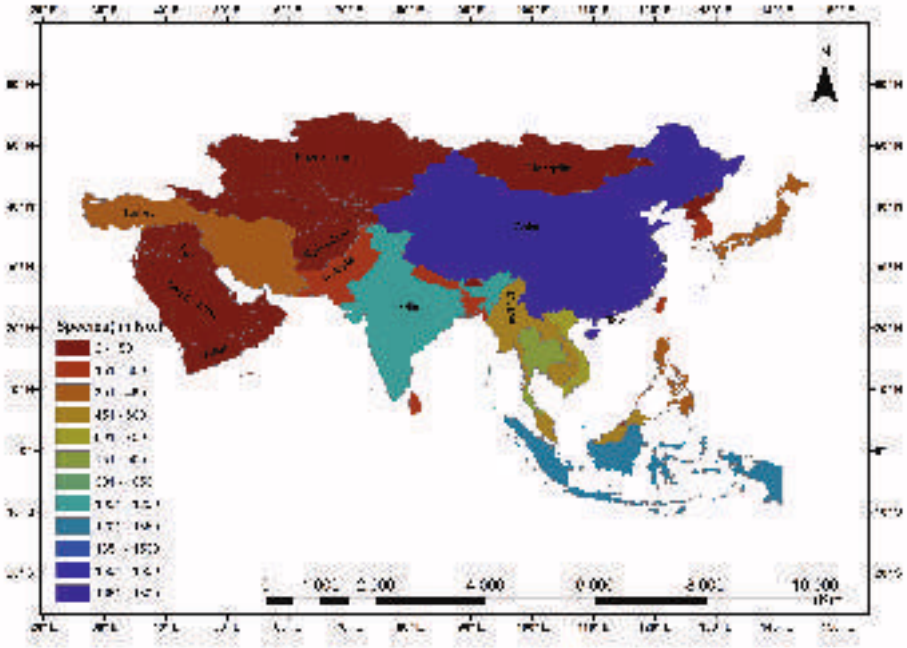
In this investigation, Freshwater Native Fish Species (FNFS) included the finfish species that inhabit freshwater or brackish water at any one of the stages of their life cycle and are native to the country boundary in the present investigation. A data science pipeline shown in the picture was followed for creating the inventory of FNFS of the Asian countries.

Diversity comparison

The top 20 taxa rich countries accounted for 97%, 97%, 98% and 100% richness of species, genus, family and order, respectively. The country ordering against relative richness was noticeably different for each taxon; China is the richest country of fish species, genus and order, and Indonesia is the fish family richest country. For each taxonomic level-Genus, Family and Order-diversity ordering was compared for the top ten taxon rich countries that covered 87% genus, 95% families and 98% order. Diversity profiling, in terms of Reny's index, revealed that no country is uniformly superior in fish diversity at the three taxonomic



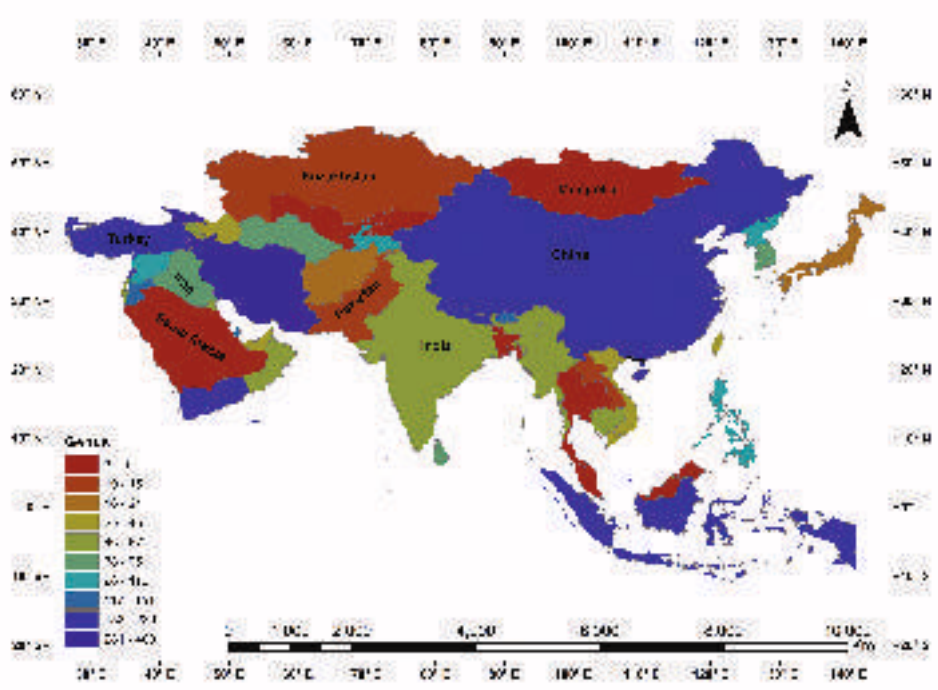
Data science pipeline for generating fish species' presence data



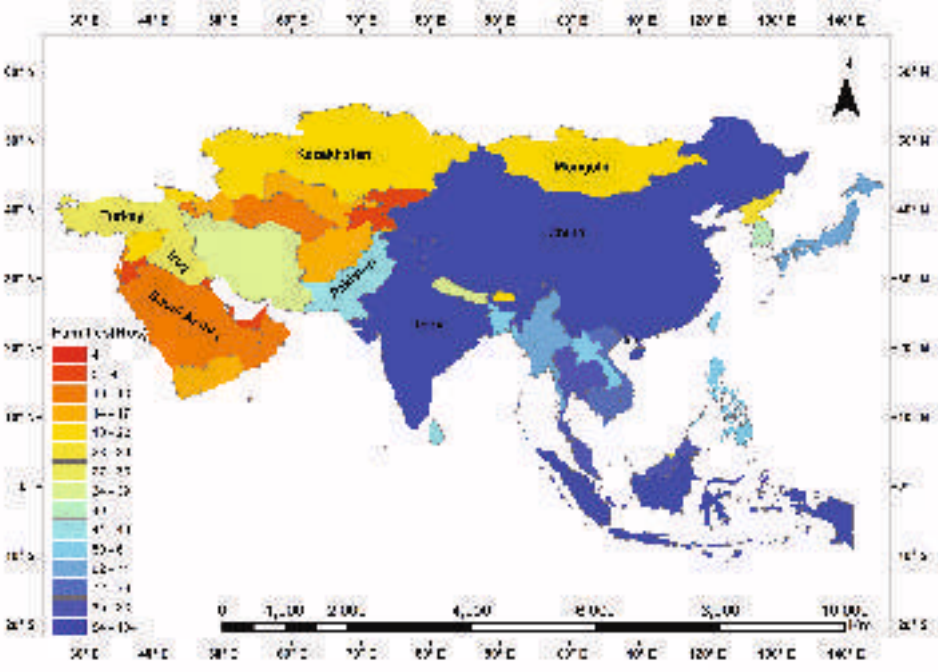
Species richness in Asian countries

level considered: genus, family and order. The diversity profile and different ordering pattern are presented and systematically described as follows.

Genus: Three popularly used diversity indices-richness, Shannon and Simpson-revealed different genus diversity ordering of countries. The top ten genus rich (in log-scale) countries were in order of China (6.00) > Indonesia (5.91) > Thailand (5.63) > India (5.63) > Vietnam (5.56) > Malaysia (5.49) > Cambodia (5.35) > Myanmar (5.30) > Laos (5.28) > Japan (5.02). Whereas the Shannon index ordered them differently as Indonesia (5.32) > Thailand (5.23) > Vietnam (5.19) > China (5.11) > Cambodia (5.09) > Malaysia (5.03) > India (4.80) > Myanmar (4.78) > Laos (4.75) > Japan (4.73), and the Simpson index (log-scale) ordered them as Cambodia (4.81) > Vietnam (4.73) > Thailand (4.72) > Indonesia (4.66) > Japan (4.44) > Malaysia (4.41) > Myanmar (4.28) > China (4.18) > India (4.03) > Laos (3.83). Reny's index profiles revealed partial fish genus diversity ordering: genus diversity of China, India and Malaysia were higher than Laos; Indonesia's genus diversity was higher than India, Malaysia and Myanmar; Thailand's genus diversity was higher than India, Myanmar, and Laos. Vietnam's diversity was higher than Malaysia, Myanmar and Laos.



Genus richness in Asian countries



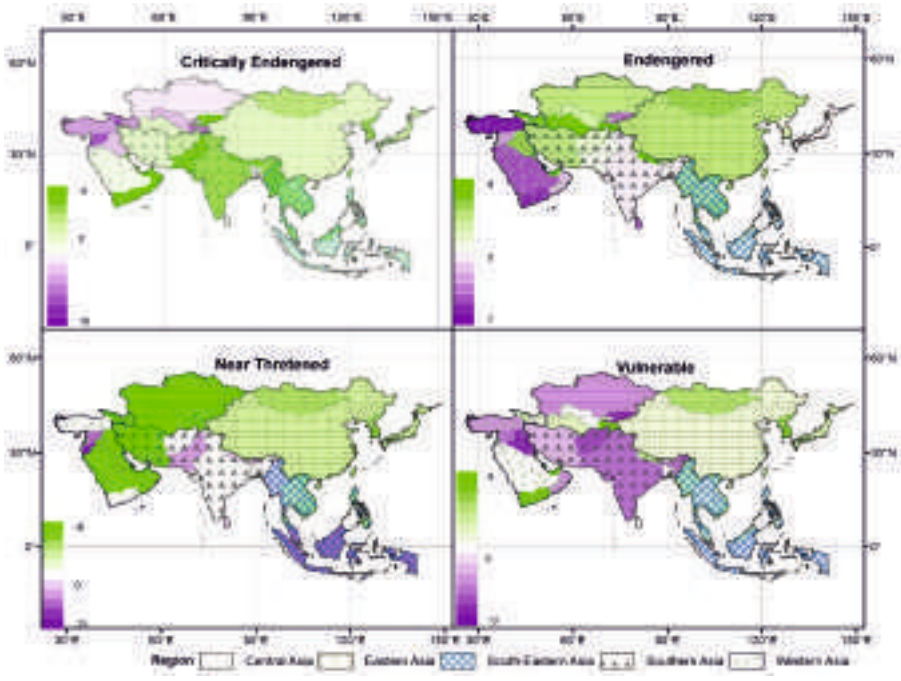
Family richness in Asian countries

Family: According to the family-level richness (log-scale), the top ten countries were in order of Indonesia (4.63) > China (4.55) > India (4.53) > Thailand (4.41) > Malaysia (4.38) > Vietnam (4.36) > Cambodia (4.32) > Myanmar (4.25) > Japan (4.20) >Phillipines (4.09). Diversity based on Shannon index was in order of Indonesia (3.70) > China (2.93) > India (2.97) > Thailand (3.40) > Malaysia (3.44) > Vietnam (3.34) > Cambodia (3.42) > Myanmar (3.13) > Japan (3.24) >Phillipines (3.06); and Simpson index ordered them as Indonesia (3.14) > China (2.24) > India (2.13) > Thailand (2.69) > Malaysia (2.88) > Vietnam (2.56) > Cambodia (2.67) > Myanmar (2.42) > Japan (2.32) >Phillipines (2.19). Although widely used indices revealed the same diversity ordering of the top ten family rich countries, their Reny's diversity profiles differed. Only Indonesia had the highest fish family diversity, and partial diversity ordering was possible for the remaining countries; but family diversity China and India-ranked as second and third, respectively-were not uniformly superior to any other countries; Thailand had relatively higher diversity profile than Vietnam, Myanmar, Japan, Phillipines; Malaysia had higher than Vietnam, Cambodia, Myanmar, Japan and Phillipines; Vietnam had higher diversity than Japan and Phillipines; Cambodia had higher diversity than Myanmar, Japan and Phillipines; Myanmar and Japan had higher

diversity than Phillipines. Considering all, Phillipines was the lowest diversity among the top ten family rich countries.

IUCN status comparison

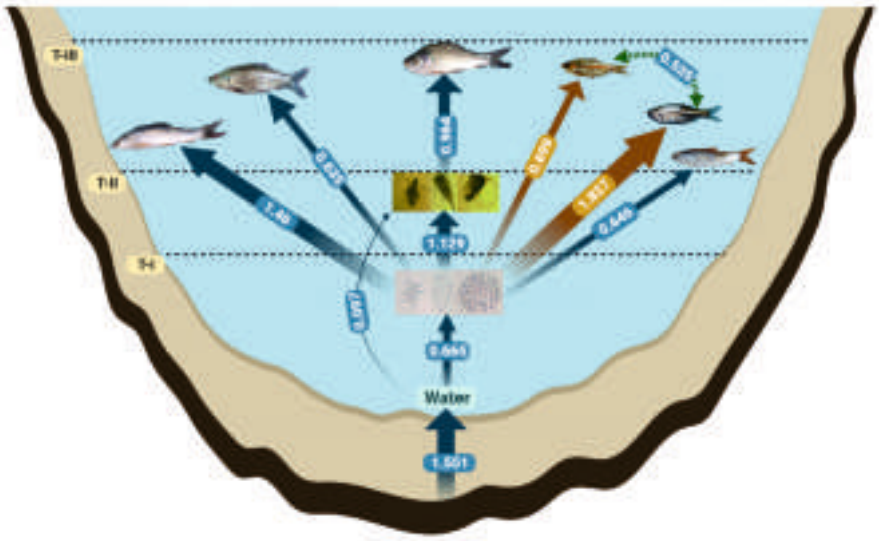
The IUCN Red list assessment accounted for 58% (assessed species = 3693) of the total Asian species richness (n = 6368) recognized in this study. In general, the number of assessed species was proportional to the species richness. The proportion of assessed species ranged between 33% and 96%; thirteen countries were below the Asian average; and thirty-five countries were above the Asian average. Noticeably, among the top five species-rich countries, the assessed proportion in China (38%) and India (56%) were below the Asian average, and the same of Indonesia (~84%) was quite high above the Asian average. Overall, 25% of the assessed species were in the data deficient category for assigning to a 'Red list' category. Countries' proportions ranged between 0 to 39%. Only four countries' proportions were below the average value-indicating a skewed pattern distributed over the countries under study. The top ten data deficient countries were in order of Vietnam (39 %) > Myanmar (29 %) > China (28 %) > Laos (26 %) > Indonesia (21%) >Philippines (21%) >Thailand (20%) >Hong Kong (19%) > Brunei (17 %) > India (17%), of which six were from the top ten species-rich countries. Vulnerable intensity of eleven countries-India, Turkey, Pakistan, Iran, Kazakhstan, Afghanistan, Syria, Iraq, Kyrgyzstan, Oman, and Kuwait-were higher than the Asian average; and remaining 37 countries' vulnerable intensities were below the Asian average. Eventually, most of the highly vulnerable countries belong to the subcontinents of south, west and central Asia. Thus, south-west region of Asia was more vulnerable for fish species as compared to the other regions-east and south-east region. Among the top



Threatened intensity pattern in the Asian countries

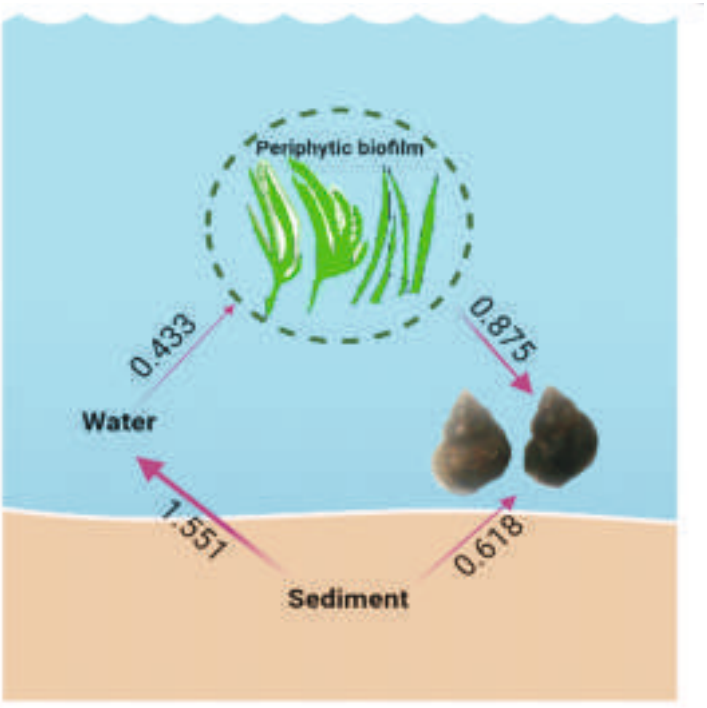
10 species-rich countries, vulnerable intensities were in order of India (10%) > Turkey (10%) > Indonesia (8%) > Laos (7%) > China (6%) = Thailand (6%) > Malaysia (5%) = Cambodia (5%) > Vietnam (4%) = Myanmar (4%).

'Near Threatened' intensities of countries ranged between 0 to 27%, of which the intensities of three west Asian countries-Jordan, Israel, and Syria-and of five south and south-east Asian countries-Indonesia, Malaysia, Pakistan, Bhutan, and Brunei-were above the Asian average. Noticeably, the 'Near threatened' intensity in the east, north-west and central Asian regions were relatively lower than the other region. Further, among the top 10 species-rich countries, the highest 'Near Threatened' intensity was observed in Indonesia (8%) and Malaysia (8%), followed by Myanmar (6%) > India (5%) = Turkey (5%) > China (3%) = Thailand (3%) = Laos (3%) > Vietnam (2%) = Cambodia (2%). The 'Critically Endangered' and



The arsenic transmission rate in food web of the aquatic ecosystem in pond and wetland in the tropic pathway

'Endangered' intensity pattern were somewhat similar: excepting one or two countries, the intensities in the east, south and south-east subcontinents were lower than the Asian average. Thus, the fish species in the western Asian countries were under relatively higher risk of 'Endangered' or 'Critically Endangered' than the other region. As for the top 10 species-rich countries, 'Critically Endangered' intensity was the alarmingly highest in Turkey (10%), followed orderly by Indonesia (5%) = China (5%) > Laos (3%) > India (2%) = Thailand (2%) = Malaysia (2%) = Vietnam (2%) = Cambodia (2%) > Myanmar (1%); and 'Endangered' intensities was in order of Turkey (16%) > India (9%) > Indonesia (7%) > Malaysia (5%) > Laos (4%) > China (3%) = Thailand (3%) = Myanmar (3%) > Vietnam (2%) = Cambodia (3%).



The arsenic transmission rate in the co-occurrence compartment path

Modeling Arsenic mobilization pathway in lotic waterbodies

The metalloid As presumably spread into an aquatic system through the biotic organism, abiotic environments and a web of complex interaction among them. Though appealing, it is tough to build a model for the full As percolation pathway in such a complex web of interaction. In this investigation, we modelled the As mobilisation pathways in two compartments: (1) the trophic level food-web compartment comprising sediment, water, phytoplankton, zooplankton and fish; and (2) the organisms' coexistence compartment-where organisms coexist by sharing common habitat without competing for food-comprising sediment, periphyton and gastropods. Traditional statistical models - e.g., ANOVA, linear models, multiple regression-are unsuitable in this context, as they fail to accommodate variables that act as both response and predictor variables. Most importantly, they cannot infer or detect indirect effects caused by the dependence induced through a third factor-for instance, an indirect association of As contamination perceivably exists between organisms with common food or habitat. We applied to accomplish the goal.

The model predicted that arsenic dermal and respiration transmission is negligible for zooplankton and fishes. It inferred a significant positive directional (Sediment → Water) causal relationship between the As concentration of sediment and of water ($R^2 = 0.9$, p-value < 0.05). It also suggests the biomagnification rate of 1.129 in zooplankton through phytoplankton ingestion. In the whole body, the biomagnification rate is noticeably higher in *A. mola* (1.827) than that in *P. sophore* (0.699). Though statistically insignificant, there is a reasonably high association between the whole body bioconcentration of *A. mola* and *P. sophore*. In case of fish muscles, the relative effect of food for arsenic transfer were in the order of *C. mrigala* (1.46) >*L. catla* (0.96) >*L. bata* (0.646) >*L. rohita* (0.635), albeit the rates were practically same for *L. rohita* and *L. bata*. The indirect effect in 'piecewise SEM' was computed as the product of effects in the path. Hence, the indirect As bioaccumulation rate from the sediment to the phytoplankton was 1.031 (=1.55 x 0.665). The bioaccumulation rates from sediment to the zooplankton were 1.164 (=1.55 x 0.665 x 1.129) and 0.15 through food and respiration paths, respectively. Similarly, the same indirect rates for the whole body of *A. mola* and *P. sophore* were 1.87 and 0.77, respectively. For the body muscles in the fishes, the same indirect rates from sediment were as follows: *C. mrigala* (=1.50) >*L. catla* (=1.30) >*L. bata* (=0.66) >*L. rohita* (=0.65).

In the co-occurrence compartment, the direct bioaccumulation rates follow the order as sediment to water (1.55) > periphytic biofilm to gastropod (0.875) > sediment to gastropod (0.618) > water to periphytic biofilm (0.433). The indirect arsenic accumulation rates are 0.671 (=1.551 x 0.433) and 0.587 (=1.551 x 0.433 x 0.875) in periphytic biofilm (sediment→water→periphytic biofilm) and gastropods (sediment→water→

periphytic biofilm→gastropod), respectively. The arsenic bioaccumulation from sediment to gastropod follows two paths: direct (sediment→gastropod) and indirect (sediment→water→periphytic biofilm→gastropod). And the percolation rate is higher through the direct path (=0.618) than through the indirect path (=0.587). These gastropods might hyperaccumulate a larger fraction of As directly from sediment through filter feeding. While grazing on periphytic biofilm consisting of green microalgae and suspended detritus, there is loss of preferable food items which are lost under water. The grazing nature of these herbivorous gastropods might be attributed to the lesser As concentration in the indirect pathway.



Openwater Aquaculture Production & Management



वार्षिक प्रतिवेदन

Annual Report

2023

Openwater Aquaculture Production & Management

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

Project Code: RWF/21-24/12

Duration: April 2021 to March 2024

Principal Investigator: M. A. Hassan

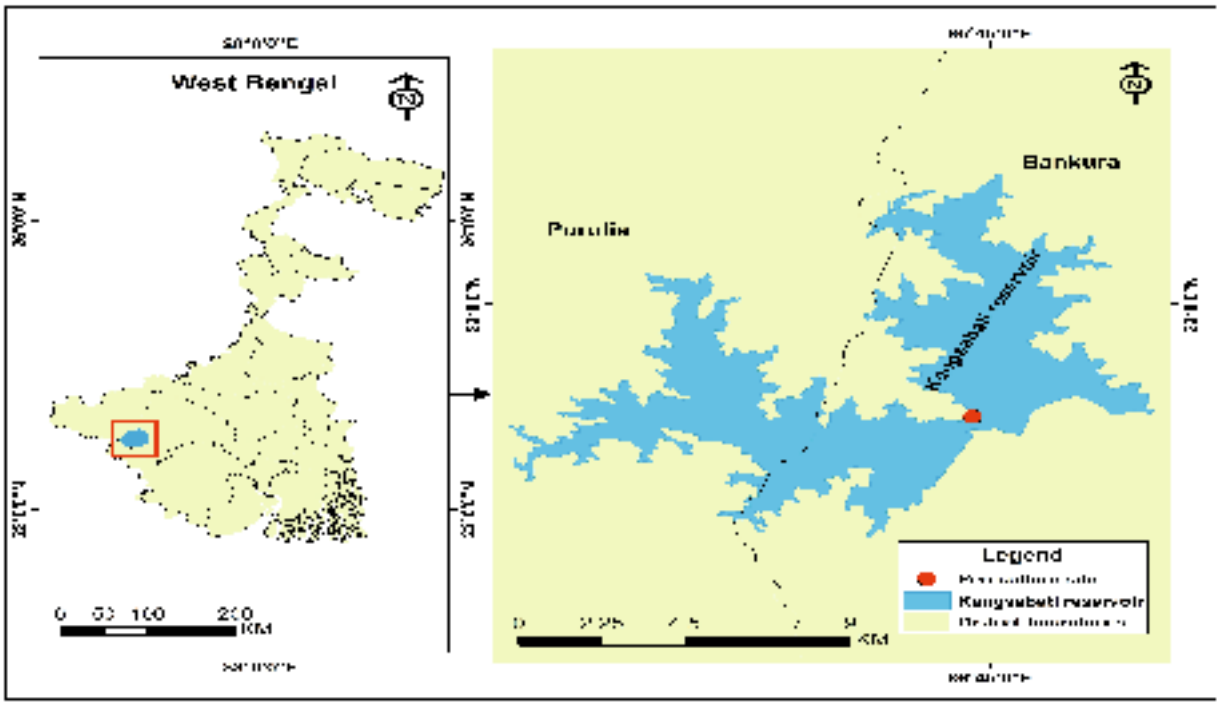
Scientific Personnel: S. K. Manna, D. K. Meena, Raju Baitha, H. S. Swain (upto 31.08.22), Rahul Das, Suhas Kamble

Summary

- A new net pen (Polypropylene based material) was designed for deep water bodies like reservoirs. The pen is capable to stand firm against dwindling water levels and wave action during prolonged culture periods. The circular structure of the pen requires less material for mending and also offers greater physical stability.
- The design was successfully tested at Maithon reservoir, Jharkhand, and later the pen infrastructure was shifted to Kansabati reservoir, West Bengal for feasibility studies.
- The pen was stocked with advanced fingerlings (87-112 g) of *Labeo catla* and *L. rohita* in 20:80 ratio, after proper acclimatization and prophylactic treatment. The fishes were fed with 2 mm floating pellets of CIFRI-CAGEGROW at 2 % of biomass.
- The fishermen reported notable increase in weight (200-250 g) during 80 days of rearing.

New pen design for table size fish production

A new design of net pen was developed to suit the deep water body like reservoirs, to counter the issues of rapid dwindling of water levels and wave action during prolonged culture period for table fish production. The design was successfully tested in Maithon reservoir, Dhanbad, Jharkhand. After successful culture of carps for more than 6 months, the net pen infrastructure was shifted to Kansabati reservoir, Bankura, West Bengal and installed there to study its feasibility in new geographic location. The net pen made of synthetic materials (net, rope, float, sinker and anchor) installed at a suitable place in the reservoir at an



Pen culture site at Kansabati reservoir, Bankura, West Bengal



Floating pen

average water depth of 6.3 m covering 0.1 ha area having perimeter of 115 m. Some minor changes, such as provision of predatory net at the top and side wall of the pen were made to protect the fishes and pen structure from birds and large predators present in the waterbody.

Considering the merits such as durability, flexibility and high tensile strength, net made up of propylene material was selected for long duration of culture period. The shape of the pen was made circular to provide greater physical stability and least material requirement. The pen installation site in the Kangsabati reservoir was selected based on the fluctuations of water level, accessibility, basin slope, muddy and least undulating bottom. PuddyAnchal Fisherman Co-operative Society Ltd. will be the participating institution for routine management of culture operation.

After the installation, the pen wall was allowed to get softened, catch silt and develop periphytic communities on the net wall for a fortnight before stocking of fingerling for table fish production. During post monsoon period (November) advanced fingerlings of 110.32± 13g with variable weights (87-112 g) of IMC comprising *Labeo catla* and *Labeo rohita* in 20:80 ratio were stocked.



Feeding in enclosure

Table: Habitat quality of pen culture site, Kansabati reservoir, Bankura

Location	22°57' 47" N and 86°44'45" E
Air Temp (°C)	27.5-35.2
Water Temp (°C)	29-34.4
Depth (m)	4.9-6.2
Transparency (cm)	102-226
DO (mg/l)	6.4-8.8
pH	6.4-8.72
Conductivity (µS/cm)	138.4-177.7
TDS (mg/l)	98-125
Free CO_2 (mg/l)	0.00
Total Alkalinity (mg/l)	44-62
Total Hardness (mg/l)	98-148
GPP (mgC/m^3/h)	46.88-109.38
Avl PO_4 (mg/l)	0.149-0.310
Total N (mg/l)	0.140-0.821
Total chlorophyll (mg/m^3)	1.198-22.022

Following the survival recorded at 77%, the initial biomass of 218.55kg (1981 advance fingerlings) of seed were stocked in pen after the necessary acclimatization and prophylactic treatment using $KMnO_4$ solution @ 2 ppm for 10 second. During last 80 days of rearing, barring few sporadic deaths, no case of disease or morbidity and mortality was noticed.

The fingerlings were fed 2mm floating pellet CIFRI-CAGEGROW® at 2% of biomass containing CP 28% and CL 5% twice daily in a feeding enclosure to avoid dispersal and wastage of feed. Monthly growth of fishes could not be monitored due to water depth and inconvenience of gear operation. However, visual assessment by fishermen during feeding activities indicated weight range of fishes between 200-250g during 80 days of rearing.

Selected water quality parameters of the reservoir near pen culture site were routinely monitored. The reservoir found to be medium productive.

Project Title: Development of environmentally sustainable feed for enclosure culture

Project Code : RWF/22-25/13

Duration: April 2022 to March 2025

Principal Investigator: D. K. Meena

Scientific Personnel: M. A. Hassan, Rahul Das

Summary

- Key achievements include elucidating nutrient retention and loading dynamics, and formulating promising strategies to maximize retention and minimize loading.
- Three isonitrogenous feeds (CP 32 %) *i.e.*, two formulated (soybean as protein source and casein as main protein sources) and one commercial feed was tested in *Pangasianodon hypothalamus* reared in 500 L circular tank for two months.
- In addition to this leaching experiment and indoor feeding trial was conducted for the efficacy testing of formulated feeds (soybean, brewer waste and casein based) was compared with commercial feed along with nutrient leaching and retention in *Oreochromis niloticus* and *Pangasianodon hypothalmus* fish flesh.
- Further, the same experiment for nutrient leaching and nutrient retention was performed with commercial feed in cage reared *P. hypothalamus* at Kangsabati reservoir.

This project focused on developing environmentally sustainable feed for enclosure culture systems. Key achievements include elucidating nutrient retention and loading dynamics, and formulating promising strategies to maximize retention and minimize loading.

In view of this, three isonitrogenous feeds (CP 32 %) i.e., two formulated (soybean as protein source and casein as main protein sources) and one commercial feed was tested in *P. hypothalamus* reared in 500 L circular tank for two months. In addition to this leaching experiment and indoor feeding trial was conducted for the efficacy testing of formulated feeds (soybean based, brewer waste based and casein based) was compared with commercial feed along with nutrient leaching and retention in *O. niloticus* and *P. hypothalmus* fish flesh. Further, the same experiment for nutrient leaching and nutrient retention was performed with commercial feed in cage reared *P. hypothalamus* at Kangsabati reservoir.

Results showed a significant difference ($p< 0.05$ %) in phosphorus leaching among the three feeds The maximum phosphorus leaching was found in commercial feed (brewery waste feed) followed soybean based feed and casein based fish feed. While in case of nitrogen leaching there was no significant ($p> 0.05$%) difference was found among the feeds.

The nutrient retention showed divers pattern. In case of Phosphorus a declining trend as compared with initial phosphorus content of the fish species. No significant difference was observed among the feeds however slight increment was observed in brewery based fish feed as compared with other feeds.The maximum phosphorus content was observed in brewery based fish feed.

The nitrogen retention (%) showed a significant difference ($p<0.05$%) between the feeds, maximum value was observed in brewery based fish feed (25.02±1.83 %) followed by casein based feed(22.19±1.5) and soyben based fish feed(16.04±0.89).

Project Title: Next generation inland open water cage culture in India with special reference to system and species diversification

Project Code: RWF/23-26/14

Duration: April 2023 to March 2026

Principal Investigator: B. K. Das

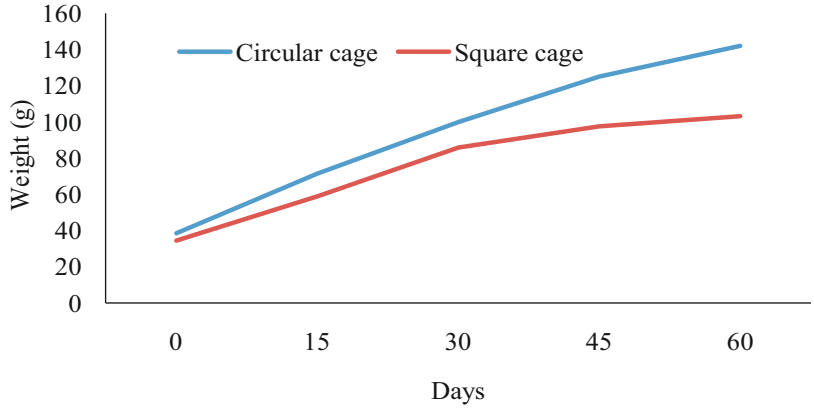
Scientific Personnel: M.A. Hassan, Gunjan Karnatak, Mishal P., Suman Kumar, Raju Baitha, Mitesh Ramteke, D.K. Meena, Rahul Das, Venkatesh Thakur, Suhas P. Kamble, Sona Yengkokpam, Dipesh Debnath, P. Das

Summary

- *Pangasaianodon hypophthalmus* was stocked in circular HDPE cages (15 m Diameter; 795 m^3 volume) and square GI cages (5m x 5m x 3m) at different stocking densities, revealing better growth performance in circular cages.
- Insulin-like Growth Factors (IGFs) expression in cage-reared butter catfish (*Ompok bimaculatus*) was studied across stocking densities, emphasizing the significance of liver-derived igf-1 as a biomarker for growth in response to culture density.
- Collection and rearing of *Sperata aor* advanced fingerlings from River Ganga were conducted, involving techniques to ensure the well-being of the collected fishes, recording length and weight, and providing suitable conditions in hatchery tanks for adaptation and growth.

Comparative evaluation of growth of *Pangasianodon hypophthalmus* in different type of cages

Pangasaianodon hypophthalmus (average weight 34.5g) was stocked in two types of cages *i.e* circular HDPE cage (15 m Diameter; 795 m^3 volume) and square GI cages (5m x 5m x 3m) at the rate of 20 fish per cubic meter. The fish were fed with floating pelleted feed having 28% crude protein and 5% crude lipid at the rate of 3-5% of body weight two







HDPE circular cage and square GI cages used for experiment at Maithon reservoir, Jharkhand

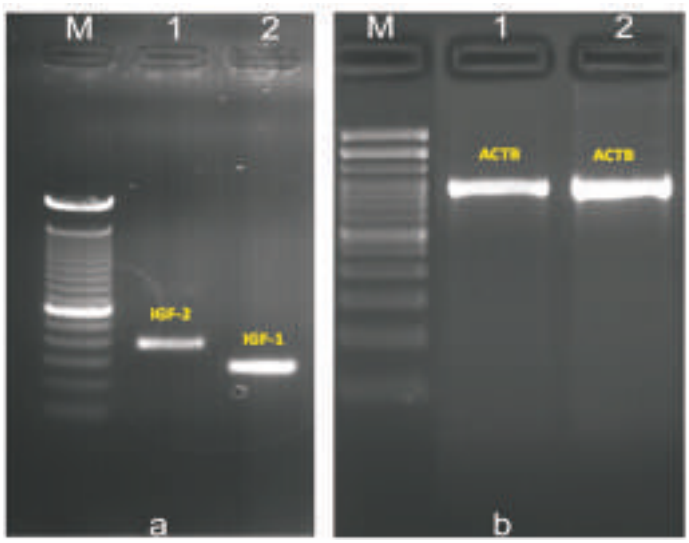
times a day. The growth and water quality were monitored at fortnightly intervals. The growth pattern of fishes in two types of cages is presented. The growth performance of fish in circular cage with greater volume was observed to be better than the smaller GI cages. The SGR, ADG, WG (%) were higher in circular cage (2.18, 1.73 and 268.8% respectively) compared to smaller GI square cages (1.83, 1.15 and 178.4% respectively). The FCR (1.45) was lower in circular cage as compared to square cages (1.57). The survival rate was 98.83 and 98.13% in circular and square cages, respectively. The FCE was 0.69 in circular and 0.64 in square cages. There was no significant difference in the water quality parameters recorded inside both types of cages. The water quality at cage site did not show any significant difference from water quality at reference site.



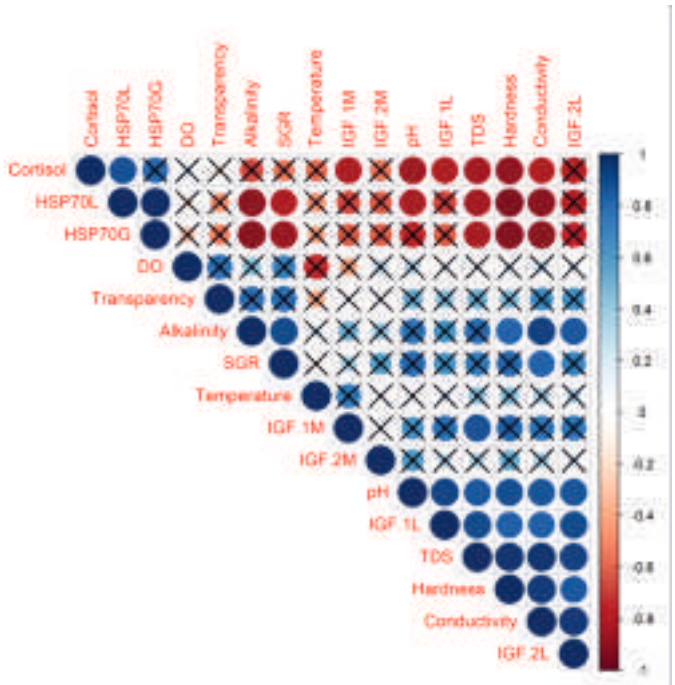
Growth monitoring of fish

Molecular Characterization and Expression Analysis of IGF-1, IGF-2 in Cage-Reared Butter Catfish in response to culture densities

Insulin-like Growth Factors (IGFs) are crucial in vertebrates, contributing significantly to growth and various physiological processes. The GH-IGF axis serves as a valuable indicator for monitoring fish growth performance. To understand expression dynamics of insulin like growth factors to stocking densities, relative expression of igf-1 and igf-2 were studied in the liver and muscle tissues of cage-reared butter catfish (*Ompok bimaculatus*) at different stocking densities (15, 25, 35 numbers m^{-3}) over a 180-day culture duration. Partial transcript sequences of Obigf-1, Obigf-2, and Obβ-actin were sequenced and submitted to NCBI gene bank. The expression of igf-1 in the liver showed significant down regulation at higher stocking densities after 120 days, correlating with increased biomass in the cages. In contrast, igf-2 expression remained unchanged across stocking densities during the culture period.



PCR amplified products of (a) IGF-1, IGF-2, (b) ACTB
(M: Marker (100bp); 1: Lane -1; 2: Lane-2)



Correlation of growth and stress related genes expression with growth rate, environmental parameters, serum cortisol and growth of cage reared *O. bimaculatus*

Elevated cortisol concentration in T3 groups after 150 days correlated negatively with igf-1 ($p<0.05$) and igf-2 ($p>0.05$) expression. The HSP-70 expression in the liver showed significant upregulation from 90th day of the culture period at higher densities. Similarly, HSP-70 showed significantly higher transcripts in gill from 90 days at higher densities. The correlation analysis between the gene expression, cortisol concentration and environmental parameters showed that IGF transcripts, in general, were inversely related to HSP-70 transcripts and serum cortisol concentration. HSP 70 showed a positive correlation with cortisol and significant negative correlation with SGR. The environmental parameters viz pH, TDS, hardness, conductivity, and alkalinity influenced expression of both type of genes. This study underscores the importance of liver-derived igf-1 in regulating growth in response to culture density in *O. bimaculatus*. The findings suggest that igf-1 can serve as an effective biomarker for growth. Similarly, HSP-70 can be used as an effective biomarker for crowding stress in this species. Additionally, the insights gained from this research can contribute to planning optimal harvest schedules and refining culture practices for *O. Bimaculatus* in open water cage systems.

Tapping the cage culture potential of indigenous fishes

Sperata aor is a bagrid catfish fish belonging to family bagridae and commonly called as *Aor*. It is a fresh water species and naturally distributed in the Indian riverine system. The fingerlings are being collected from up and downstream of Farakka Barrage by lift net, hand net, gill net, locally catching technique by fishermen of upstream of river Ganga called '*Jhanki Jaal*'. The collection process was preferred during morning time to avoid temperature stress to the collected fishes. The injured fishes with their broken spines or fishes caught by hook-line are avoided during collection. During transportation to avoid physical injuries, only 1-2 fishes are kept in FRP tanks of 100 L capacity. Before releasing into tanks, the collected fishes were given a dip treatment with 7 ppm $KMnO_4$ to avoid parasite, if any. The collected advanced fingerlings were shifted to the hatchery FRP tank of 5000-liter capacity filled upto $1/5^{th}$ with freshly filtered river water with desirable water-quality parameters. Before releasing in tank, the length and weight was recorded. The length and weight of the collected stock ranges from 14-26 cm and 33-150 g, respectively. A total 46 advanced fingerlings were stocked in two tanks to avoid crowding, in each tank the stone rocks and floating macrophytes were kept for proving natural hiding environment to them. The aerator facility was also provided for keeping oxygen to saturation levels. *Sperata aor* feeds on benthic organism such as crustaceans, molluscan, worms, insects, and fishes. The fishes are accepting the live feed. The fishes have been adapted to accept the commercially available sinking feed (35% CP). The water quality parameters were monitored regularly and 20% water exchange has also been carried-out weekly to maintain the quality of rearing water.



Sperata aor at the river site soon after the collection



Sperata aor

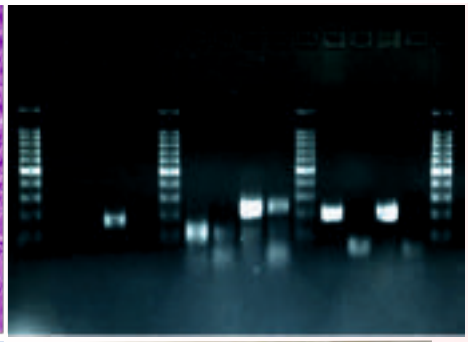


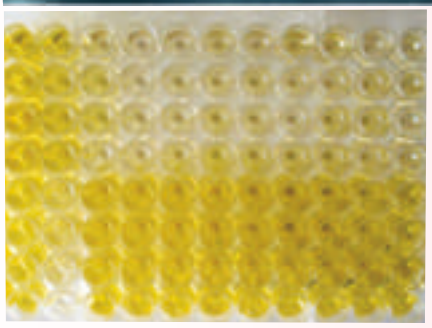
S. aor stocked into the rearing facility



Riverine collection of *Sperata aor* by the local fishers

Aquatic Environmental Biotechnology



वार्षिक प्रतिवेदन

Annual Report

2023

Aquatic Environmental Biotechnology

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

Project Code: FREM/20-23/17

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

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

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

Duration: April 2020 to March 2024

Scientific Personnel: Vikash Kumar (PI, w.e.f. 31.12.21); B. K. Behera (PI, upto 30.12.22), Tanushree Bera, Niti Sharma (w.e.f. 01.04.21), Suvra Roy (w.e.f. 01.04.22)

Summary

- Microbial metagenomic in sediment samples of 6 wetlands based on the riverine connection (open or closed) and pollution status (polluted and non-polluted), potential to identify pollution bioindicator/biomarker micro-organisms in the wetlands and understand the microbial ecology, novel microbial interactions and biogeochemical cycles in the wetland ecosystems were studied.
- Bacterial diversity and community composition analysis provide insights into the ecological roles of bacteria within the wetland sediment microbiome *via* the diversity-driven cultivation and functional characterization of bacterial strains.
- Metagenomics profile of a polluted water body has been assessed and found that the sewage site has the highest concentration of microorganisms including virus and bacteria.
- The wetland microbiome has 50% of the genes involved in metabolism, 20% genes in cellular processes & signalling and 18% of the genes in information storage & processing.
- The bio-remediation capabilities of bacterial isolates were characterized and microbial consortiums were developed for the potential removal of ammonium from contaminated water bodies.

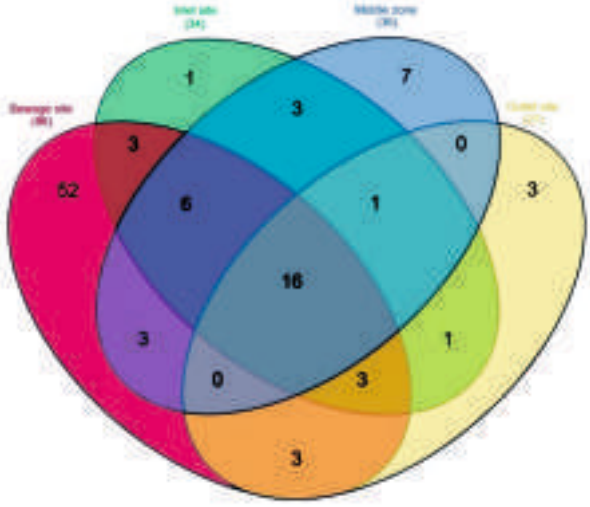
Metagenomic profiling of East Kolkata floodplain wetland (Sardar Bheri)

Constructed wetlands are artificial systems created to help treat wastewater by leveraging the natural processes found in wetland plants, soils, and related microbial assemblages. Because of its low cost, low energy consumption, and minimal mechanical technology needs, the natural wastewater treatment system has been recognized as a sustainable ecotechnology for developing nations. One such artificial wetland for wastewater treatment is East Kolkata Wetlands (EKWs), which have been recognized as one of the most exceptional wetlands in the world for their capacity to treat wastewater. About 2500 tons of solid garbage and 600 million liters of sewage are created daily on average from Kolkata and are disposed of close to the EKW site. Nonetheless, anthropogenic stressors, plastics, industrial effluents, hospital discharges, heavy metals, and other potentially hazardous components have contaminated the environment, putting EKW in imminent danger. Sediments in aquatic environments are rich sources of high microbial diversity and varied ecosystems. Therefore, research on the microbiome in naturally occurring wastewater treatment wetland sediments can offer fresh perspectives on potential bio-indicator species and biomarker populations. In order to directly access the genetic makeup of vast communities of organisms from environmental samples, without the need to create pure cultures, metagenomics applies a spectrum of genomic technologies and bioinformatics tools. Compared to phylogenetic surveys, metagenomics offers a far more comprehensive description by granting access to the functional gene composition of

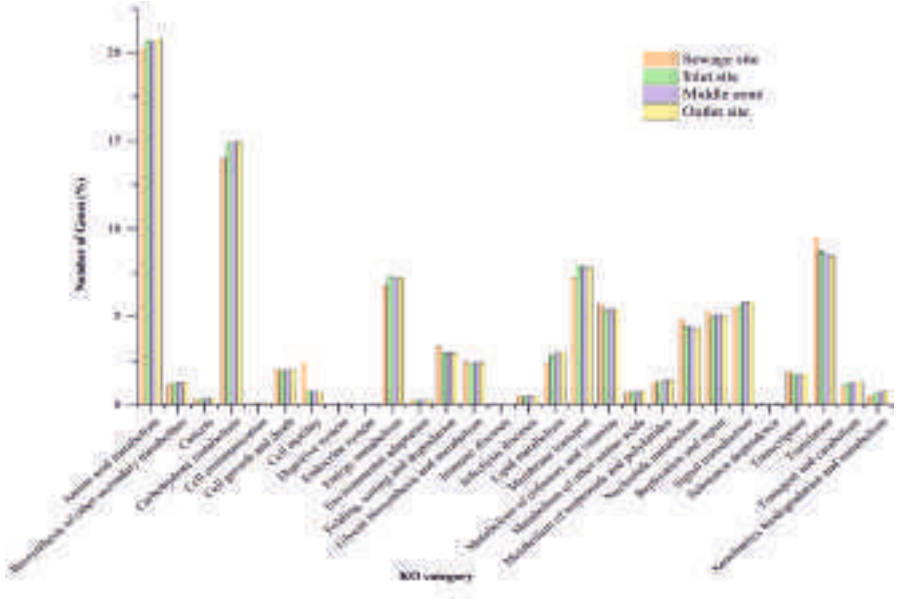
microbial communities. Hence, we conducted a metagenomic investigation in Sardar Bheri, which is located in the East Kolkata wetland (latitude 22˚25'N to 22˚40'N and longitude 88°20'E to 88°35'E).

New insights into the microbial community

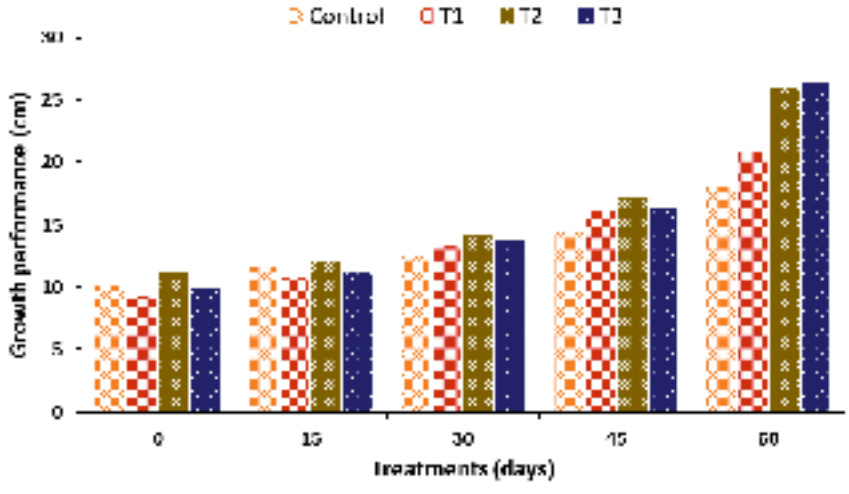
High-throughput sequencing and bioinformatics analysis revealed 57 phyla and 117 different classes of microorganisms were determined in sediment from the East-Kolkata Wetland. A comparative study on all approaches to the taxonomical classification revealed that the occurrence of microorganisms is highest observed in sewage site sediment, then inlet site, middle zone and outlet site sediments respectively. Further, a taxonomical classification study confirmed that domain Bacteria predominated in all the studied sites (86-89%), followed by Eukaryote and Archaea. Looking at the taxonomic profile of bacterial communities, Proteobacteria were the most abundant phylum of the bacterial community in Sardar *bheri* of East-Kolkata Wetland representing i.e., sewage site: 63.12%, inlet site: 44.03%, middle zone: 45.28% and outlet site: 44.66% of the detected bacteria. Other abundant phyla were represented by *Firmicutes*, *Bacteroidetes*, *Actinobacteria*, *Verrucomicrobia*, *Chloroflexi*, *Acidobacteria*, *Planctomycetes*, *Nitrospirae*, *Spirochaetes* and *Cyanobacteria*. Among the Archaea, *Euryarchaeota* were dominating at the phylum level in all the sites followed by *Crenarchaeota* and *Thaumarchaeota*. *Methanosaeta, Methanolinea, Methanobrevibacter, Methanobacterium, Methanofollis, Methanoregula* and *Methanospirillum* are major abundant archaeal genera in all the samples. In addition, microbial community diversity indices results revealed the higher Shannon and Simpson diversity in sewage site (0.9573 and



Venn diagram showing number of shared and unique characteristics (at genus level) between the different sampling sites of the East-Kolkata Wetland



Functional classification of East-Kolkata Wetland metagenome data according to KO (KEGG orthology)



Effect of bacterial consortium on growth performance of *Labeo catla*

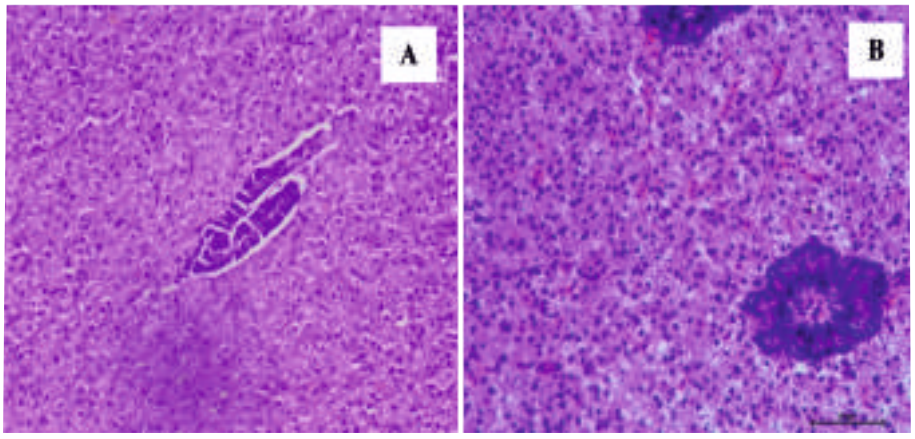
5.15) and lower in the outlet site (0.9483 and 5.061).

Functional metagenomic profiling of sediment microbiome

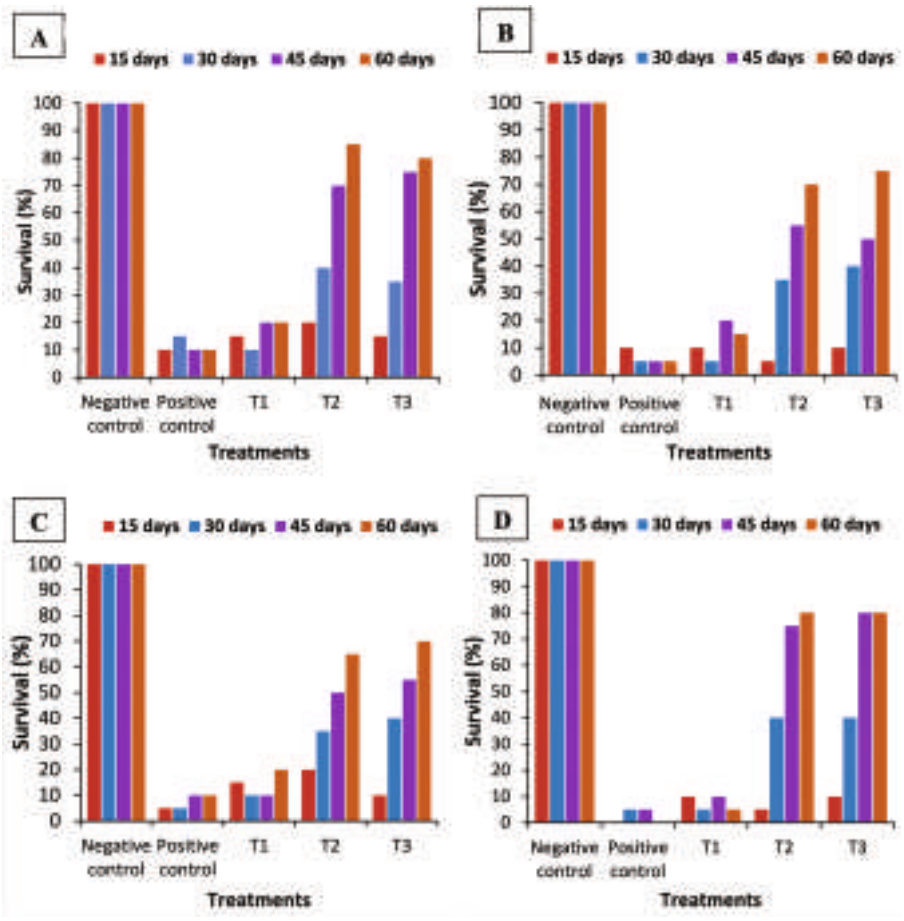
Functional annotation through KEGG orthology showed that almost 60% of the genes were involved in metabolism, flowed by genetic information processing, environmental in formation processing, cellular processes and human diseases. In addition, functional analysis indicated the presence of a wide variety of genes possibly involved in xenobiotic degradation and metabolism (Fig 2). A total of 13211 (sewage site), 9982 (inlet site), 9695 (middle zone), and 9050 (outlet site) genes were assigned related to the degradation of xenobiotic pathways in the metagenome of East Kolkata Wetland sediment. In addition, 57 species/strains of bacteria related to bioremediation potential have been identified from sediment microbiome of EKWs. Moreover, 44 antibiotic resistance genes/subtypes (ARGs), 43 heavy metal resistance genes (HMRGs) belonging to 14 different categories and 1436 sequences which includes 71 potential plastic degrading bacterial strains/species were detected from east-Kolkata wetland. To the best knowledge, this is the first study to investigate the microbial community composition and different functionality in a constructed wastewater treatment wetland system through a metagenomic approach.

Microbial consortium to induce growth and disease resistance in *Labeo catla* against pathogenic bacteria

The combined effects of climate change and aquaculture intensification have accelerated the spread of essential fish pathogens. Therefore, to address these issues without further environmental degradation, it is crucial to explore



Histological analysis of liver samples collected from control (A) and treatment groups (B)



Survival assay of *Labeo catla* after 15, 30, 45 and 60 days post experiment challenged with (A) *Pseudomonas aeruginosa*, (B) *Aeromonas veronii*, (C) *Edwardsiella tarda* and (D) *Proteus penneri*

effective and safe alternatives to chemical methods of protection against microbial diseases. Biocontrol, an approach involving methods that utilize natural interactions between organisms, offers a potential solution. Microbial consortia can contain a diverse array of microorganisms that exhibit variations in their environmental preferences, host fish, different preferential sites of colonization, and activity against different pathogen species. Although individual microbial strains may possess different modes of action, the amalgamation of multiple microorganisms within consortia can

Table: Heavy metals (μgg^{-1} wet wt.) concentration in fish muscle

Parameters	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	-	-

broaden the spectrum of their activities against a wide range of fish pathogens. Additionally, the microorganisms present in biocontrol consortia can contribute to fish growth promotion and/or enhance the activity of the other microorganisms, further increasing the potential of such products. We developed a microbial consortium containing six non-pathogenic bacterial strains. Initial investigations indicated that isolated consortium exhibited anti-virulence and antibacterial properties against pathogenic bacteria. Later, experiment feed was prepared using six different bacterial strains including SH1, SH2, 10, 14, 28 and ITO at 10^3 (T1), 10^5 (T2) and 10^7 (T3) cfu/ml and fish were fed for 60 days. Increased growth performance, normal cellular structure of hepatic tissue and immunological response were observed at 15-, 30-, 45- and 60 days post-experiment in the microbial consortium supplemented group. In addition, higher survival was observed in microbial supplemented group against pathogenic *Pseudomonas aeruginosa, Aeromonas veronii, Edwardsiella tarda* and *Proteus penneri*.

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

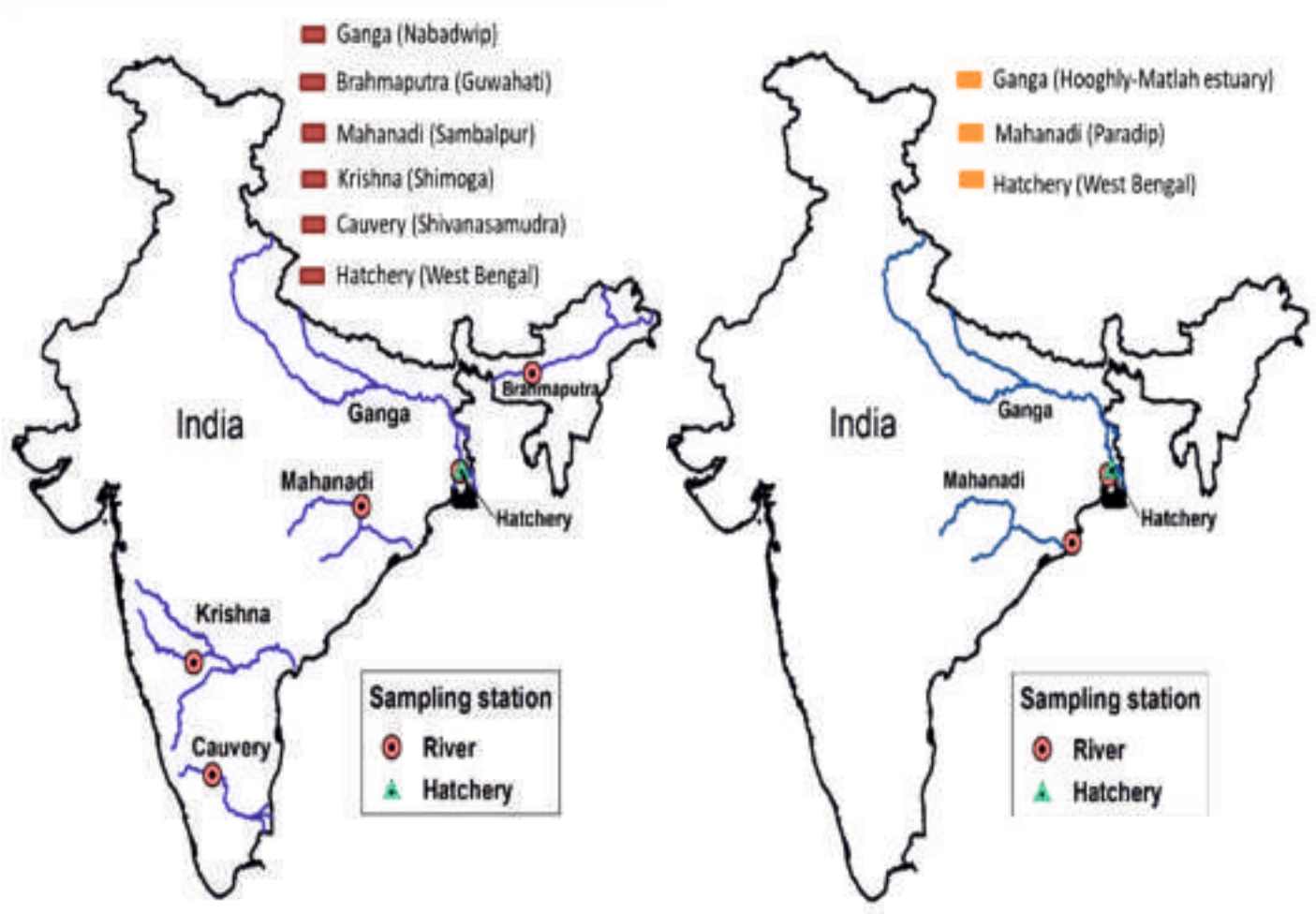
Duration: April 2020 to March 2024

Scientific Personnel: Suvra Roy (PI, w.e.f. 21.12.22); P. K. Parida (PI, upto 20.12.22), D. Bhakta, V. L. Ramya

Summary

- Two small indigenous catfish species of the bagridae family, *Mystus gulio* and *Mystus cavasius* were characterized.
- For the genetic stock characterization of *Mystus* species, *M. cavasius* samples (dorsal fin) were collected from the rivers Ganga, Krishna, Cauvery, Brahmaputra and Mahanadi, and samples of *M. gulio* were collected from the river Ganga, Mahanadi and hatchery (Naihati).
- Total of 127 sequences mitochondrial Cytb gene of *M. cavasius* were submitted to NCBI; while a total of 86 sequences mitochondrial Cytb gene of *M. gulio* were submitted to NCBI.
- 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 OP893799 and OP856487 respectively.
- The *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.

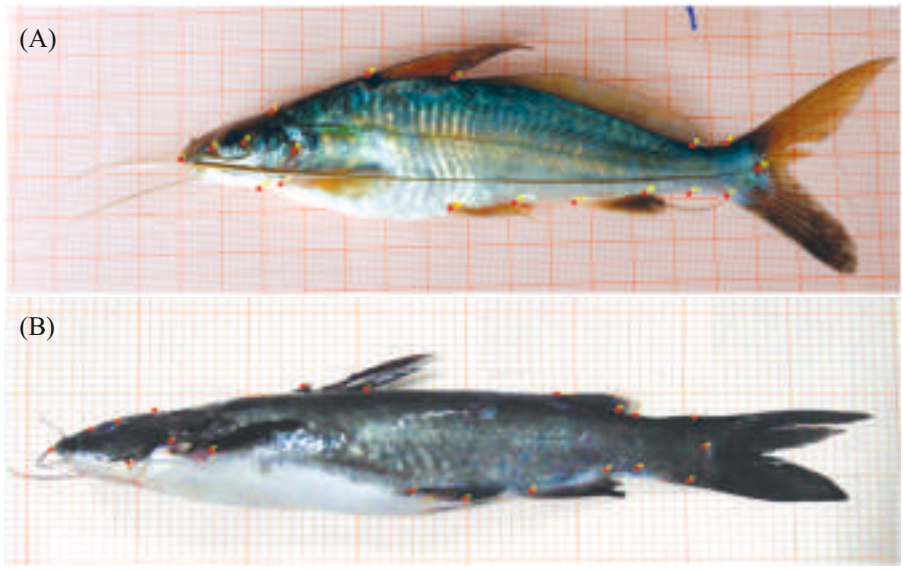
The freshwater aquatic ecosystem of India is regarded as the hotspot of fish diversity and a high degree of endemism contributes to the world's biological resources. However, genetic diversity is facing many threats due to population bottlenecks including smaller effective population size, over-harvesting and pollution of rivers. Fish species distribution in inland fresh waters is also highly regulated by physical barriers and the river dynamics. Knowledge of the genetic structure and mapping of the genetic diversity within and among populations of species can provide insights into the basis of adaptation to environmental changes, susceptibility to diseases, barriers to migration and reproduction, and paths of speciation. Hence, conservation of genetic diversity in freshwater fish species is foremost for maintaining the genetic variation among species and population. In addition, selection of appropriate marker is prerequisite to determine the genetic diversity, and molecular markers especially mitochondrial DNA (mtDNA) is the most commonly used population genetic marker to determine the variation at interspecific and intraspecific levels. Taken this into account, in the present study attempt has been made to acquire information on genetic differentiation, structure and evolutionary relationships of two small indigenous bagrid catfish species *Mystus cavasius* and *Mystus gulio* after collecting the individuals from Indian major rivers.



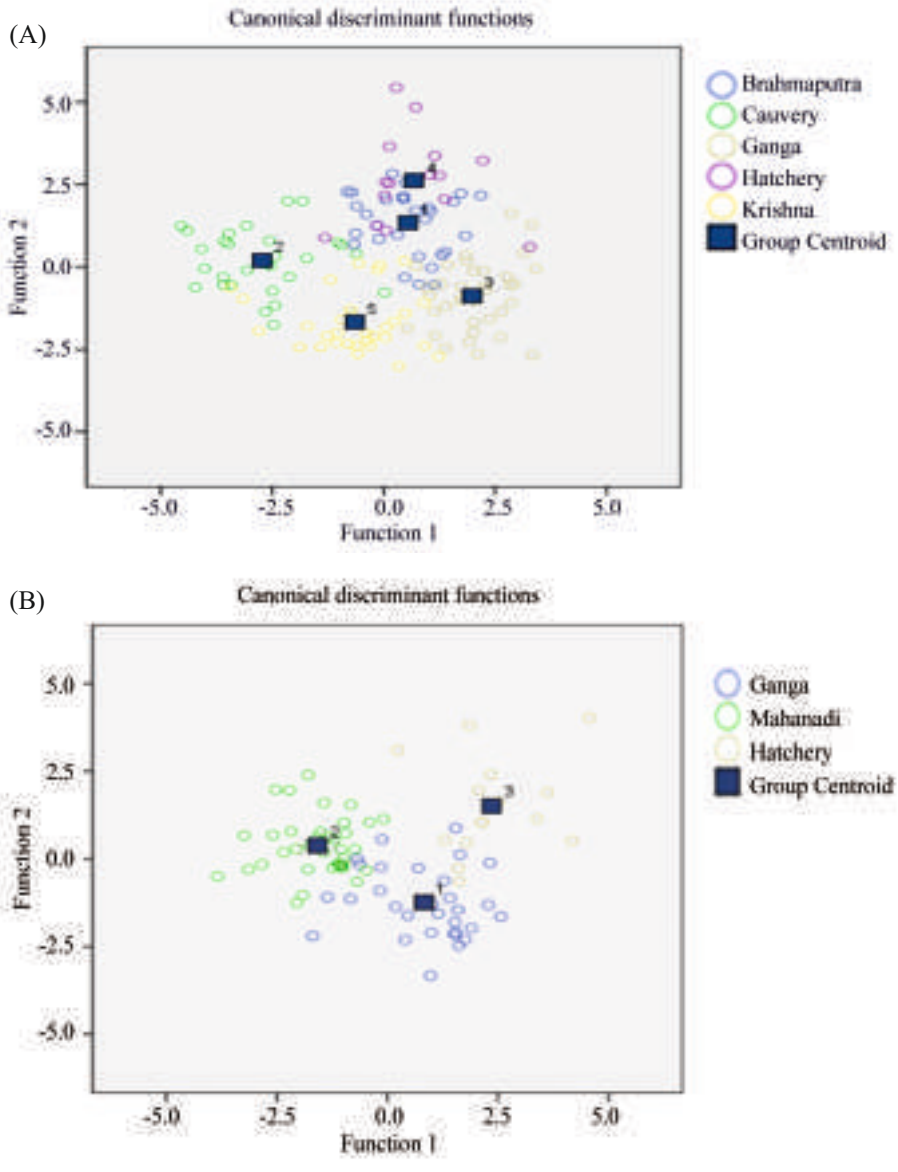
Map showing the sampling locations of *M. cavasius* (A) and *M. gulio* (B) individuals

Truss analysis

Population structure of *Mystus cavasius* and *Mystus gulio* were studied using conventional and image-based analysis method. The study was carried out with five stocks of *M. cavasius* namely Cauvery, Krishna, Brahmaputra, Ganga and Hatchery stock. A total of 36 (*M. cavasius*) and 40 (*M. gulio*) truss measurements were used in the study for stock discrimination. Eighteen and twenty land marks were used to generate 36 and 40 truss distance measurements of *M. cavasius* and *M. gulio* respectively. The landmarks were digitized on the image using the software "tpsdig2 V2.1"17 and the data were encrypted into tps files in the form of X-Y coordinates. Linear combinations of two software platforms, tpsDig2 v2.1 and PAST were used to extract the truss distances. Data were checked for normality and logarithmic transformations were deployed in the data. There is the significance difference among the stock were observed in the one-way ANOVA and the data was used for different multivariate analysis. The principal component analysis, factor analysis and discriminate analysis were deployed to determine the variation of conventional and truss variables. For *M. cavasius* total three PCA explained 75.6% and for *M. gulio* total of two PCA explain 89.4% of variation. For *M. cavaisus* first factor were related to the body depth, fins and caudal region. Second factor related to head, and the third factor is related with anal fin and its relative distance with other fins. For *M gulio* factor 1 highlighted the most variations in body shape and factor 2 related to head shape. Discriminant function analysis in *M. cavasius* showed that hatchery and Brahmaputra stock are related, whereas southern rivers showed similarity. In *M. gulio* hatchery stocks are isolated from other wild stock, however wild stock showed similarity compared hatchery stock.



Landmarks used for truss analysis (A) *Mystus cavasius* and (B) *Mystus gulio*



Discriminate function plot from truss measurements of *M. cavasius* (A) and *M. gulio* (B)

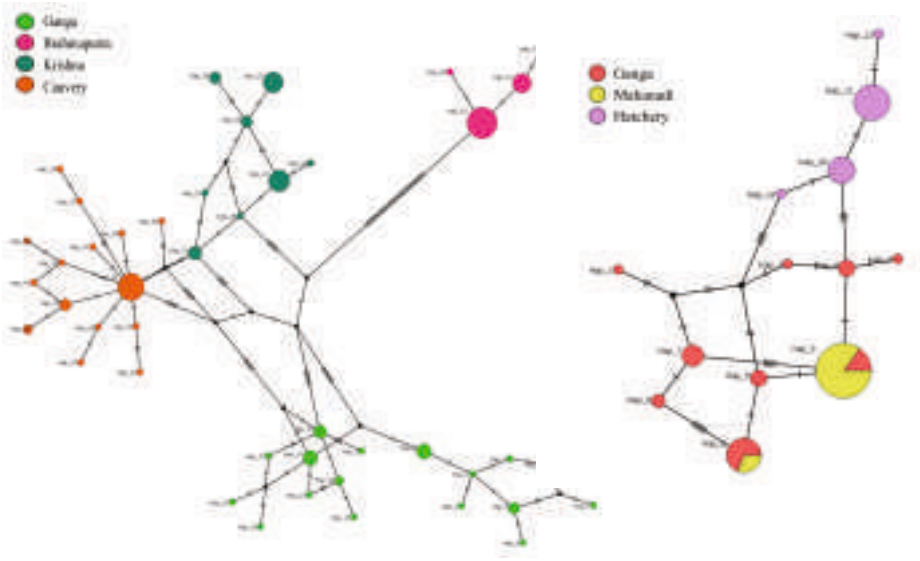
Genetic stock characterization

Mitochondrial cytb region characterization

For the genetic stock characterisation, *M. cavasius* samples (dorsal fin) were collected from the rivers Ganga, Brahmaputra, Mahanadi, Krishna, Cauvery and hatchery. Total 189 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 Ganga river, OQ434681- OQ434685, OQ451804- OQ451829 from the Brahmaputra river, OP921084, OQ861053-OQ861057, OR701335-OR701344, OR805691-OR805704 from the Mahanadi river, OP503683-OP503689, OP535407- OP535419, OP546036-OP546047 from the Krishna river, ON881331-ON881358, OP588455- OP588459 from the Cauvery river and OR046975-OR046982, OR113058-OR113081 from hatchery. Similarly, *M. gulio* samples were taken from the river Ganga, Mahanadi, Pazhayar River and as well as hatchery. A total of 116 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 Ganga river, OP221263-OP221265, OQ630910- OQ630919, OQ744659- OQ744677 from the Mahanadi river, OR640099-OR640100, OR662154-OR662166, OR683450-OR683464 from the Pazhayar river and OP851491-OP851495, OP87102- OP87111, OP985171- OP985179 from hatchery.

Genetic diversity indices

Haplotype (Hd) and nucleotide diversity (π) were considered as an indicator of within population genetic variation, and higher genetic variation in the group depicts higher genetic diversity. DnaSP 6.1 was used to determine the molecular indices and pairwise FST within and between the populations to assess the population structure. A hierarchical analysis of molecular variance (AMOVA) was performed for *Mystus* populations based on mtDNAcytb region using Arlequin v3.5.1.3. The phylogeographic haplotypes network was constructed using NETWORK 4.612. In the present study, cytb region generated 44 haplotypes for *M. cava*sius population, haplotype diversity (Hd) ranges from 0.488 to 0.935, highest Hd observed in Ganga river population and lowest in Brahmaputra river population; whereas nucleotide diversity (π) was relatively low for all the studied populations ranging between 0.0004 (Brahmaputra) to 0.003 (Ganga). In case of *M. gulio* population cytb region generated 13 haplotypes, with Hd ranges from 0.225 (Mahanadi) to 0.855 (Ganga) and nucleotide diversity ranges from 0.0004 (Mahanadi) to 0.0028 (Ganga). The AMOVA analysis of hierarchical gene diversity revealed that high proportion of the total variance was accredited to among-population variation (92.11% for *M. cavasius* and 70.55% for *M. gulio*) whereas 7.89% (*M. cavasius*) and 29.45% (*M. gulio*) of the variation was accredited to within-population variation, and with fixation index (FST= 0.921 and 0.706 respectively) and significant p-value, suggesting that there is geographical structure between groups.



The Median-joining network of *M cavasius (A) and M. gulio* (B) based on haplotypes of mtDNA cytb region

1	MZ853182- MZ853183	*Opsarius bendelesis*
2	MZ665467	*Diodon sp.*
3	MT928124- MT928150	*Mystus Sp.*
4	MT782163	*Hemibagrus punctatus*
5	Zoobank registration of the germplasm: urn:lsid:zoobank.org:pub:754B27CD E061 - 4F8E - 95DD-70C73688B576	*Puntius* sp.

Evolutionary and phylogeographic relationships

The Median joining haplotype networks helped to predict the evolutionary relationship among unique haplotypes and the genealogical history of individuals. The haplotype median-joining network for both *M. cavasius* and *M. gulio* population based on cytb region revealed that there were significant

differences in haplotype distributions and frequencies. Haplotype phylogeny can differ along the genome regions due to the recombination, the process of swapping genome regions between haplotypes during the meiosis process. Our intent was to find out haplotype effects for selected Indian major river populations by leveraging phylogenetic relationships between the haplotypes. Phylogenetic tree with cytb analysis resulted into four principal clades for *M. cavasius* population and three clades for *M. gulio* population. While there are no shared haplotypes in the *M. cavasius* population, there are shared haplotypes in the *M. gulio* population between the Ganga and Mahanadi river populations, indicating a shared ancestral origin and subsequent gene flow among populations. The phylogeographic results and haplotype networks supported the genetic variability exhibited in Mystus population of Indian major rivers. The current work has implications for conservation and management since it demonstrates the genetic structure, evolutionary linkages, and differentiation of *Mystus gulio* and *Mystus cavasius* within and among populations from important Indian rivers.

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

Project Code: FREM/21-24/19

Duration: April 2021to March 2024

Scientific Personnel: D. J. Sarkar (PI), Santhana Kr. V., Tanushree Bera, Suvra Roy (w.e.f. 01.04.22)

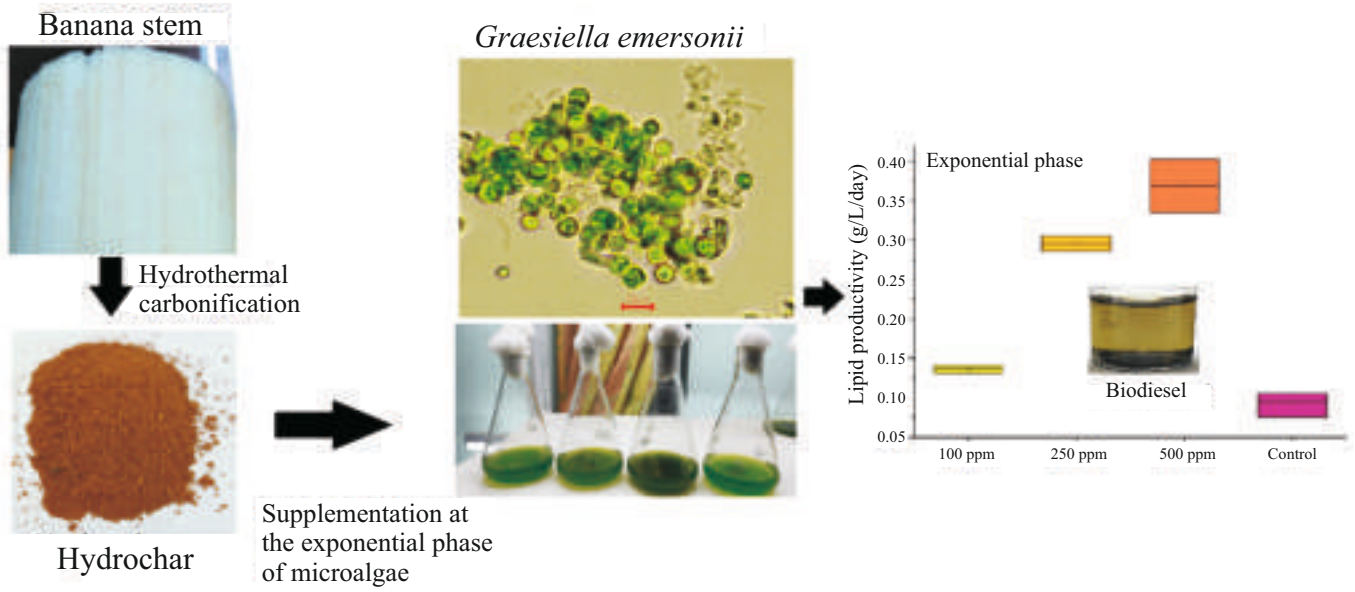
Summary

- To curb phosphate pollution in inland aquatic ecosystems, nanostructured material was prepared by impregnating metal oxides into cellulosic material. The material could adsorb 4805 µg PO_4/g with an incubation time of 20 hr at 10 ppm initial PO_4 concentration.
- The effect of this material on a model microalga (*Graesiella emersonii*) was evaluated. The material addition to the microalgae in the initial and exponential phases inhibited cell growth (92% and 77% reduction, respectively).
- *In vitro* cytotoxic effect of phosphate remediating nanomaterial was assessed in Zebrafish (*Danio rerio*) gill cell line. The 20-50 ppm concentration of the material was found not markedly cytotoxic to cells.

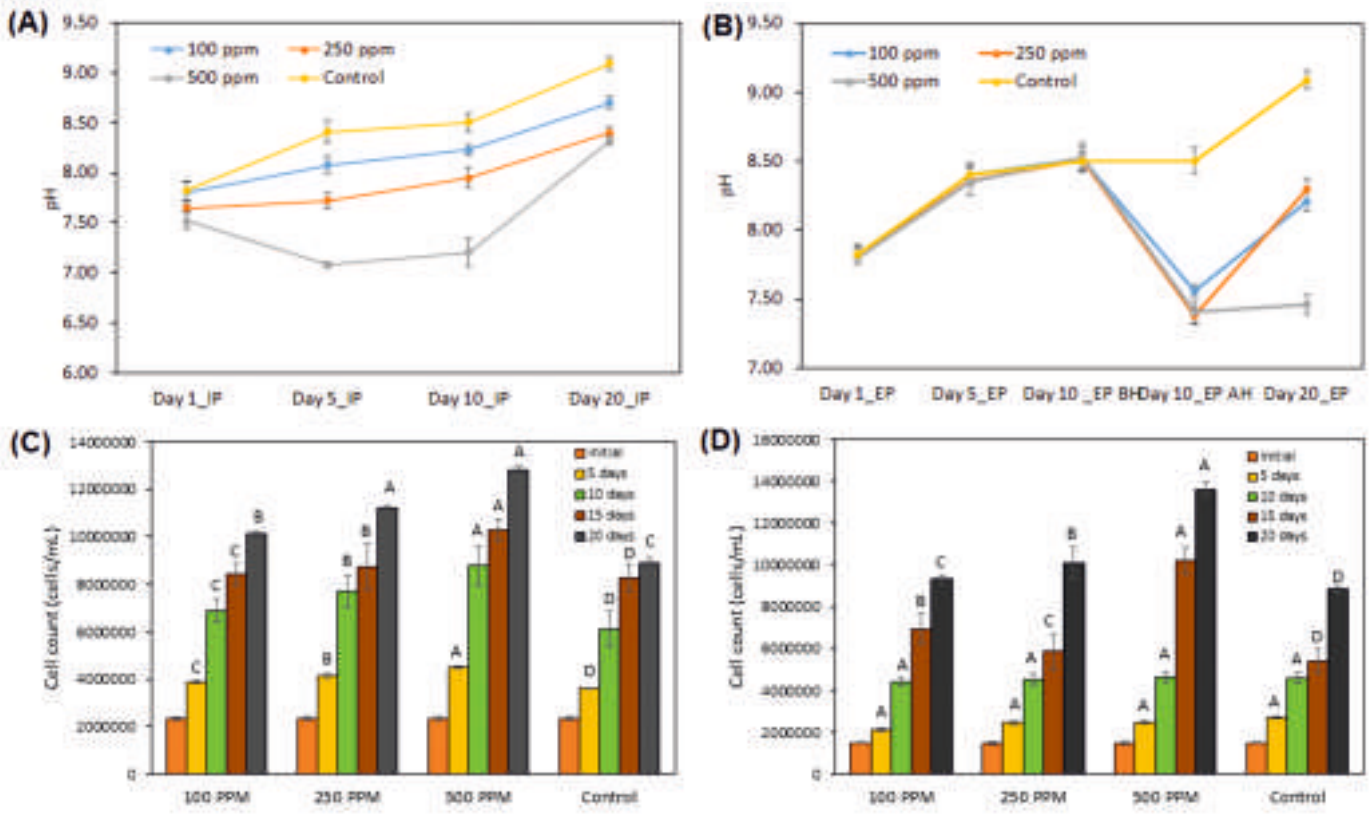
Banana pseudostem derived hydrochar as supplement for microalgal growth and biodiesel production

Characteristics of the hydrochar and media combination

The physical and chemical characteristics of the raw hydrochar solution and their supplementation at initial and exponential phase of microalgae were estimated and depicted in Table. pH of the experimental culture solution was analysed from day 1 to day 20 at 5 days interval and depicted here. The pH of the hydrochar raw solution was acidic in nature and it ranged from 4.55 to 6.16 at the test concentrations. Similarly, hydrochar supplementation in the IP treatment also lowered the pH in a dose-dependent manner (7.52 to 7.81) as compared to control (pH 7.84). Even for EP treatments for pre-grown algae, the hydrochar supplementation also reduced the average pH from 8.52 to 7.45 on 10th day. The electrical conductivities of hydrochar supplemented growth media for both IP and EP treatments were found lower than the control. This may be due to the chelation of active ions present in the Bg11 growth media by the various functional groups present in the hydrochar. It was also found that the electrical conductivity of the medium was higher in case of EP treatment as compared to the IP treatment. This may be explained by less time received by hydrochar to chelate ions from growth medium in case of EP treatment as compared to IP treatment. The turbidity of the all the hydrochar supplemented treatments was higher as compared to control. The COD of the control ranged from 280-360 ppm and it increases (400-1296 ppm) while increasing the dosage of hydrochar. It was also observed that the addition of hydrochar to the culture media during inoculation (IP) led to higher COD value (1.5 to 1.8 times) than their addition to the pregrown microalgae treatment (EP).



Flow diagram of banana pseudostem derived hydrochar as growth supplement for alage biodiesel production



pH of microalgae culture media upon hydrochar addition during initial phase (IP) (A) and exponential phase (EP) (B); Cell count in the culture media upon hydrochar addition during initial phase (IP) (C) and exponential phase (EP) (D).

Effect of hydrochar addition on *G. emersonii* cell count

The cell count of the microalgae at different days was calculated. In IP treatment, hydrochar supplementation led to improved cell count as compared to the control in dose dependent manner. The highest cell count was noticed in 500 ppm hydrochar-supplemented treatment ($1.28\pm0.02 \times 10^7$ cells mL^{-1}). Similarly, in case of EP treatment, hydrochar supplementation significantly improved the cell count and the highest number of cells were found in 500 ppm treatment ($1.36\pm0.03 \times 10^7$ cells mL^{-1}). The number of cells grown in EP treatment (500 ppm) was 1.3 and 1.5 times higher than the IP treatment (500 ppm) and control medium, respectively.

Table: Chemical properties of growth media after hydrochar addition

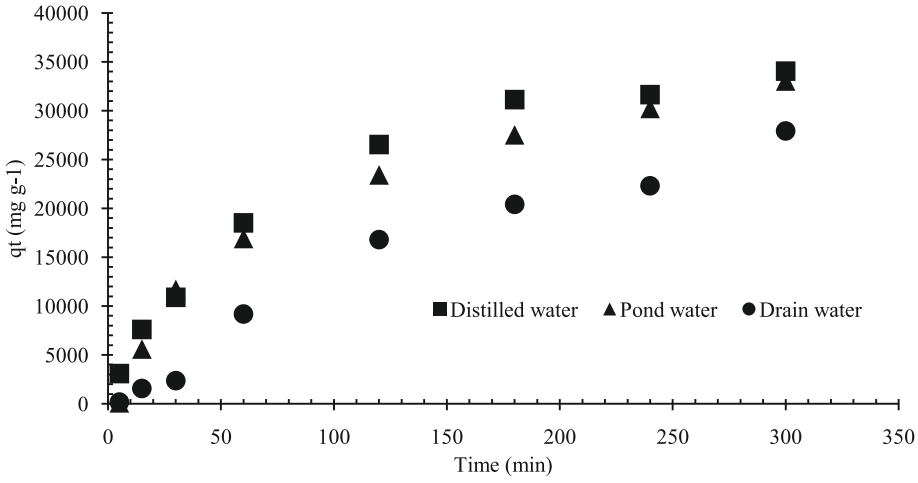
Parameters	Dispersed hydrochar solution										
	Raw solution			IP treatment				EP treatment			
	100 ppm	250 ppm	500 ppm	100 ppm	250 ppm	500 ppm	Control (1st day)	100 ppm	250 ppm	500 ppm	Control (10th day)
pH	6.16±0.03	4.86±0.02	4.55±0.04	7.81±0.1	7.65±0.1	7.52±0.2	7.84±0.01	7.56±0.06	7.38±0.04	7.41±0.05	8.5±0.09
Electrical conductivity (µS/cm)	59.6±3.6	29.5±2.8	45.6±4.1	1202±64	1198±19	1203±10	1346±31	1807±24	1848±15	1824±21	2080±34
COD (ppm)	280±21	300±16	360±38	912±51	992±26	1296±27	472±13	640±11	560±8	400±9	440±12
Turbidity (NTU)	481±34	733±19	1110±29	152±11	423±6	742±12	2.7±0.04	135±3	213±2	433±14	40.5±4

Effect on fatty acid profiling of microalgae

The FAME profiling of extracted lipids from microalgae grown in different treatments was analysed and depicted in Table. Microalgae grown on EP treatment contains higher amount of saturated fatty acids when compared to control and IP treatment. Among EP treatment, 250 ppm supplementation to microalgae contains higher amount of saturated fatty acids when compared to 500 ppm treatment (27%) and control (12.6%). The SFA/UFA ratio was also more than one in that treatment which represents good quality lipid for biodiesel production. The presence of methyl palmitate was noticed in all treatments and the control group. The microalgae grown in EP treatment (250 ppm) contained significantly higher amount ($p<0.05$) of methyl palmitate content when compared to control. The increased addition of hydrochar significantly reduced ($p<0.05$) the methyl palmitate content in microalgae. There is no significant change ($p>0.05$) in oleic acid content of EP treatment as compared to the control, however the level was significantly higher ($p<0.05$) than the IP treatment. The methyl linolenate content in EP treatment was significantly lower ($p<0.05$) than the IP treatment irrespective of dosages and there was a non-significant decrease ($p>0.05$) noticed when compared to control. The increased addition of hydrochar increased the methyl linolenate content in microalgae. The lowered methyl linolenate content (6%) in the 250 ppm EP treatment of the present study showed biodiesel of higher oxidative stability. It clearly shows that addition of 250 ppm of banana stem based hydrochar to the exponential phase grown microalgae increased the production of desirable fatty acids like methyl palmitate (39%), oleic acid (30%) and produced highly stable biodiesel with low amount of methyl linolenate content (6%).

Effect on biodiesel property of microalgae

The vehicular properties of biodiesel based on the FAME profile was given in Table. The iodine value (IV) of EP treatment was significantly lower (100 ppm - 50.32 g I_2 100 $g^{-1}$and 250 ppm-53.87 g I_2 100 g^{-1}) ($p<0.05$) when compared to control and IP treatment. The biodiesel produced from the EP treatment grown microalgae has CN values ranging from 54 to 60 which complies with both ASTM and European standards for CN value. The DU values of the present study range from 94% to 140% in IP treatment and 52% to 77% in EP treatment. In both cases, increased hydrochar supplementation significantly increased the DU value. Similarly, the highest oxidative stability was noticed in EP treatment and however increased supplementation significantly decreased ($p<0.05$) the stability of the fuel (18 h to 9.4 h). The cold filter plugging point (CFPP) of biodiesel is an important property which denotes the flow of fuel inside the engine at low temperatures. The CFPP varied from -9 to 1.4°C in hydrochar added treatments and 26.5°C for the control group which is well within the standard range. The density of the biodiesel produced was slightly higher than the standard values and the density of petro-diesel



Phosphate adsorption kinetics of HCAL-C in phosphate spiked distilled water, pond water and wastewater

Table: Fatty acid profiling of *G. emersonii* grown at different concentrations and different time of Hydrochar supplementation in BG11 medium

Fatty acids	Formula	100 ppm		250 ppm		500 ppm		Control	P value
		IP	EP	IP	EP	IP	EP		
Saturated fatty acids (SFA) (%)									
Methyl tetra decanoate	C14	-	3.3 ± 1.0^{a}	-	2.2 ± 0.3^{b}	-	-	-	***
Methyl pentadecano ate	C15	7.1 ± 1.3^{bc}	1.6 ± 0.3^{e}	10.1 ± 1.8^{b}	14.5 ± 1.6^{a}	-	5.8 ± 1.2^{cd}	3.2 ± 0.1^{de}	***
Methyl palmitate	C16	28.3 ± 0.5^{cd}	50.6 ± 3.6^{a}	28.8 ± 2.4^{cd}	39 ± 5.4^{b}	22 ± 1.4^{d}	34.8 ± 3.1^{bc}	25.4 ± 2.6^{d}	***
Octadecano ate	C18	4.8 ± 0.21^{b}	-	1.7 ± 0.4^{c}	-	-	-	20.1 ± 2.1^{a}	***
Monounsaturated fatty acids (MUFA) (%)									
Methyl palmitoleate	C16:1	7.2 ± 1.3^{a}	2.4 ± 0.2^{c}	5.6 ± 0.6^{ab}	4.2 ± 1.0^{bc}	4.7 ± 0.8^{b}	7.5 ± 1.1^{a}	5.6 ± 0.3^{ab}	***
Cis9-oleic methyl ester	C18:1	18.5 ± 2.0^{b}	34.6 ± 4.1^{a}	3.7 ± 0.5^{c}	30 ± 3.6^{a}	11.7 ± 0.6^{bc}	34.5 ± 5.1^{a}	30.5 ± 4.1^{a}	***
Polyunsaturated fatty acids (PUFA) (%)									
Methyl linoleate	C18:2	16 ± 1.8^{b}	3.4 ± 0.6^{e}	17.7 ± 1.2^{ab}	4.1 ± 0.3^{de}	19.8 ± 1.1^{a}	10.1 ± 2.1^{c}	7.5 ± 1.1^{cd}	***
Methyl linolenate	C18:3	18.1 ± 1.5^{c}	4.2 ± 0.3^{d}	32.5 ± 4.2^{b}	6 ± 0.4^{d}	41.8 ± 5.1^{a}	7.3 ± 0.8^{d}	7.7 ± 1.2^{d}	***
% of saturated fatty acids		33.1	55.5	40.6	55.7	22	40.6	48.7	
% of unsaturated fatty acids		66.9	44.5	59.4	44.3	78	59.4	51.3	
SFA/UFA		0.5	1.3	0.7	1.3	0.3	0.7	0.9	

(0.832 g/m^3) which suggests the complete combustion of the fuel inside the engine. The present study found that both 100 and 250 ppm supplementation of hydrochar produced good quality biodiesel, but the lipid productivity was significantly high in 250 ppm treatment.

Phosphate adsorption capacity of metal oxide carbonaceous material

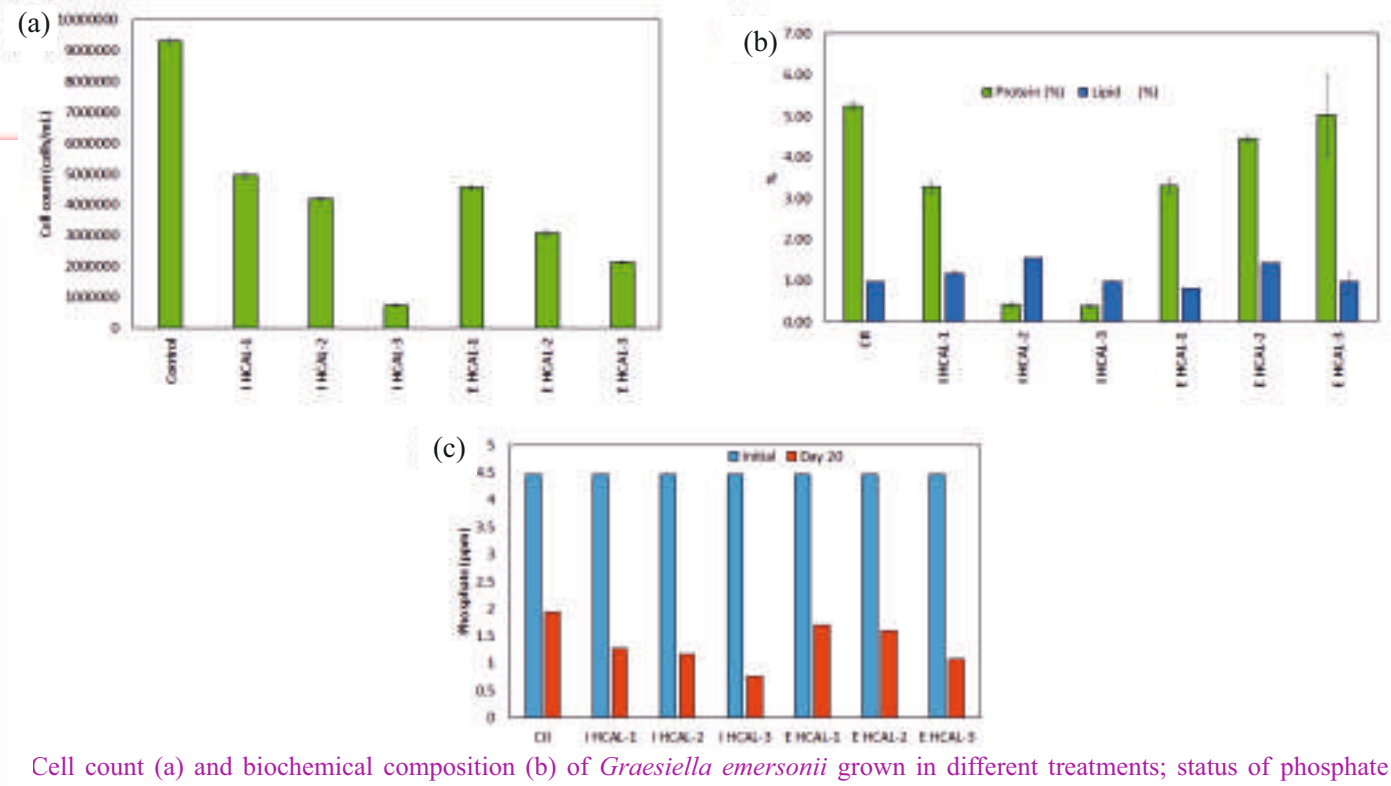
In light of the sustainability of aquatic ecosystems, phosphate contamination of freshwater resources, such as wetlands, is an urgent problem. Anthropogenic activities such as agriculture, urbanization, and industry have resulted in the contamination of freshwater supplies with phosphates. The primary point sources of phosphate contamination are untreated home and commercial wastewater. In contrast, phosphate in agriculture steadily accumulates in wetlands due to a variety of hydrological processes, such as leaching and runoff, which causes algal blooms and anoxic conditions that kill fish and other aquatic life. Therefore, the current research is making an attempt to create a phosphate remediating substance, the application of which will cause the wetland water's accessible phosphate content to decrease. 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. 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.

Metal oxide nanocomposites (HCAL-C) as a growth inhibitor of microalgae

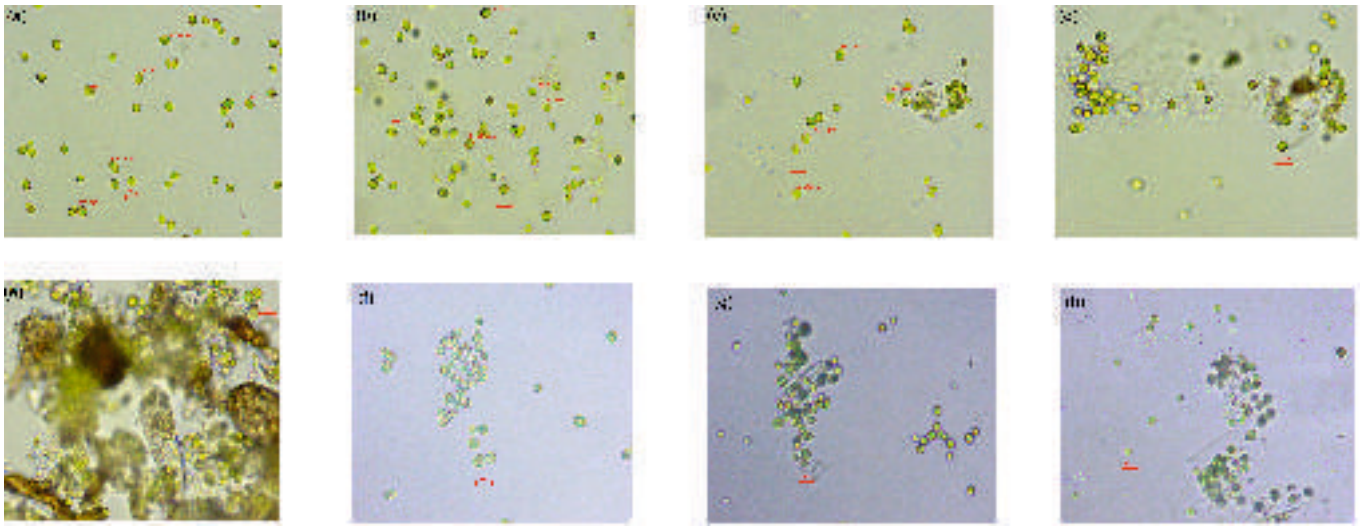
Nutrient pollution is one of the major issues in inland aquatic ecosystem and leads to eutrophication, which in turn kills the fish due to oxygen depletion. Hence, a metal oxide nanocomposite was synthesized to

Table: Biodiesel quality of *G. emersonii* grown on different dosage and different time of hydrochar supplementation in BG11 medium. Values are represented as mean and SD.BIS- Bureau of Indian Standards; ASTM: American standards for testing materials; ES- European standard.

Biodiesel properties	100 ppm		250 ppm		500 ppm		Control	BIS	ASTM	ES
	IP	EP	IP	EP	IP	EP				
Saponification value (mg KOH/g)	200.71±1.63^{abcd}	204.28±2.82^{ab}	200.42±2.07^{bcd}	205.51±1.16^{a}	196.77±2.10^{d}	202.81±1.41^{abc}	199.09±0.51^{cd}	NA	NA	NA
Iodine value (g Iodine/100 g)	102.66±0.80^{c}	50.32±0.43^{g}	125.56±0.53^{b}	53.87±0.56^{f}	158.26±0.62^{a}	74.95±1.08^{d}	66.01±1.05^{e}	NA	NA	⩽120
Cetane number	47.31±0.4^{d}	60.19±1.0^{a}	41.51±0.6^{e}	59.12±0.2^{a}	33.68±0.25^{f}	54.10±0.62^{c}	56.88±0.61^{b}	NA	⩾47	⩾51
Degree of unsaturation (% wt)	93.90±0.56^{c}	52.20±0.31^{f}	109.70±1.13^{b}	54.40±0.38^{f}	139.60±1.12^{a}	76.80±1.68^{d}	66.50±0.55^{e}	NA	NA	NA
Long chain saturation factor (% wt)	5.23±0.11^{b}	5.06±0.02^{b}	3.73±0.06^{c}	3.90±0.15^{c}	2.20±0.15^{d}	3.48±0.11^{c}	12.59±0.34^{a}	NA	NA	NA
Cold filter plugging properties (℃)	1.39±0.01^{b}	0.81±0.04^{c}	-3.73±0.1^{e}	-3.15±0.14^{d}	-8.96±0.15^{g}	-4.59±0.17^{f}	26.54±0.22^{a}	NA	NA	5 to −20
High heating value (MJ/kg)	39.66±0.13^{abc}	40.30±0.12^{a}	39.33±0.24^{bc}	40.20±0.07^{ab}	38.99±0.28^{c}	39.99±0.6^{abc}	40.28±0.14^{a}	NA	NA	⩾35
ln (Kinematic viscosity) (mm2 /s)	5.25±0.03^{b}	5.67±0.1^{a}	5.25±0.05^{b}	5.67±0.13^{a}	5.28±0.05^{b}	5.28±0.06^{b}	5.25±0.06^{b}	2.5-6.0	1.9–6.0	3.5–5.0
Density (g/cm3)	0.94±0.01^{a}	0.93±0.01^{a}	0.94±0.00^{a}	0.93±0.02^{a}	0.93±0.00^{a}	0.93±0.01^{a}	0.94±0.11^{a}	0.86-0.9	0.86–0.89	0.86–0.9
Oxidative stability (h)	6.05±0.05^{e}	18.11±0.08^{a}	4.94±0.13^{f}	14.27±0.12^{b}	4.50±0.07^{f}	9.37±0.13^{d}	10.35±0.22^{c}	⩾6	>3	⩾6



Cell count (a) and biochemical composition (b) of *Graesiella emersonii* grown in different treatments; status of phosphate concentration at algae growth media after 20 days of HCAL treatment (c)



Optical microscope images of *Graesiella emersonii* (a) Control; (b) Control+P; (c) I-HCAL-1(d) I-HCAL-2; (e) I-HCAL-3; (f) E-HCAL-1(g) E-HCAL-2; (h) E-HCAL-3

remove/chelate phosphate from the water bodies and the toxic effect of these nanocomposite on microalgae was also evaluated. In the present study, effect of nanocomposite material on microalgae *Graesiella emersonii* growth, morphology, photosynthesis and cytotoxicity was evaluated under controlled condition. The BG11 medium was prepared for 200 mL and to that 9 mL of inoculum which contains 1.2×10^5 cells/mL was added. Then, the nanocomposite powder (0.023, 0.049, 0.094 g) was dispersed in 200 mL of BG11 medium to make the final concentration of 0.0001, 0.0002, 0.0005 ppm, respectively (initial phase addition). In addition, the microalgae were also grown up to 10 days and then nanocomposite powder was added to media containing pre-grown microalgae was also evaluated (exponential phase addition). The whole experiment was conducted for 20 days. The addition of nanocomposites to the microalgae at both the growth phases inhibited the cell growth and the rate of inhibition was dose dependent. There was a 92% and 77% reduction in cell growth was noticed in the initial and exponential phase treatment when compared to control, respectively. The cell viability was also affected due to the addition of nanocomposites powder in both phases of treatment. The low dosage of nanocomposites induced the SOD and CAT activity and the high dosage decreased the SOD and CAT activity which leads to oxidative stress. Further the effect of nanocomposites on the expression of genes involved in photosynthesis such as *Rbcl*- involved in catalyzing the CO_2 fixation, *psab*- binding with P700, the primary electron donor of photosystem I (PSI), *psbc* - binds chlorophyll and catalyze the photochemical processes of PSII. The result showed that exposure to nanocomposites at high dosage downregulated all the studied gene expression when compared to the control. Besides the addition of hydrochar to the culture medium directly binds the phosphate and reduced the availability of phosphate to the microalgae. Hence the study concludes that the added nanocomposites was found toxic to the microalgae by either directly affecting the photosynthesis process or indirectly bind the phosphate from the solution and made it unavailable to the microalgae.

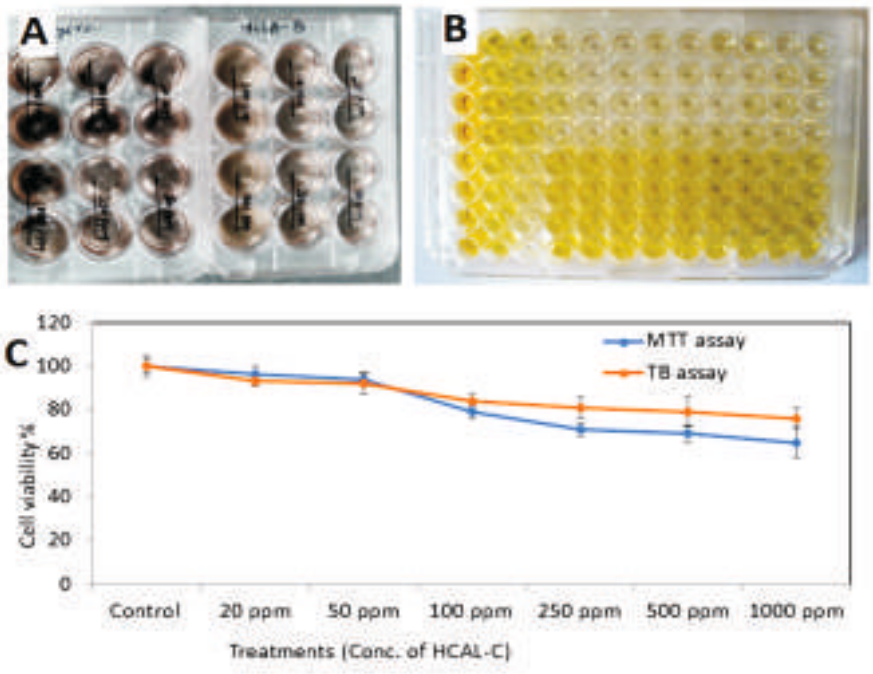
Toxicity assessment of phosphate remediating nanomaterial compound HCAL-C

Cytotoxicity assessment

In vitro cytotoxic effect of phosphate remediating nanomaterial compound HCAL-C was assessed in Zebrafish (*Danio rerio*) gill cell line using two basal cytotoxicity end points Trypan blue (TB) dye and MTT assays. For TB assay, zebrafish gill cell monolayers were exposed to the carbonaceous nanomaterial at various concentrations (20, 50, 100, 250, 500, and 1000 ppm) on 12-well plates. The cell viability is evaluated after 48 hours cells exposed to the nanomaterial product using fluorescent cell viability indicator dyes (0.4% Trypan blue) and an automated cell counter. The findings are used to calculate the effective concentrations (EC20 value) result in a 20% decrease in cell viability. The examined phosphate remediating nanomaterial compound EC20 value was determined to be 1000 ppm and 500 ppm respectively. Then cell proliferation experiment was performed with 3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide (MTT) cell proliferation assay kit (Abcam, Ab211091) using 96 well plates following the manufacturer's instructions. The lower concentration of HCAL-C was not markedly cytotoxic to cells when compared to the control cells and cytotoxicity increased in a dose dependent manner. *In vitro* cytotoxicity data show that HCAL-C has essentially the same cytotoxic effect in both TB and MTT assays.

Acute toxicity assessment

In the next experiment, fish fingerlings were used in an acute toxicity bioassay for phosphate remediating developed nanomaterial compound HCAL-C at different dose levels. In accordance with OECD guidelines, the acute toxicity of HCAL-C was examined in IMC *Labeo rohita* (18.8±2.2g) for 96 hours at various exposure concentrations (20, 50, 100, 250, and 500 ppm). At the examined dose levels, no mortality or behavioral abnormalities was observed.



In vitro cytotoxicity assessment of phosphate remediating nanomaterial compound HCAL-C. Exposure of HCAL-C to the zebrafish gill cell monolayers in 12-well plates for TB assay (A) and in 96 well plates for MTT assay (B) and analysis of cell viability by MTT and TB assay (C)

Project Title: Aquatic environmental health assessment and novel formulations development for fish health management

Project Code : FREM/23-26/20

Duration: April 2023 to March 2026

Scientific Personnel: B. K. Das (PI); Asit K. Bera, H. Chowdhuri, D.J. Sarkar, P. Maurye, Soma Das Sarkar, Santhana Kumar V, Kavita Kumari, Vikash Kumar, Suvra Roy, M. Shaya Devi

Summary

- Tilapia mortality investigation in East Kolkata Wetland revealed to TiLV and TiPV infections, along with the presence of *Aeromonas hydrophila* and *A. veronii* infections in the affected fish.
- The *Aeromonas hydrophila* pathogen has been selected to develop *in-situ* diagnostic tool. The primers has been developed for HRPzyme activity against haemolysin gene of *Aeromonas hydrophila*.
- Protease activity of the fish mucus as evaluated by azocasein assay. TherResults demarcated that the inter- and intra-species differences were existed among groups. Activity of the proteases were checked by azocasein assay for active enzymes. Protease level was highest in the *Cyprinus carpio* (306.84±2.38 U/mg protein) and lowest in the *Ctenopharyngodon idella* (11.2±0.23 U/mg protein).
- In order to develop alternative antibacterial therapy, a plant based essential oil was combined with oxytetracycline at much lower MIC values (OTC/4-16 + EO/4-8), which could synergistically (FICI ≤0.5) kill the sensitive strain of the bacteria. The oil at its MIC/4 (EO/4) when combined with MIC/4-8 of the antibiotic (OTC/4-8) synergistically could kill both the resistant strains in *in vitro* studies.
- A microbial consortium containing bacterial strains has been developed. Initial investigations indicated that isolated consortium exhibited antibacterial properties against pathogenic bacteria. Further investigation and field study is under progress.

Summary

- A comparative bioconversion of *Salvinia molesta* - a floating aquatic weed had shown a higher yield of stable vermicompost manure (38.94%) than the garden wastes (25%). It offers an ecofriendly viable solution to the aquatic weed management in the drinking water unit proving the concept of "waste into wealth".
- *Salvinia molesta* (SM) is a floating aquatic fern extract was used for microalgae culture with better quality and higher biomass productivity (0.03 g/l/day) as compared to the GW extract (0.02 g/l/day) and BG11 (0.01 g/L/day).
- A composition with combination of herbal extracts, as well as immunostimulant minerals and elements was developed for fish feed supplement. Trials have yielded exceptional results in terms of overall fish survival over the winter months. Furthermore, higher diet preference and tolerance to winter-onset diseases have been seen in studied fish species.

Aquatic environment assessment

Tilapia mortality outbreak in November, 2023 in East Kolkata Wetland was investigated in details under the project. In the mass mortality event, among cultured *Oreochromis niloticus* (Tilapia) resulting in the loss of over 90% of Tilapia. Water and sediment quality parameters were analysed and correlated with the disease occurrence. Heavy metal analysis was also done to find out any contributing stress factor.

Pathogen identification

During the disease outbreak the affected fish displayed various symptoms, including popped eyes, fin erosion, depigmentation on the body, hemorrhagic spots at the anal portion, belly, eye, and abdomen. Upon dissection, findings revealed watery intestines and the absence of food particles in the stomach. PCR-based diagnosis identified the presence of Tilapia Lake Virus (TiLV) and Tilapia Parvovirus (TiPV) in the infected fish. TiLV and TiPV are emerging infections in Tilapia globally. All tested individuals were positive for TiLV, while 90% tested positive for TiPV. Further examination of infected fish involved sampling the kidney, liver, and blood to assess bacterial infections. *Aeromonas hydrophila* and *A. veronii* were isolated and identified through 16S rRNA gene sequencing. Overall, the study highlights the occurrence of a significant Tilapia mortality event in East Kolkata Wetland attributed to TiLV and TiPV infections, along with

Table: Water quality parameters of Gorumara bheri, East Kolkata wetland during outbreak of Tilapia mortality

Sl. No.	Parameter	Site 1	Site 2	Site 3
1	Depth (cm)	120.0	125.0	128.0
2	Transp (cm)	75.0	81.0	84.0
3	Temp Air (°C)	31.0	31.2	31.4
4	Temp Water (°C)	31.1	30.2	30.8
5	pH	8.68	8.45	8.39
6	Sp.cond (µS/cm)	756.0	761.0	780.0
7	D.O. (ppm)	6.0	5.6	4.4
8	FreeCO_2 (ppm)	Nil	Nil	Nil
9	TDS (ppm)	528.0	539.0	553.0
10	Chloride (ppm)	172.0	190.0	198.0
11	Salinity (ppm)	336.0	372.0	381.0
12	Total Alkalinity (pp m)	164.0	168.0	184.0
13	Total hardness (ppm)	192.0	196.0	200.0
14	Ca^{++} (ppm)	48.1	49.7	50.5
15	Mg^{++} (ppm)	17.5	17.5	18.0
16	Nitrate -N (ppm)	0.03	0.04	0.04
17	Silicate -Si (ppm)	19.2	7.4	20.8
18	AV. Phosphorus (ppm)	0.76	0.98	0.94



Mass mortality in Tilapia fish at East Kolkata wetland with septicemic symptoms

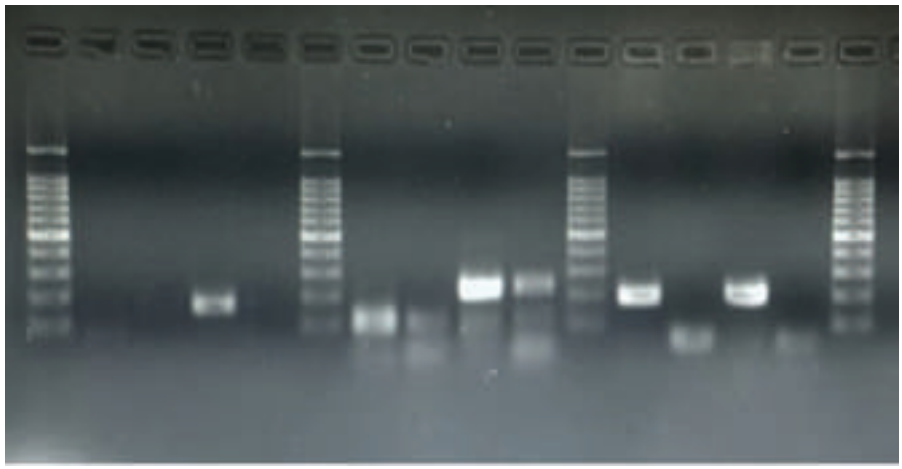
the presence of *Aeromonas hydrophila* and *A. veronii* bacterial infections in the affected fish. This report offers valuable insights into the prevalence and possible co-infections involving Tilapia Parvovirus in Nile tilapia. It enhances our understanding of emerging infectious diseases in the field of aquaculture.

Development of fish pathogen diagnostics tool for fish health

The *Aeromonas hydrophila* pathogen has been selected to develop *in-situ* diagnostic tool. The primers has been developed for HRPzyme activity against haemolysin gene of *Aeromonas hydrophila*. The microbial DNA were isolated from three different culture i.e AKB5, AKB11 and ATCC. The microbial cultures were revived on nutrient media. The microbial DNA were isolated from these three cultures. The universal primers AH-2968F/ AH-2968R and NJ35-1F/NJ35-2R were used for PCR amplification. The primer HRPZYME sequence were ligated to primer pair AH-2968F/AH-2968R. The primers worked well for AKB5 and ATCC culture except AH-2968F/AH-2968R which could not amplified ATCC culture. The PCR amplicon were of 167-200 bp fragment. The sequence information for different genes The amplicons were sequenced and the sequences were submitted to NCBI GenBank. The sequencing results confirmed ligation of HRPZYME sequence and presence of specific *Aeromonas hydrophila* culture.

Evaluation of antimicrobial proteins/peptides of fish mucus biomatrix

Fish epidermal mucus which acts as an external barrier for the biological/non-biological environmental contaminants provide possibilities to study the interaction of fish and environmental factors in a non-invasive way. Among many immune related components present in the fish epidermal mucus, the proteases (like trypsin (serine proteases), cathepsin D/B/L (cysteine or aspartic proteases) and metalloproteases are known to directly act or activate complement system against the pathogenic/non-pathogenic bacteria, along with increase in the expression of antibodies and antimicrobial peptides. The study on proteins/proteases of epidermal mucus will highlight the neutralizing abilities of different fish species for defence against similar opportunistic and drug-resistant pathogens. It will



PCR amplification of *Aeromonas hydrophila* AKB5 and ATCC culture using primer pairs AH−2968F/ AH−2968R, NJ35−1F/NJ35−2R and HRPZYME- AH−2968F/ HRPZYME- AH−2968R primers. L1: 100 bp ladder, L2-5: AH−2968F/ AH−2968R primers, L6: 100 bp ladder, L7-10: HRPZYME- AH−2968F/ HRPZYME-AH−2968R primers, L11: 100 bp ladder, L12-L15: NJ35−1F/NJ35−2R primers, L16: 100 bp ladder, L2, L7, L12: ATCC culture, L4, L9, L14: AKB5 culture, L3, L5, L8, L10, L13, L15 are no template control reactions

help in making the strategic planning for eradication of important fish diseases. Experimental fish samples were collected, and summery statistic of body weight reveals that *Oreochromis niloticus* (Nile tilapia) were more homogeneous compared to the other fish species. Analysis of proteins isolated from the fish epidermal mucus showed variation in concentrations (mg/ml; CV(%)) among conspecies which revealed that *Oreochromis niloticus* (Nile tilapia) has the highest and *Labio catla* (Indian Major Carp) showing the lowest protein concentration among the groups. Mucus protein extracts of all fishes were resolved by 1D gel electrophoresis technique for analysing similarities/differences in the protein compositions and expression patterns. Results revealed variations in the prominent proteins within and among the fishes. Proteins were expressed in the range of 11.1 to 118.1 kDa. *Hypophthalmichthys molitrix* revealed highest quantitative expression whereas *Cirrhinus mrigala* showed lesser. Maximum number of proteins are screened in the low MW range (<30 kDa). Intensity pattern of low MW proteins shows stability as compared to the other categories; although high MW proteins shows fluctuated intensity signal (range from level: very low - 1, low - 2, high - 3, and very high - 4). Heat-map analysis of gelatin 1D Zymography technique shows the intensity level of the proteolytic enzymes present in the epidermal mucus of different fish species. Cluster analysis has revealed the resemblances existed between the fish species having similar expression pattern of proteolytic enzymes in terms of observed signal intensity. Four groups are formed as per the proteolytic band count analysis which revealed that *Cyprinus carpio, Labeo rohita*, and *Labeo bata* belongs to a group with similar pattern whereas *Cirrhinus mrigala* and *Ctenopharyngodon idella* forms another group. Intensity pattern of proteolytic bands suggested a group comprising *Labeo catla*, *Labeo rohita*, *Cirrhinus mrigala*, and *Cyprinus carpio* with similarity. Box-plot analysis shows an intra-species variability of total proteolytic enzymes expressed in the respective fishes. *H. molitrix* and *C. carpio* shows more variability in the proteolytic enzyme counts than the other fishes. Changing pattern of protein count varies at different MW range. Two types of MW ranges were decided to envision the visible proteolytic pattern in gels. More proteolytic bands in the window representing 31-60 kDa MW range whereas window representing high MW proteolytic bands are less in number. The changing pattern of average signal intensity in different MW range of protein. As expected, high MW proteolytic bands exhibit more intensities than the low MW bands. Proteolytic enzymes with different MWs were present in the epidermal mucus of all the fishes. Band with proteolytic activity were observed in the range 29.2 to 89.1 kDa. Results showed that *H. molitrix* and *Ctenopharyngodon idella* revealed high expression (each max. of 05 transparent bands) whereas *Labeo rohita* showed less expression (02 transparent bands) of proteolytic enzymes. Some of the proteolytic bands are expressed in all these fish species with equal intensities and numbers. Heterogeneity in the expression pattern of proteolytic enzymes revealed adaptation differences in the studied fishes. High expression level of some distinctive proteolytic bands suggested that the immunocompetencies of these fishes triggers at different rate in spite of facing similar challenges in shared habitat. Protease activity of the fish mucus as evaluated by azocasein assay. Results demarcated that the inter- and intra-species differences were existed among groups. Activity of the proteases were checked by azocasein assay for active enzymes. Protease level was highest detected in the *C. carpio* (306.84±2.38 U/mg protein) and lowest in the *Ctenopharyngodon idella* (11.2±0.23 U/mg protein). Wide variation was seen in the epidermal mucus protease activity of the group representing Exotic carp (*Ctenopharyngodon idella*, *H. molitrix*, and *Oreochromis niloticus*). However, a mild variation was observed in the group representing Indian Major Carp. Among the group, the specimens of Lc (65.14 ± 0.44 U/mg protein) had higher protease activity as compared to the *Labeo rohita* (40.24±0.71 U/mg protein) and Cm (34.1±0.65 U/mg protein). Individual member of Indigenous Minor Carp (Lb) had shown medium range (36.83±0.79 U/mg protein) of protease activity.

Development of formulation

a. Combination efficacy of essential oil and antibiotic against antibiotic resistant fish pathogen

Plant-derived compounds can exhibit a direct antibacterial activity and/or an indirect activity as antibiotic resistance modifying compounds, which, combined with antibiotics, increase their effectiveness.In this study, a plant essential oil (EO) (*Cymbopogon sp.,*Poaceae family) was studied *in vitro* for its antibacterial efficacy against two



Cirrhinus mrigala was used for the collection of samples



Step wise process of utilizing aquatic weed for cost effective production of beneficial micro algae - A waste to wealth approach

oxytetracycline (OTC) resistant and one OTC sensitive strains of *Aeromonas hydrophila* of fish origin. The MIC of the oil ranged between 4.00-5.33 mg/ml as against 10.67 µg/ml in case of OTC). When the oil was combined with OTC at much lower MIC values (OTC/4-16 + EO/4-8), could synergistically (FICI $\leqslant$0.5) kill the sensitive strain of the bacteria, the oil at its MIC/4 (EO/4) when combined with MIC/4-8 of the antibiotic (OTC/4-8) synergistically kill both the resistant strains in *in vitro* studies. The individual components of the oil (GC-MS) when computationally studied for their antibacterial efficacy, pharmacokinetics, drug-likeliness, bioavailability, environmental suitability etc. yielded results favouring a possible drug.

b. Development of microbial consortium

A microbial consortium containing bacterial strains has been developed. Initial investigations indicated that isolated consortium exhibited antibacterial properties against pathogenic bacteria. Further investigation and field study is under progress.

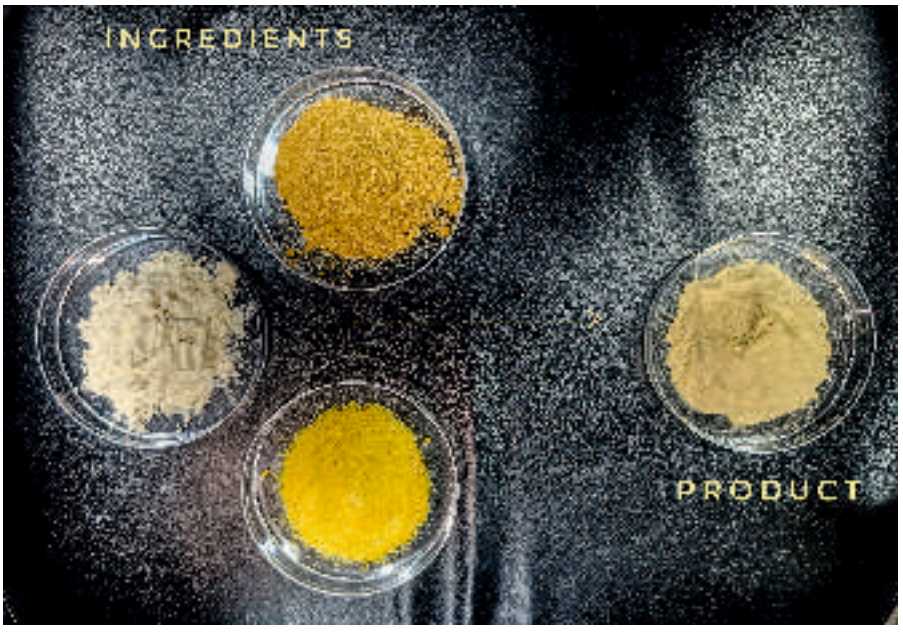
c. Comparative bioconversion process for hydrophyte management

Salvinia molesta - a floating aquatic weed-from river Ganga has immensely manifested in the steady and slow-moving environment of the sedimentation unit which hampers timely supply of drinking water, and its removal is a labour-intensive process in the Indira Gandhi Drinking Water Treatment Plant, Palta, Barrackpore Kolkata. A comparative bioconversion of these weeds had shown a higher yield of stable vermicompost manure (38.94%) than the garden wastes (25%). Thus, the present study offers an ecofriendly viable solution to the aquatic weed management in the drinking water unit proving the concept of "waste to wealth".

d. Nutritional benefits from nuisance hydrophytes: An innovative technology for managing aquatic environment

Aquatic weeds are one of the emerging concerns globally due to its rapid expansion in the aquatic ecosystem and its invasive nature. This has immensely affected the sedimentation tank of Indira Gandhi

Drinking Water Treatment Plant which receives the floating macrophytes along with water sources from Ganga River. *Salvinia molesta* (SM) is a floating aquatic fern and a rapidly growing competitive plant which has manifested in the steady and slow-moving environment of the siltation tank. The excessive growth of the weed hampers the sedimentation process which indirectly affect timely supply of drinking water and its removal is a labour-intensive process. Hence in the present study, these weeds were first converted into vermicompost manure and its extract (aerobic and anaerobically digested) was prepared and tested as nutrient source to enhance growth performance and lipid production from a freshwater microalga (*Graesiella emersonii* MN877773). The efficacy of the extract was then tested in combination with BG11 medium. Further, the SM based extract was compared with commonly available vermicompost (garden-wastes) based extract (GW). The result revealed that SM-based extract yielded higher microalgal biomass productivity (0.03 g/L/day) as compared to the GW extract (0.02 g/L/day) and BG11 (0.01 g/L/day). However, the lipid productivity microalgae grown SM based extract was 1.2 and 1.4 times lesser than the BG11 and GW based extract. The present study offers an ecofriendly and economically viable solution to the aquatic weed management in the drinking water unit by valorization of the wastes into nutrient rich green microalgae. More lucidly, it also paves a way for proving the concept of "waste to wealth".



Development of fish feed supplement using natural ingredients

e. Development of fish feed supplement composition

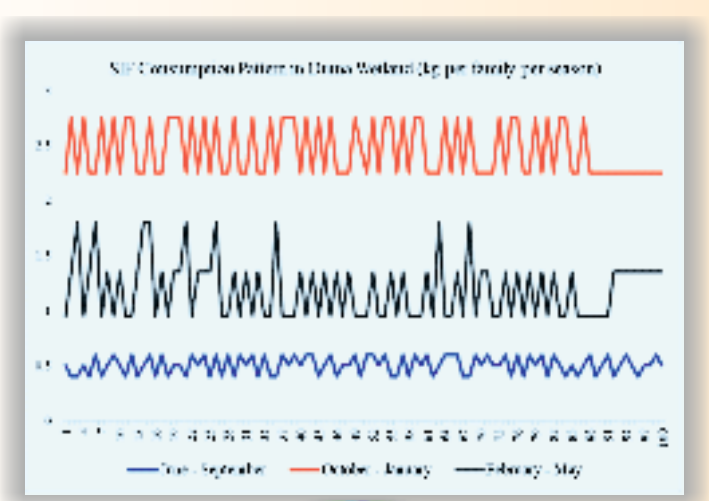
Temperature affects the fish's ability/desire to obtain food, as well as how they digest food, absorb nutrients inside the gastrointestinal tract, and store surplus energy. As a result, temperature determines the rates of essentially all biochemical reactions in fish, as well as the rate of physiological activities. Temperature is known as the abiotic ecological master factor because it has such a huge impact on fish. This composition is a superb combination of herbal extracts, as well as immunostimulant minerals and elements. Trials have yielded exceptional results in terms of overall fish survival over the winter months. Furthermore, higher diet preference and tolerance to winter-onset diseases have been seen in species such as carp, tilapia, and koi. Reduced blood cortisol levels were a strong indicator of stress reduction in cultured fish after administration of the substance. The constancy of the haemoglobin level to that of the control group cast doubt on the formulation's ability to combat winter stress. In comparison to past winter years, reduced feeding has been much lower in the trial fish.

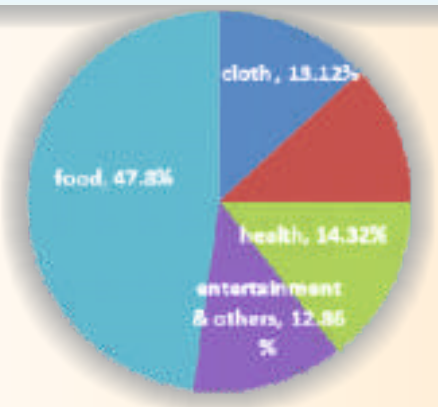
वार्षिक प्रतिवेदन

Annual Report

2023

Fisheries Socio-Economics





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Annual Report

2023

Fisheries Socio-economics

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

Project Code : FSE / 20-23 / 04

Duration: April 2020 to March 2025

Scientific Personnel : B. K. Das (PI), P. K. Parida (upto 20.12.22), A. Roy, P. Debroy, Lianthuamluaia, Mitesh Ramteke, Satish Koushlesh, T. Nirupada Chanu, M. A. Hassan, Arun Pandit, H. S. Swain (upto 31.08.22), S. P. Kamble, A. K. Das, Ganesh Chandra, Raju Baitha (w.e.f. 01.04.22), Prajna R. Behera (w.e.f. 01.12.2021), Suman Kumari (w.e.f. 01.04.22), Anjana Ekka (w.e.f. 01.10.2022), Gunjan Karnatak (w.e.f. 01.04.2023)

Summary

- Seven SDGs *viz*., SDGs 1: End poverty, 2: Zero hunger, 5: Gender equity and women empowerment, 8: Economic Growth,12: Sustainable Consumption and Production, 13: Climate Action and 14: Life below water were the major focus of the project.
- In Chhattisgarh, maximum percentage of the expenditure of the fishers were on food purposes (47.80%) followed by 14.32%, 13.12%, 12.86%, and 11.94% on health, clothing, entertainment, and education purposes, respectively. A total of 4.15 kg SIFs per fisher family per year was available in Duma wetland, West Bengal. Average number of income generating activities per household ranged from 3.92 to 4.4 in floodplain wetlands of Lower Ganga Basin.

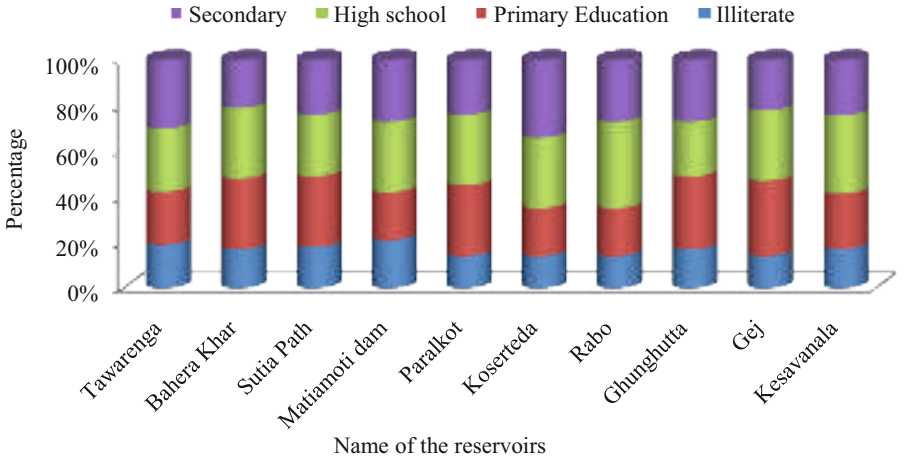
Sustainable reservoir fisheries management to address SDG 1, SDG 2 and SDG 8

The Chhattisgarh state has 30.42% tribal population who often suffer from unemployment resulting in abject poverty. On the other hand, the state is blessed with plenty of water resources out of which 0.826 lakh ha area under the reservoirs. The inland fisheries management in the reservoirs could help the tribal communities residing in the catchment areas to generate their income and livelihood as well as nutritional security. Therefore, a study was conducted to assess and analyze the potential of the small reservoirs, in addressing the livelihood security issue of the tribal populace through reservoir fisheries management.

The study was carried out in 10 nos. of tribal fisher dominated small reservoirs of Chhattisgarh state from May 2022 to May 2023. A total of 250 tribal fisherman respondents were selected for the present study, selecting 25 nos. of respondents from each reservoir. The water samples from the selected reservoir were collected in pre-monsoon season from different limnological zones (lotic, intermediate and lentic) during morning hours and were analyzed following APHA (2017). The field demonstrations of CIFRI-HDPE pen installation, awareness cum inputs distribution programmes, and carp stocking were carried out. The species selected for stocking in the pen nursery were *Labeo catla*, *L. rohita* and *Cirrhinus mrigala*.

Socio-economic condition of the tribal populace

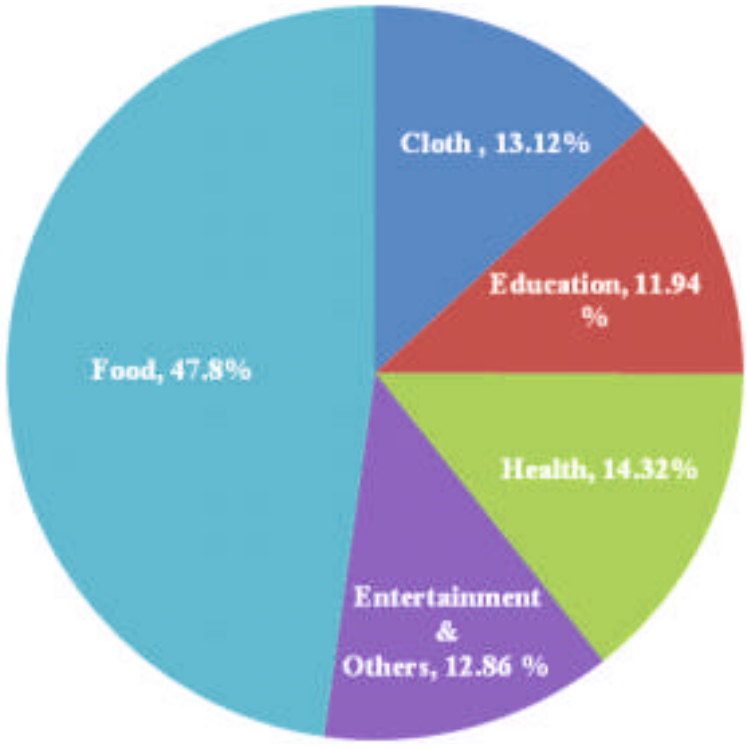
The socioeconomic status of an individual or group is defined by a variety of social and economic factors, including their income, their level and kind of education, their family type occupation etc. In the survey, it was found the average age of the tribal fishers is 46 years. In all the reservoirs, illiteracy is most prevalent among the sample populace (ranging from 14% to 21%). In Motiamoti dam illiteracy is most prevalent among the tribal fishers i.e. 21%. None of the beneficiaries was found to be graduate. The majority were school dropouts either after primary school education or during higher school education.



Educational status of the tribal fishers in the selected reservoirs

In the study area, the average monthly income of the beneficiaries from all the sources ranged from ₹ 7160 to ₹ 9680. The lowest average income was found in the Ghunghutta reservoir area.

Expenditure pattern signifies how much portion of one's income is expended in different areas of his/her daily life. In the present study, five major areas namely food, clothing, education, health, entertainment, and others have been identified in which the respondents spent money. It has been found that the maximum percentage of the expenditure was allocated for food purposes (47.80%), and followed by 14.32%, 13.12%, 12.86%, and 11.94% on health, clothing, entertainment, and others and education purposes, respectively. Hence, it is clear from the result that food constitutes a major part of the overall expenditure of the fisherman. But, what is very noteworthy is that the lowest percentage accounts for education purposes. This is very alarming because, without proper education, no one can proceed further for future development. Therefore, serious consideration is needed to look into the matter and necessary initiatives should be taken to improve the educational facilities of these tribal fishermen communities so that they can educate their children and exploit the opportunities for income generation and employment. This will ultimately lead them towards a sustainable livelihood.



Expenditure pattern of the tribal fishers in the selected reservoirs

Demonstration of pen culture activities in selected reservoirs in Chhattisgarh

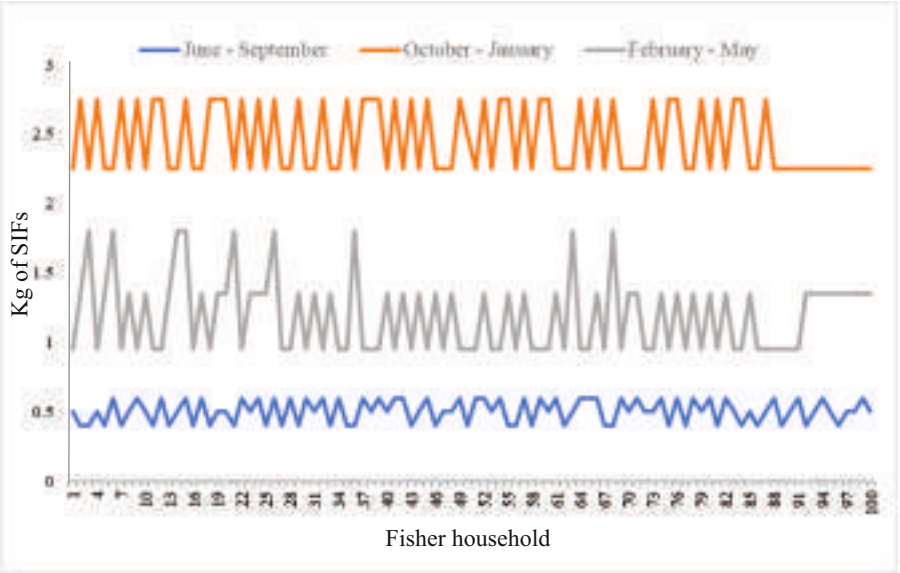
The results of carp fish seed rearing in CIFRI HDPE Pen revealed that out of nine reservoir good quality seeds were harvested from six reservoirs and penculture could be a viable option for production enhancement in the reservoirs. Torenga, Keshvanala, Matiamoti, and Koserteda reservoirs were each stocked with 50,000 seeds. The average body weight of the seed varied from 1.66g to 6.3g. The feeding rate was 3% of the body weight. However, Torenga and Koserteda faced issues with damage to the pen structure due to bad weather. Paralkot, Baherakhar, Sutiyapath, Rabo, and Ghunghutta reservoirs were stocked with Catla seeds ranging from 20,000 to 29,000 in number. The average body weight of the seeds was around 5g. The feeding rate was also 3% of the body weight. Among these, Rabo faced issues with damage in the pen structure due to bad weather. The average size of the fish varied across the reservoirs, with Ghunghutta having the highest average size of 270g. The data provided gives an insight into the stocking and feeding practices in various reservoirs in India. The number of stocked seeds and their average body weight, the average size of the fish, the rate of feeding, and the constraints faced in each reservoir are all crucial factors that influence the productivity and sustainability of the fisheries. The feeding rate is lower than standard pond based aquaculture practices, which recommended feeding rates of 5% of the fish body weight. The average size of the fish in the reservoirs where data was available varied considerably, from 6.12 g (mixed) in Matiamoti to 270 g in Ghunghutta.

Sustainability challenges for reservoir fisheries are complex and can vary depending on factors such as location, climate, and management practices. Some sustainability challenges include: habitat degradation, invasive species, climate change, social and economic pressures, inadequate management and governance, limited community engagement etc. By integrating principles and practices of reservoir fisheries managers can work towards maintaining sustainable fish populations, preserving biodiversity, and supporting the well-being of local tribal communities dependent on these resources.

Small Indigenous Fish (SIF) to attain SDG 12: A case study from Duma Wetland

Duma is the largest horse-shoe shaped wetland in Asia, situated in the lower Gangetic plains with a rich

fishery resource consisting of SIFs (71.45% of fish harvest). Data about role of SIFs in Duma wetland for consumption pattern and marketing were collected from 101 fishers in June 2022. The fishers harvest SIFs during their daily fishing schedules either individually or in small groups which is open-access in nature. 15 varieties of SIFs are consumed in the fisher households. Analysis of longitudinal fish consumption was done by estimating the quantity of individual fish species consumed by a household. Quantitative data were analyzed on how much fish was consumed, which species were cooked, and in what form, annually. 33% of SIFs catch is consumed by the fishers. The remaining 67% is disposed for sale in nearby markets. The price of SIFs is highest in the summer season from April to June @ ₹ 275 per kg. There is no catch or profit-sharing mechanism with the Fishers' Co-operative Society. Appropriate institutional management measures including benefit sharing mechanisms are recommended for sustainability of the SIFs fishery resource. Each household consumed on an average 0.51 kg per week in monsoon (June to September), 2.45 kg per week in post-monsoon (October to January) and 1.19 kg per week in pre-monsoon season (February to May). With an average family size of 4, a total of 4.15 kg SIFs per family per year was available for consumption, resulting in 1.04 kg per capita per year and 0.09 kg per month.



SIF consumption pattern in Duma wetland (kg per week per family)



A fisher family of Duma wetland

Livelihood diversification for meeting SDG 1 and SDG 2 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. It is widely seen as a strategy for spreading risk and reducing vulnerability. It is also an important strategy to bring out the rural people out of poverty.

The eastern and north eastern region of India possess majority of the flood plain wetlands of India. The Planning Commission, Government of India, has divided the country into 15 agro-climatic regions. Among them, Lower Gangetic Plains region (Region III) falls exclusively in West Bengal state. This zone covers the entire State of West Bengal, except four districts namely Darjeeling, Cooch Behar, Jalpaiguri and Purulia. In the eastern region the Lower Gangetic plains possess a significant number of floodplains. Hence, for the present study Beledanga, Kholsi, Sindrani and Chamta were selected from this region. The primary data were collected by personally interviewing the fishermen using survey schedules during 2022-23 covering one hundred fisher households from each selected wetland by using simple random sampling method. Therefore, a total of 400 fishers were interviewed from these four floodplain wetlands. An interview schedule was developed

Table: Number of economic activities per fisher family

Beel	Total activities	Off fishing activities	Share of off-fishing income (%) in total income	Non- fishing activities	Share of non-fishing income (%) in total income
Beledanga	3.96	1.04	9.90	2.92	19.50
Chamta	3.92	0.68	10.27	3.24	18.33
Kholsi	4.40	0.48	11.56	3.92	32.53
Sindrani	4.20	0.66	10.88	3.54	27.51
Overall	4.12	0.72	10.72	3.41	24.99

keeping in view the objectives of the study and the variables to be measured.

The degree of livelihood diversification was measured from the point of view of sources of income, shares of fisheries and non-fisheries income in the total income and by constructing diversification indices. In the present study, Simpson index measures was used to study the diversification as described below.

Extent of livelihood diversification

Sources of income

Only fishing in wetland could not provide them necessary livelihood. Hence, fishermen had diversified income sources in all the wetlands, but the extent varies. Average number of income generating activities per household ranged from 3.92 in Chamta to 4.4 in Kholsi. In Kholsi, the number of income sources as well as the non-farm income sources were highest (4.4 and 3.92, respectively), followed by Sindrani (4.2 and 3.54) and Beledanga (3.96 and 2.92). In Beledanga, less number of fishermen households were involved in off fishing activities. in Chamta the fisheries provide sufficient income which discouraged the fishermen to diversify their income portfolio with the non-fishing income. In general, around 11% income comes from the off-fishing sources, whereas, around 25% of the total income comes from non-fishing sources. Share of off-fishing incomes were more or less similar in all the beels, whereas, in the share of non-fishing sources the figure varied from 19.5% in Beledanga to 32.5% in Kholsi.

Income from fisheries and non-fisheries sources

The extent and proportion of fishery and off fishery/non-fishery incomes in total income of households of each wetland are worked out. Fisheries remains the most important source of livelihood across all the beels. The study has revealed that on an average 52 per cent of the total household income were derived from fishery sources. However, these proportions varied across different waterbodies. In Chamta and Beledanga, the contribution of fishing in total income of household was found to be 59 % and 55 % respectively. In Kholsi, the contribution of fisheries was lowest, 46%. Overall, the contribution of off-fishery/non-fishery occupation in total income was estimated to be around 48%.

The average total income per household was ₹ 14104 which ranged from ₹ 12,256 in Beledanga to ₹ 15,786 in Kholsi. Labour wage, private or Govt. service, rickshaw van pulling, driving, petty business, crop farming, animal husbandry were the major non-fishing income sources. Whereas, fish vending, ferry-service, fishing gears repairing were the major off-fishery sources of income. The youth generally resort to the labour wage works or factory works, to earn their livelihood. Members of some the households are found to be engaged in self-employed activities like bidi making, weaving, carpentry, tailoring, tuition etc. The table shows that in Kholsi, the number of non-fishery activity was more, therefore, their monthly income was also more than the other beels.



Capacity building cum skill development through exposure visit of the fishers

Capacity building of women of vulnerable community in ornamental fisheries to meet SDG 5

Capacity building and skill development of the women of vulnerable community in ornamental fisheries was done. The trainings were conducted for 24 women from Kultali, Sundarbans, 50 women entrepreneurs from Ranchi, 12 women from Odisha, and for 30 women entrepreneurs from Deoghar and East Singhbhum, Jharkhand. Field visits to the ornamental fish market at Galiff Street were conducted for exposure towards marketing of ornamental fish and their accessories.

Project Title: Socio-economic profile of inland fishers: A rapid assessment

Project code: AES/23-24/05

Duration: April 2023 to March 2024

Scientific Personnel : Arun Pandit (PI), Aparna Roy, Ganesh Chandra, Anjana Ekka, Piyashi DebRoy

Summary

- A comprehensive literature survey was done on the socio-economic status of inland captured riverine fishers of India from the earlier works of ICAR-CIFRI since 1970.
- The Ganga river was given a special focus. It was found that all the socio-economic variables were better in lower stretch. The education level among the fishers was very low. The average family size was 5 and most of the studies.
- Fishing was the primary occupation to about the 70% respondent fishermen. Similar analysis were carried out for the other rivers also. Even in the current time the average years of school education received by the fishermen were 3.17 years, 3.55 years and 1.47 years respectively in lower, middle and upper stretch of the river.
- The monthly income from fish catch which was only around ₹ 2500 in 2001 rose to ₹ 4345 per month in 2021, which denotes that there is no increase in real income.

Socio-economic conditions of the riverine fishers across different rivers of India

In the recent times the rivers of India are being subjected to excessive stress due to various reasons like, anthropogenic pressure, climate change, agricultural and industrial run-off, municipal wastes, multiple dam constructions etc. These lead to shrinkage of fishing areas, destruction of fish spawning areas and habitats and damage to boats and nets. The adverse effects of these stress are being evident poor fish catch and loss of livelihood of fishing communities. Many members of the fishing communities are migrating to other occupations in search of livelihood.

Ganga river

CIFRI (2011) found that all the socio-economic variables were better in lower stretch. In 2012, in the Tribeni and Nawabganj stretches of the Ganga river it was found that more than 80% of the households were under below poverty line. Only 10% of the population was educated beyond high school level (CIFRI, 2012). Joshi et al (2013) reported that between Devprayag and Kanpur stretches of Ganga about 28,000 fishermen were dependent on river with employment dependence of around 42%. CIFRI (2014) examined the livelihood assets of fishers' households in the Ganga river basin taking 11 districts from West Bengal, Bihar, Jharkhand and Uttar Pradesh. The study indicated that five livelihood assets of the fishers were not well balanced. The human capital of the fishers *i.e.* family education (86% were literate), health facilities (98% children were properly vaccinated) in North 24 Pargana district were better than Hooghly district. In Pakur district of Jharkhand 91% of the sampled population belong to fishermen caste (SC) with poor literacy rate (CIFRI, 2016). About, 40% of the members of the fishermen community were indebted and their average indebtedness was Rs. 11,000. The average family size among the fishers of Varanasi district was 7. Due to financial constraint, they were unable to send their children to schools. In Allahabad district, the literacy rate of the

fishermen was 56%. In Siwan and Saran districts of Bihar the literacy rate among fishers household was better being around 65%, but in Gopalganj district the same was low, 48%. Among female members the literacy was significantly low.

Roy et al (2016) revealed that 60% of hilsa fishers of lower stretch of river Ganga belonged to jele/malo community. The average family size was 5 and most of the hilsa fishers had education up to primary level. In the stretch of Farakka to Sagar light house of Ganga the head of the household had only 1.66 years of schooling and majority of them were illiterate (40.40%) (Pandit et al., 2019) The average size of the family was around 4. Fishing was the primary occupation to the 70.30%. respondent fishermen.

Das et al. (2022) described the livelihood patterns of fishers off the Ganga river involving 24 districts of Uttarakhand, Uttar Pradesh, Bihar and West Bengal. They found that the scheduled Caste including Mallah, Kewat and Nisad, and their multiple sub castes are dominant in Hindu community's fishers. A major number of fishers almost 60% involved in Hilsa fishery were belonging to the Scheduled Caste known as 'Malo' or 'Jele' community in West Bengal. 40 to 50 years was the age group in which maximum percentage of fishermen fell. The average years of school education received by the fishermen were 3.17 years, 3.55 years and 1.47 years respectively in lower, middle and upper stretch of the river.
In a recent study of ICAR-CIFRI in 2021-2022 revealed that the average family size of the fishers in WB stretch was 4.7 and in UP was 6.5. The agricultural land holding was very poor, being only 0.008 acres per household in WB and 0.05 acres in UP. Fishing was the major occupation of around 76% and 94% of the respondents in WB and UP, respectively. Only 42% and 38% of the respondents had *pucca* houses in these two states.

Other rivers

ICAR-CIFRI, 2018 found Setti/Sibnapadayar and Varurathuragakulam important indigenous fishermen castes in the Cauvery river stretch. In the Tapti river the fishermen mainly belonged to caste Dheemar, Bhoi, Jhinga Bhoi, Machhindra and Bhoi. Among the fishers of river Siang there were social and cultural values/beliefs among the riparian population, such as white scaled fish like *Labeo gonius*, *Barilius* sp., etc. were considered as sign of good fortune by Missing community (ICAR-CIFRI, 2018). At Hogenakkal falls, fish-based tourism model was prescribed for additional livelihood for inland fishers of in Cauvery river (ICAR-CIFRI, 2020).

About half of the respondent fishers at upstream and downstream of the proposed Sardar Sarovar dam were secondary (Class 6-10) level educated and 21% were illiterate (ICAR-CIFRI, 2021). Overall, 80% respondents were dependent on fisheries alone as primary occupation. The average family size of fisher's households was around 5. About 79 % of the total respondents were land less. In Debi river in Odisha Pandit et al. (2021) found that the head of the household had just 4.8 years of schooling and on average one-third of the respondents were illiterate. The average family size was 6.4 individuals per family. Their dwelling units were mainly of the kachha type across all the pucca houses were owned by only 7.1% of fishers. Fishing was the main occupation of around 61% of the fishers.

Income and livelihood of the fishers: A temporal analysis

Ganga river

ICAR-CIFRI (1993, 1994, 1995) studied the economics of migratory winter fishery of Hooghly estuary and concluded that contrary to subsistence character of riverine fisheries of freshwater zone, winter migratory fishery seems to be a highly remunerative. They estimated that the income per fishermen was about ₹ 3000 as wage and 4,175 fishermen were engaged in winter fisheries.

The net returns from fish catch was ₹ 29,869 per family for an average catch of 1,431.7 kg in the Kanpur to Farakka stretch of the Ganga river (Sinha and Katiha, 2001). ICAR-CIFRI (2011) found that the income and expenditure pattern of fisherman in upper stretch is quite different than that of lower stretch. In upper stretch, the main income source is 'other activities' (42%), whereas in lower stretch maximum income comes from fishery (63%). Livelihood diversification and migration were more in upper stretch. In the Hooghly estuary ICAR-CIFRI (2011) found that the monthly income of majority (66%) of the families was between Rs.1107 to 1439.

Roy et al. (2016) found that Hilsa fishers in the lower stretch of river Ganga earned ₹ 67,385 per year out of which hilsa contributed 38.84%. Due to less income from fishery, the fishers were compelled to work as daily labourer. In Pakur district of Jharkhand under the Ganga river basin the main source of income of fisher community was fishing and annual income from fishery was ₹ 47,390 (ICAR-CIFRI, 2016). Other than fishery, they also worked as labour in stone chip mines etc. which contributed 44% to the total family income. While in the Varanasi and Allahabad districts of Uttar Pradesh the average annual income of fishers was ₹ 42,000 and ₹ 46,000, respectively. In Gopalganj district of Bihar the average annual household income from fisheries was ₹ 53,000.
Pandit et al. (2019) found that the level of livelihood diversification, measured by Simpson index, for Farakka to Sagar light house stretches of Ganga was low. The extent of diversification was more in

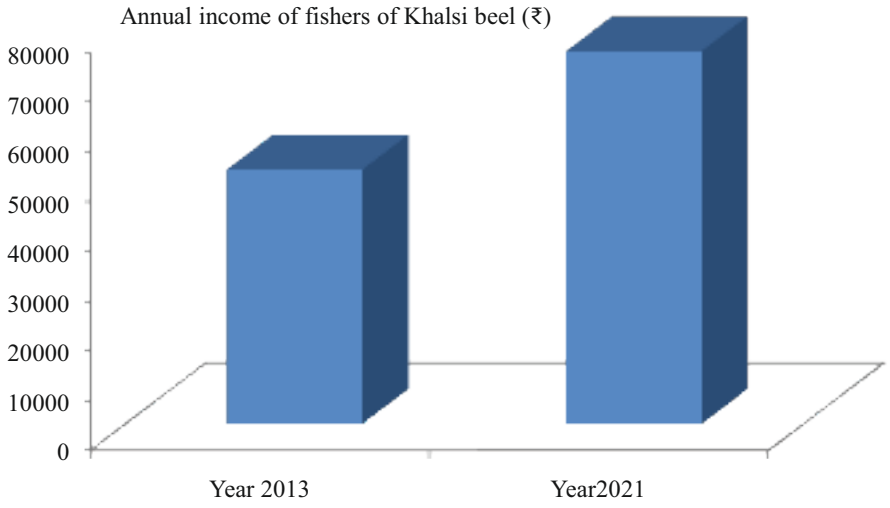
the upper stretch. In the lower and middle stretches, contribution of fishing in the total income of the household was found to be 75.88% and 72.04% respectively. In the upper stretch, fisheries contribution was 65.32%. Further the study revealed that Simpson index, family size, age of respondent, education of respondent were the factors which affected the per capita income significantly. The recent study of ICAR-CIFRI in 2022 also revealed that the income diversification was quite low. The Simpson's index of income diversification was found to be 0.18 in West Bengal and 0.30 in UP.

Das et al. (2022) described the livelihood patterns of fishers off the Ganga river involving 24 districts of Uttarakhand, Uttar Pradesh, Bihar and West Bengal. They found that the economic status of the fishers was very poor to moderate condition due to decreasing trend of fish production from in past few decades. They reported that the average monthly incomes of the fishermen were ₹ 7,283, ₹ 5,866, and ₹ 4,345 in lower, middle and upper stretch of the river, respectively. Fisheries-related activities form a major part of their total income and play a great role in their livelihood.

Other rivers

CIFRI (2004) reported from Damodar river that the fishermen had low income and most of them abandoned fisheries in favour of agricultural labour and other professions for want of sufficient fishes round the year. The fisher folk of the Torsa river had annual average family income of Rs. 46,574 and average hand holdings of 1.25 Katha (ICAR-CIFRI, 2017). The woman-headed family earned significantly less than that of male-headed family. Fishing in Torsa River contributed 62% to family income of a fishermen family.

Socio-economic survey of fishers along the Cauvery river revealed an average monthly income from riverine fisheries as Rs. 10,500/month with average eight man-months in fisheries (ICAR-CIFRI, 2018). Fishers were found to be 56% dependent on the river Cauvery for their livelihoods. Whereas, in river Tapti the average income of the fishers from riverine fisheries was ₹ 5,500/month. Fishers depend on the river for 6.5 man-months for their livelihoods.



Socio-economic survey conducted in river Siang found that almost 87% of the respondent population was dependent on Siang for their livelihood (ICAR-CIFRI, 2019). Average dependence of the populace on the riverine fisheries was 4.5 man-months. Average income from river fisheries was ₹5,500/month. In Chaliyar river the average income of the fishers was ₹11,000/month from riverine fisheries. Fishers were dependent on riverine fisheries for about 5.5 man-months. Other than fishing, fishers were also involved in small scale business (timber mill and sand mining) spending 4.5 man-months in a year.

ICAR-CIFRI (2021) found that overall, 80% respondent fishers of Narmada river were dependent on fisheries alone as primary occupation. Majority of the families fell in the category of ₹ 1-2 lakh per annum income category. In a recent study of ICAR-CIFRI in 2022 revealed that the level of income diversification was quite low in Tons (Uttar Pradesh), Torsa (West Bengal), Bramhaputra, Kolong (Assam) and Narmada, Mahi (Gujarat) rivers. 0.63 in Torsa, 0.47 in Tons, 0.39 in Bramhaputra, 0.64 in Kolong, 0.49 in Narmada and 0.68 in Mahi. The diversification was found to be more in small/minor rivers.

Temporal changes in socio-economic characteristics of Khalsi beel fishers

An attempt was made to capture, document and analyze the changing trends and patterns in the livelihood of wetland fishers of India whose contribution in the inland fisheries sector of the country is too big to ignore.

Khalsi beel was taken as a case study which is a closed ox-bow lake spread across 62 ha area situated in Haringhata block of Nadia District in West Bengal. It is a shallow beel, seasonally open. The fishery activity is operated by Fishermen Cooperative Society, named "Khalsi Udbastu Samabay Samiti". During 2013, data were collected from 100 fishing households and after ten years in the year 2021 data were again collected from the fishermen community of the Khasli beel. The

fishermen did not experience major transformations in population size, development patterns, and social characteristics. However, their average income has been improved from ₹ 51,290 to ₹ 75,113. About 46% increment was noticed in gross income of the fishers. In 2013 about 86% were in Below Poverty Line, whereas in 2021 there is slight improvement, as 80% of the sample populace was found under BPL category. However, there is a notable change in the expenditure pattern, earlier the fishermen of Khalsi beel area utilized only 2.3% of their earning on education, now their expenditure is about 10% for education.



Kholsi beel

Project Title : Investigating the feasibility of the Food-Energy-Water nexus in the Cauvery River Basin

Project Code : FSE/23-24/06

Duration: April 2023 to March 2024

Scientific Personnel : Anjana Ekka (PI), Arun Pandit and Dibakar bhakta

Summary

- The study explores the tradeoff among agriculture, hydropower, and species richness in the Kabini watershed, using hydro-economic modeling to understand dam viability.
- The presence of a dam leads to significant electricity generation (₹91.10 crores/year) but lower fish species richness (19.28), impacting biodiversity.
- Dam-associated agriculture contributes ₹3317.37 crores annually. In contrast, the without dam scenario shows higher fish species richness (23) but no electricity generation.
- Agriculture in this scenario contributes ₹3098.09 crores/year. This highlights the need for balanced decision-making, considering the benefits of electricity generation and agriculture against ecological consequences, emphasizing sustainable development for energy, biodiversity, and economic goals.

All ecosystem services of rivers are governed by the flow regime and the flow regime is influenced by many biotic and abiotic factors and interactions among them which include topography, land cover, climate, and anthropogenic modifications. In recent decades, the water demand has increased. The huge investments in water technology for harnessing the societal benefit from river water have resulted in substantial hydrological alterations of rivers. Large-scale energy developments are often controversial projects with economic, social, environmental, political, and physical consequences. The tradeoff among species richness, agriculture, electricity, and fish species is a complex and multifaceted issue that involves balancing the needs of human societies with the preservation of biodiversity and environmental sustainability. Therefore, this study explores the level of tradeoff between agriculture, hydropower, and species richness to understand the economic and environmental viability of dams



Figure provides a comprehensive overview of the Kabini watershed in the upper Cauvery basin. The watershed is defined according to the positioning of the T. Narasipur gauge station. The notation "RM" denotes the modeling of the Kabini reservoir, while "F1" and "F2" represent the upstream and downstream areas of the reservoir. Additionally, "CA" signifies the command area that receives irrigation from the reservoir.

	Economic value of electricity (₹ Crore)	Fish Species Richness	Economic value of agriculture production (₹ Crore)
With dam	91.1	19.28	3,317.37
Without dam	0	23	3,098.09

The level of production of different ecosystem services under the dam and without dam scenario in the Kabini reservoir

using hydro-economic modelling.

Figure provides an overview of the tradeoff analysis between electricity generation, Fish Species Richness (FSR), and the economic value of agriculture in scenarios with and without a dam. In the presence of the dam, the economic contribution of electricity is estimated to be ₹ 91.10 crores annually, indicating a significant contribution to power supply. However, this comes at the expense of a lower species richness (SPR) of 19.28, suggesting potential ecological impacts due to the alteration of the flow regime. On the economic front, dam-associated agriculture generates an economic value of ₹ 3,317.37 crores demonstrating its contribution to the local economy. Conversely, the "Without dam" scenario shows no electricity generation but a slightly higher fish species richness at 23, implying better preservation of biodiversity. The economic value of agriculture in the absence of the dam is estimated to be ₹3,098.09 crores, indicating a relatively lower economic impact compared to the dam scenario. This analysis highlights the need for careful consideration and balanced decision-making, weighing the benefits of electricity generation and economic value against the potential ecological consequences associated with dam construction. It emphasizes the importance of sustainable development practices that aim to optimize multiple objectives, including energy needs, biodiversity conservation, and economic well-being.

वार्षिक प्रतिवेदन

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

Funding Agency: ICAR

Duration: 2018 to 2023

Scientific Personnel: S. Kumari (PI), Archana Sinha, S. Yengkokpam, N. Sharma

Summary

- Domestication of Gangetic leaf fish, *Nandus nandus* was achieved in indoor aquarium setup with submerged macrophyte plantation.
- Successful rearing of artificially bred peacock eel, *Macrognathus aral* juvenile was achieved in glass aquarium with supplementary feeding.
- Larval rearing of artificially bred *Danio dangila* in captivity was successful .
- Monthly study of the reproductive characteristics of *Mystus tengara* revealed its breeding season from April to September with peak spawning during June and July.
- Captive breeding of dwarf chameleon fish, *Badis blosyrus,* was achieved for the first time.

Culture of *Nandus nandus*

Nandus nandus, an indigenous fish mostly distributed in the basins of river Ganga, Brahmaputra and is commonly known by various names as Mud perch, Gangetic leaf fish and Mottled Nandus, Bheda in Uttar Pradesh, Meni, Roina, and Nadosh in West Bengal. The fish were collected from wetlands of West Bengal and stocked in two different glass aquarium tanks with different setup, one a plane glass tank, while other was a planted tank. In the plane glass tank we observed low food acceptance and high cannibalism and the fishes were also affected by diseases like fin rot, gill rot, etc. We then set up a planted aquarium tank mimicking natural environment for maintaining *N. nandus* in captivity.

Experimental setup

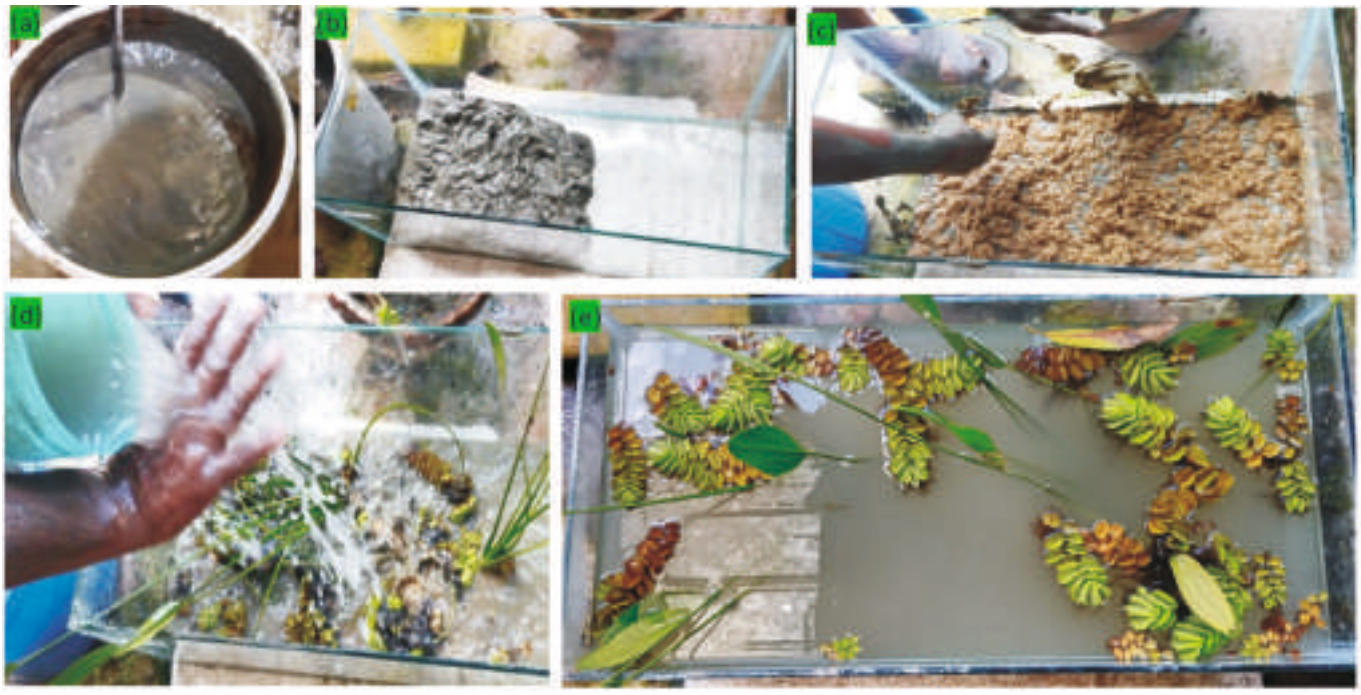
An aquarium of size 3 x 1.5 x 1.5 ft^3, sufficient for growth of 5-6 fish was prepared in various sequential steps starting from collecting the Gangetic soil, preparing a soil bed for plantation. The bed also includes small gravels and a thin layer of sand at the bottom. Freshwater aquatic plants such as Amazon sword, *Hydrilla*, *Salvinia* were planted into the soil bed. The tank was filled with 15 gallon of water and was left undisturbed for a week to settle. A total ten fish of size 7.2-10.3 cm and weight 7.4-12.8 g were released into the tank. In the first week, the fish was reluctant to accept feed such as tubifex. From the 10th day onwards, the fish were acclimatized in this new environment and started accepting feed.

Rearing of *Macrognathus aral* juvenile

Macrognathus aral is one of the most important freshwater fish of Southeast Asia. It is popular and widely recognized for its excellent taste. This fish has a high market value. It is primarily found in open water bodies, such as rivers, canals and beels. Its body is elongated and compressed with a long fleshy snout used to excavate substrates in slow-moving rivers and streams. It has a distinct brown or olive colour on body and false eyes spot at the base of dorsal fin called ocelli. These ocelli usually varies in number (3-5) giving a resemblance to peacock. In the previous year (2022) successful breeding was performed and juveniles were raised successfully this year in captivity in a plane glass aquarium (3x2x2 ft). The juveniles were fed in fusoria and micro-particulated shrimp powder in the first month. From the second month onwards tubifex feeding was started. Live feed such as plankton collected from the pond and tubifex were given daily thrice till 3rd month. The size range of 1st batch of fish in one year have reached to 16.7-18.5 cm and weight 17.3-19.6 grams.

Danio dangila larvae rearing in captive condition

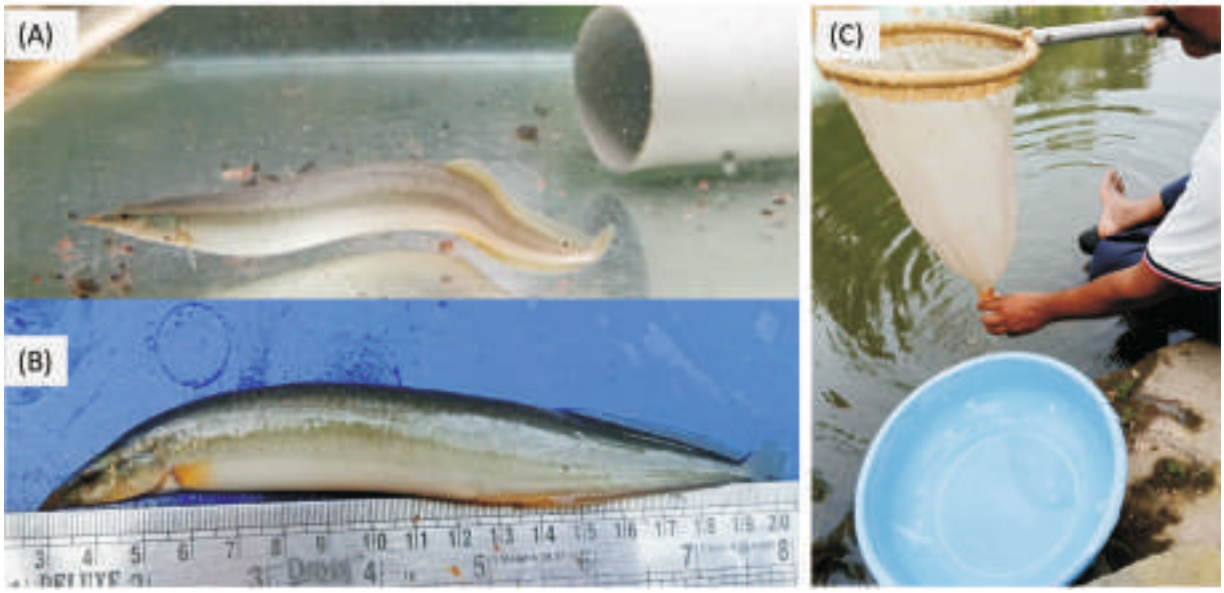
Danio dangila is one of the most popular ornamental fishes among the danion group. It is a freshwater species native to northeastern hill region of India. This fish is the largest among all danio species and can grow up to 6 inches long. A successful breeding was accomplished in the previous year of this indigenous fish and larvae were nurtured this year. The larvae were fed with green water and, infusoria in the first week of rearing. Later, the larvae were fed with newly hatched brine shrimp on hatchlings after 3rd week. Regular water quality was monitored and an optimal temperature and water conditions were maintained. Chain formation started in the form of vertical bars bridging parallel horizontal strips initiating in the 6th week, from posterior end to anterior end. The fish reached 8.5 cm length and 5.1 grams weight in one year.



(a) Disinfecting soil collected from river Ganga (b)Preparing soil bed at the bottom of aquarium (c) Layering with sand and gravels in soil bed (d) Planting freshwater aquarium plants (e) Planted aquarium tank setup ready for releasing fish



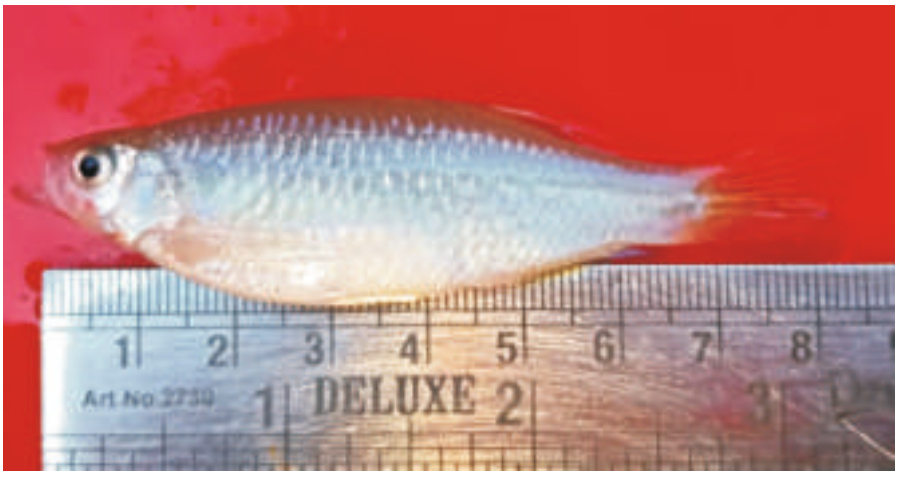
N. nandus reared in tank for maturation



(A) One year old fingerling with hideout in aquarium, (B) One year old fingerling measuring maximum length (18.5cm) attained in one year , (C) Plankton collection from pond for feeding

Reproductive characteristics of *Mystus tengara* from the Brahmaputra River valley

Mystus tengara, locally known as tengara, is a small catfish belonging to Bagridae family under order Siluriformes. It is widely distributed in the Indian subcontinent. Apart from food value, the fish also has ornamental value. In the present study, *M. tengara* (50 no.) from the rivers and wetlands of Brahmaputra River system were collected every month during July 2022 to June 2023 to study its reproductive characteristics. The fish possess yellowish green to dark greenish black colour with around five silvery bands on either side of the body with a black spot behind the operculum. The total length and weight of the male fish ranged from 6.8-9.5cm and 3.6-8.6gm, respectively and in female fish these ranged from 6.8-10.15cm and 3.5-11.21gm, respectively. Male dominance over female in the collected population was observed with male to female ratio of 1.18:1. Five gonadal maturity stages, namely, immature, maturing, mature, ripe and spent were identified for both male and female. Gonadal development was observed to starts during January and maturity with gut occupancy of 80-100% was observed in the months of June and July. At the time of maturation, males are distinguished with elongated genital papilla in front of the anal fin while females have a fuller body. The gonodo-somatic index (GSI) ranged from 0.54-1.07 in male fishes and 0.45-17.84 in female fish. Absolute fecundity ranged from 10160-16131 ova/ fish and the relative fecundity ranged from 1231.1 to 1455.5 ova/gm body weight. Monthly study of the reproductive characteristics revealed that the breeding season for the fish species extended from April to September with peak spawning during the month of June and July.



One year old *Danio dangila* reared in tank under controlled condition



(a) (b) (c)



(d)



(e)

(a) Immature female gonad, (b) female gonad at maturing stage, (c) fully matured female gonad, (d) male specimen of *M. tengara* and (e) female specimen of *M. tengara*

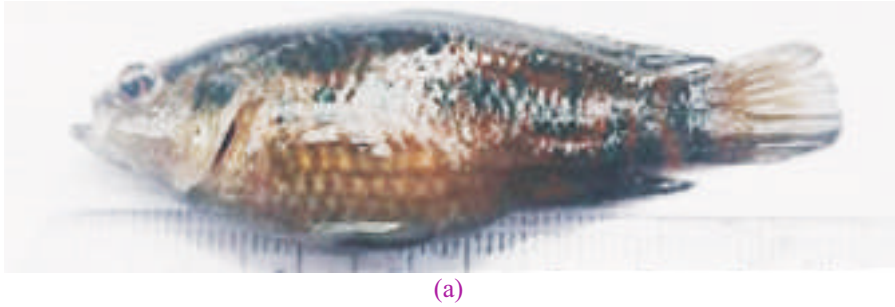
First successful breeding of dwarf chameleon fish, *Badis blosyrus*, in captivity

Badis blosyrus, also known as dwarf chameleon is indigenous to Northeast India with distribution in the Brahmaputra River drainage. The fish is a well-known ornamental fish having attractive colour, calm

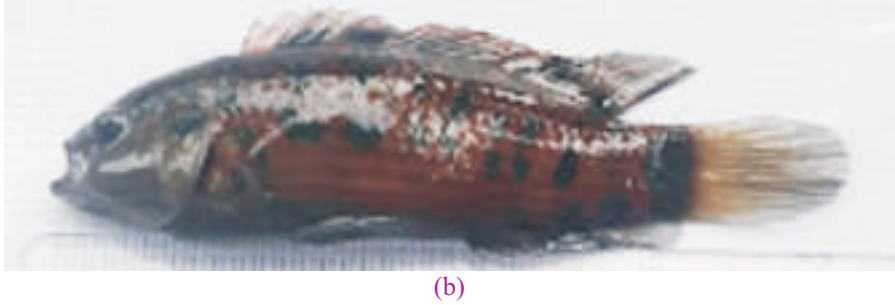
behavior and distinctive swimming techniques. Adult fish were collected from Deepor beel and nearby streams in Kamrup (Metropolitan) district of Assam during the month of January and acclimatized to aquarium glass tanks for one month. Courtship behaviour was observed during March-April in captive condition. One pair of matured fish was transferred to a rectangular FRP tank with rounded corners that was connected to an aquaponics system. The total length and weight of the fish were 6.8 cm, 3.8 g for female; and 8.0 cm, 3.5 g for male. The water parameters during the breeding trial were temperature: 20-28°C, pH: 7.0, dissolve oxygen: 6-8 mg/l, alkalinity: 100-184 mg/l, and ammonia (NH_3):0-0.0012 mg/l. The tank was provided with pebbles, submerged plants and earthen pots (hideouts) for breeding purpose. Fish were fed *ad libitum* with wet feeds (chicken liver, ant eggs). Spawning was observed during the month of June and the male guarded the eggs inside the pot for around 10 days. The eggs hatched in 2-3 days and the larvae become free swimmers in 6-8 days. This is the first report of captive breeding of *Badis blosyrus*.



Breeding pair of *Badis blosyrus* in FRP tank



(a)



(b)



(c)

(a) Gravid female (b) Mature male (c) 45 days old fry

Project Title: Network Project on Antimicrobial Resistance (AMR) in fisheries and aquaculture (State: West Bengal)

Funding Agency: ICAR, New Delhi

Duration: 2018 to 2023

Scientific Personnel: A. K. Sahoo (PI), A. K. Bera

Summary

- A total of 160 fish samples were collected from North 24 parganas, Burdwan, Howrah, Hoogly, Murshidabad and Maldah districts of West Bengal for investigation on the AMR against *Staphylococcus aureus, E.coli* and *Aeromonas* sp. A total of 92 *Staphyloccus* spp. were isolated. More than 75% of *S. aureus* isolates were resistant to Penicillin. While, 125 *E.coli* isolates were isolated and showed 28% resistant towards amoxicillin-clavulanic acid followed by 24%. A total of 121 *Aeromonas* isolates were isolated, of which showed 33.33% resistant to amoxicilin-clavulanic acid and 30.70% were resistant to Cephalothin. Antimicrobial Awareness Week (WAAW) was conducted for fish farmers, students and general public during 18-23 November 2023.

Increasing prevalence of antimicrobial resistance is a global issue and is one of the major threats to global public health and is one of the 21st century's major health challenges. Realizing the importance of AMR in farmed fish species in West Bengal, a total of 160 fish samples were collected during the period January to December 2023. During this period, different districts *i.e*. North 24 parganas, Burdwan, Howrah, Hoogly, Murshidabad and Maldah were covered. Fish species wise sampling was carried out *i.e* 45.6% of *Labeo rohita*, 21.9% *Catla catla*, 18.1% *Cirrhinus mrigala* and 14.4% *Oreochromis* sp. Anit-biotic Sensitivity Test and resistance pattern of *Staphyloccus* spp., *E. coli* and *Aeromonas* spp. were carried out. A total of 92 *Staphyloccus* sp. were isolated. Of this, 6 isolates were found to be positive for coagulase test and concluded to be *Staphylococcus aureus* after molecular confirmation by 23S rRNA PCR followed by gel electrophoresis. And the rest were identified as Coagulase negative *Staphylococcus* (CONS). Antimicrobial susceptibility testing of the isolated revealed that more than 75% of *S. aureus* isolates were resistant to Penicillin. Around 50% of the *S. aureus* isolates showed resistance to Erythromycin and Linezolid. 80% of the CONS isolates were resistant to Penicillin and more than 50 % of isolates were resistant to Cefoxitin and Oxacilin.

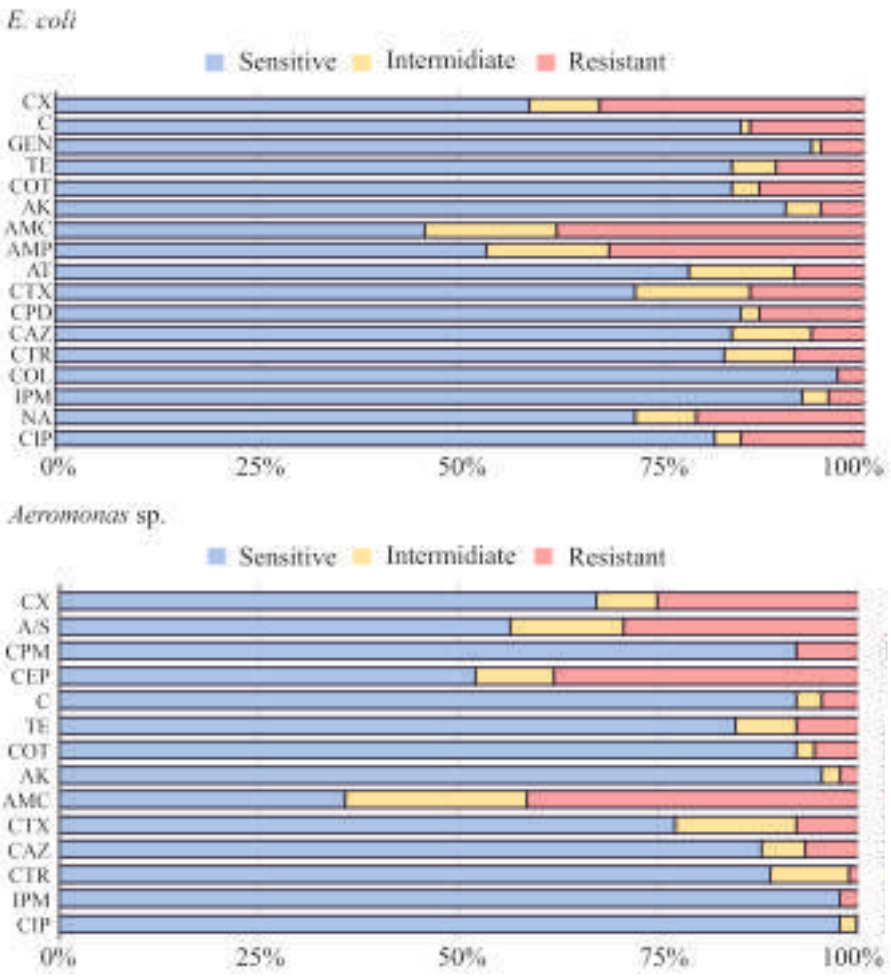
A total of 125 *E.coli* isolates were identified by colony morphology in Mac Conkey agar, Biochemical tests (Gram stain, ImViC test and Oxidase test) and pentaplex PCR by observing amplification of *lacY, cydA, phoA, lacZ* and *uidA* genes. Antimicrobial resistance pattern of the isolates were 28% towards amoxicillin-clavulanic acid followed by 24% and 23.2% towards cefoxitin and ampicillin respectively. Of the 160 samples, 121 *Aeromonas* spp. were isolated. The presence of *Aeromonas* spp. was presumed by observing yellow colonies in ADAV agar plates, positive result in oxidase test of the isolates and PCR for genus specific 16s rDNA. 33.33% of *Aeromonas* spp. isolates were resistant to amoxicilin-clavulanic acid and 30.70% isolates were resistant to



AST Pattern of *Staphylococcus* sp. (CONS) and *Staphylococcus aureus*

cephalothin. PCR for TEM, SHV, CTX-M and TET (B) genes showed positive result with 61.34%, 10.08%, 4.20% and 9.24% isolates respectively.

As a part of the project objectives, awareness programme on Antimicrobial Resistance and World Awareness programmes on AMR in fisheries and aquaculture were during World Antimicrobial Awareness Week (WAAW), 18-23 November 2023 among a wide range of stake holders including students, common people, fish farmers and state department officials at Farakka, Murshidabad, Krishi Vigyan Kendra, Maldah and at ICAR-CIFRI, Barrackpore. During the programme, more than 200 participants were actively involved.



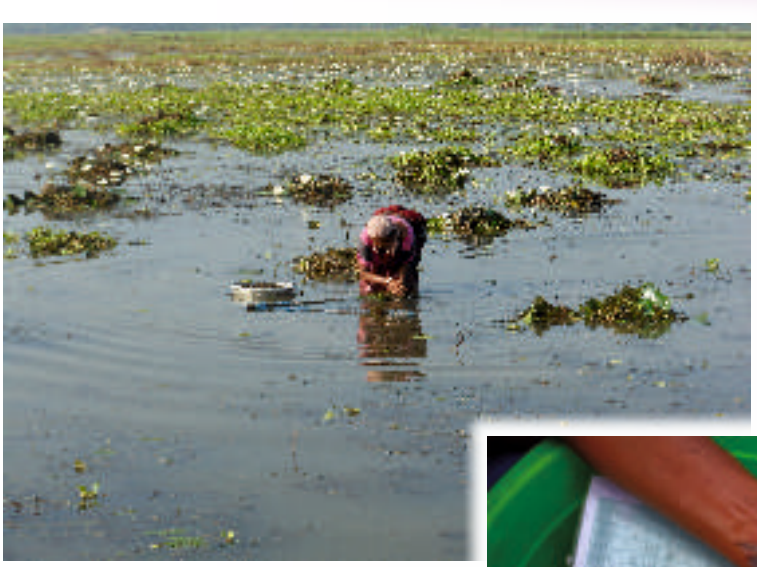
Antimicrobial susceptibility pattern of *E.coli* and *Aeromonas* isolates





Awareness programme on AMR organised in different places of West Bengal

Externally Funded Projects





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Externally Funded Projects

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, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India

Duration: November 2023 to April 2026

Scientific Personnel: B. K. Das (P.I.), A. K. Sahoo, Raju Baitha, Dibakar Bhakta, D. K. Meena, Ajoy Saha, Mitesh H. Ramteke, Canciyal Johnson, Santhana Kumar V., T. N Chanu, D. N. Jha, Md. Absar Alam, Vikas Kumar, and V. R. Thakur

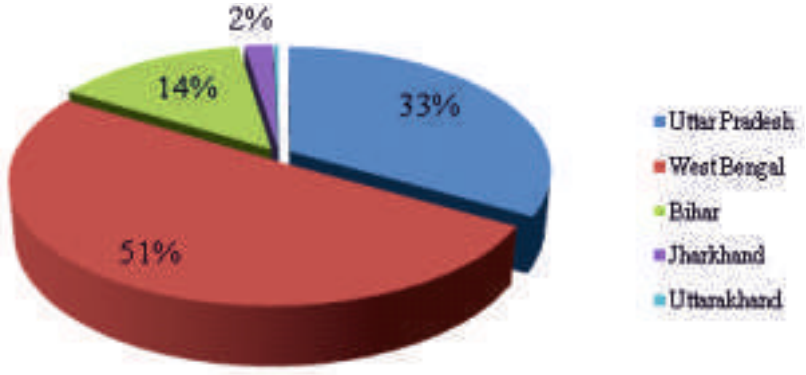
Summary

- In order to conserve and restore the populations of Indian Major Carps (IMC) and Mahseer in the river, the institute has conducted 19 distinct ranching operations in 2023, releasing 28.88 lakh fingerlings.
- The FiSAT program was employed for stock assessment of four important small indigenous species (SIF) from the River Ganga: *Johnius coitor*, *Cabdio morar*, *Salmostoma bacaila*, and *Gudusia chapra*. The results indicated that the species *C. morar* was heavily exploited. On the lower stretch of the River Ganga, all of the fish stocks are optimally exploited (E_{opt}), except for the species *C. morar*.
- A total of 21,319 Hilsa brood fish, 15.97 lakhs of fertilized eggs and 10,356 thousand spawns were also released in the upstream of Farraka Barrage during 2023. 12% of juvenile hilsa were recovered upto Sahibganj (Jharkhand), Bhagalpur, Patna and Buxar (Bihar) showed the re-establishing of hilsa breeding habitat in the middle stretch of Ganga.
- Artificial breeding of Hilsa was carried out in Godakhali and Farakka regions of river Ganga with the goal of enhancing the Hilsa population in the river. The fertilization rate of 72-80%, was achieved and the hatching rate was recorded at 57-60%.
- The institute conducted 102 awareness campaigns in various states, including Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. 7,530 fishermen, fisherwomen, students, members of the local community, and entrepreneurs took part in and were sensitized.

Component I

Restoration of selected fish species (IMC and Mahseer) of River Ganga through ranching

ICAR-CIFRI has undertaken a tremendous effort to implement the "National Ranching Programme" during the year 2023 across the several states. ICAR-CIFRI carried out 19 different ranching activities over the time to conserve and restore Indian Major Carps (IMC) and Mahseer in the river, releasing 28.88 lakhs fingerlings (produced through induced breeding of Gangetic brooders) of IMC, and Mahseer. Maximum fish ranching efforts were conducted in the state of West Bengal (51%), followed by Uttar Pradesh (33%), Bihar (14%), Jharkhand (2%), and Uttarakhand (0.3%). Compared to the previous year (2022), an increase of 6.81% of ranching was undertaken during the present year (2023). As an outcome of the ranching, currently 53% increase of IMC (1.84 tonnes) was reported from Buxar (Bihar) when compared during 2017-18 (0.97 tonnes). While an increase of 78% of IMC (14.6 tonnes) was recorded from Prayagraj (Uttar Pradesh) at present (2022-23) in comparison with period 2020-21(11.4 tonnes).



State wise percentage (%) share with regard to ranching activities

Glimpses of ranching in river Ganga



Ranching at Balagarh, West Bengal by women fisher folks



Ranching at Ballia by Hon'ble MP, Ballia, Shri Virendra Singh Mast



Ranching at Rishikesh, Uttarakhand by Shradhey Acharya Bal Krishna Ji, VC, Patanjali University and Ayurvedacharya, Patanjali Yogpeeth Haridwar



Ranching at Farakka, West Bengal by officials of NTPC and State Fisheries Department

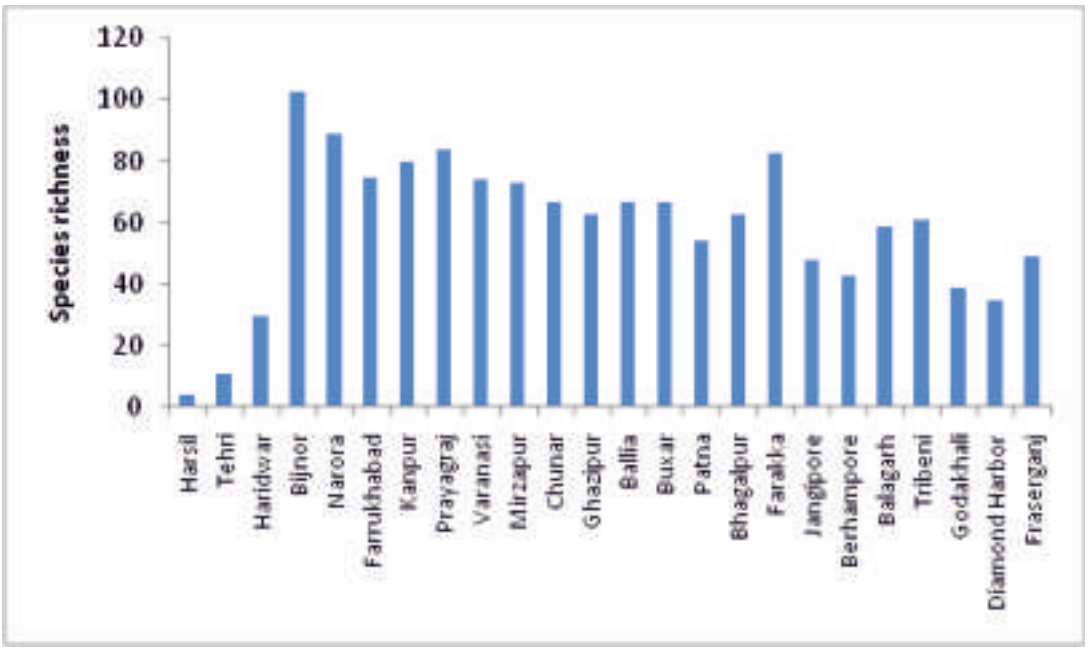


Ranching at Sahibganj, Jharkhand by Hon'ble Union Minister, Shri Shantanu Thakur

Stock assessment of selected fishes of river Ganga

A total of 183 fish species (174 native and 9 exotic) belonging to 124 genera, 57 families, and 20 orders were recorded from the Ganga River under the Namami Gange project.

During pre monsoon 2023, the upper stretch reported 18 fish species with highest at Haridwar (13 species), Tehri (7) and Harsil (1). Cypriniformes was the dominant fish order (86%) during the period. Species like *Crossochelius latius* (29%), *Tor putitora* (19%), *Labeo dero* (18%) and *Salmo trutta* (12%) were the major component of fish catch in the upper stretch. In the middle stretch, minor catfish was recorded to contribute 10.08%, while the major catfish was found with 3.38%. In the lower stretch of river Ganga (Buxar to Godakhali), order



Site wise fish species richness recorded from river Ganga (2020-2023)

Cypriniformes consisted of the maximum share of the species (33 species) followed by Siluriformes (24 species), Perciformes (17), Gobiiformes (6), Clupeiformes (6).

Status of exotic fishes in river Ganga

Among the nine reported exotic fish species, common carp was found to be the most abundant species among the exotics with a size length ranging from 42-308 mm with a distribution index value of 54%. During post monsoon distribution was maximum at Ballia (70%), followed by Mirzapur (7%), Gazipur (5%), Buxar (4%), Kanpur (4%), Prayagraj (4%), Chunar (2%), Farukhabad (2%), Varanasi (1%), Tehri (0.41%), Bijnor (0.08%), Narora (0.04%).

New distribution of exotic fishes in River Ganga

During a recent exploration in river Ganga, *Cyprinus carpio* var. communis is reported for the first time from Farakka particularly from the upstream of the Farakka barrage. Three fish specimens of size range 180-250 g was found to caught in gill net of mesh size 45 mm operating in the area. The fish specimens have

(A)



(B)



A. Common carp collected at upstream of Farakka barrage; B. Crocodile fish (*P. disjunctives*) collected from River Hooghly

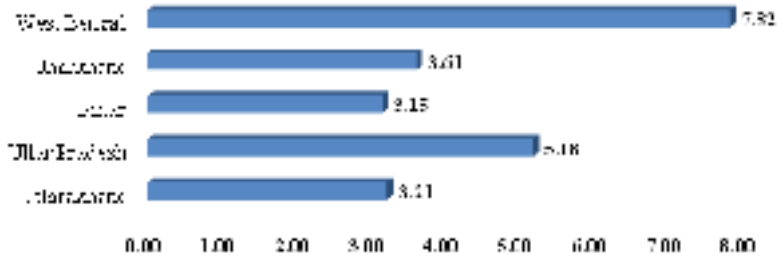
been reportedly occurred due to flooded condition of the river. At the time of local survey, a gravid single female specimen of a loricariid exotic catfish *P. disjunctivus*, was reported (Total length : 285 mm; Weight: 110 g) for the first time from river Hooghly at Barrackpore, West Bengal. Flooding of the river catchment during monsoon might have caused the entry of the exotic species into the river.

Stock status of Small Indigenous Fishes (SIFs) in river Ganga

The FiSAT program was performed to estimate stock assessments of four important small indigenous species (SIF) from the River Ganga: *Johnius coitor*, *Cabdio morar*, *Salmostoma bacaila*, and *Gudusia chapra*. The estimated exploitation rate for *Johnius coitor*, *Salmostoma bacaila*, and *Gudusia chapra* was relatively lower than the optimum level of 0.5 and considerably lower than E_{max} values, indicating that their stocks are experiencing low fishing pressure in the region. The FiSAT results indicated that the species *Cabdio morar* was found to be heavily exploited. On the lower stretch of the River Ganga, all of the fish stocks are optimally exploited (E_{opt}), except for the species *Cabdio morar*. The population dynamics of all of the species have been described for the first time on the lower stretch of the River Ganga.

Catch per Unit Effort (CPUE) of river Ganga

The average catch per unit effort (CPUE) from river Ganga varied from 0.48 kg to 55.95 kg/fisher/day during summer; 0.65 to 48.04 kg/fisher/day in monsoon and 0.28 to 53.57 kg/fisher/day in winter. The present study observed that the West Bengal (7.82kg/fisher/day) was the highest CPUE followed by Uttar Pradesh (5.18kg/fisher/day), Jharkhand (3.61kg/fisher/day), Uttarakhand (3.21kg/fisher/day) and Bihar (3.15kg/fisher/day).



State-wise CPUE (kg/fisher/day) of river Ganga

ICAR-CIFRI has surveyed two important Gangetic tributaries viz. River Koshi and River Haldi in order to document the existing fisheries and limnological status. The Koshi River was surveyed during winter season and 56 fish species has been recorded. Sahora (Bhagalpur) was having highest fish species richness (33) while fish species richness (13) was least at Piparahipatti Golari (Supaul). Major commercially important fishes observed were *Bagarius* sp., *Sperata* spp., *Wallago attu*, *Labeo catla*, *L. rohita*, *Chitala chitala* and *Rita rita*. Among Small Indigenous Fishes, the major catch was observed in following manner, *Cabdio morar>Ailia coila>C. reba>L. bata>L. boga>Salmostoma bacaila*. The Gangetic dolphin (*Platanista gangetica*) was sighted in all the surveyed districts of Bihar. Additionally, crowned river turtle (*Hardella thurjii*) was recorded in Paharpur, Nauhatta (26º00' 46.1 " N, 86º27' 31.0") of Saharsa district while Indian peacock soft shell turtle (*Nilssonia hurum*) was recorded from Dumrighat (25º32' 35.7 " N, 86º43' 23.4" E) of Khagaria district.

In river Haldi, West Bengal three shellfish species (*Penaeus monodon*, *P.semisulacatus* and *Scylla serrata*) and 15 fin fishes were recorded. The fishes were divided into six orders, twelve families, twenty genera, and fifteen species. The dominant family was Clupeidae (39.86%), followed by the Engraulidae (32.13%), Polynemidae (17.67%), and Bagridae (5.58%). The main harvested species in the river Haldi was found to be *Tenualosa ilisha* (39.57%), followed by *Setipinna phasa* (18.11%), *Polynemus paradiseus* (16.10%), and *Coilia dussumieri* (14.02%).

Plankton and benthic faunal status of river Ganga

Along the river stretch maximum average plankton density was recorded at Berhampore (2405560 cells/l) and minimum at Narora (1600 cells/l) in upper Ganga. Among the phytoplankton, 96 genera from entire stretch of river Ganga were recorded during the period. A total of 22 species of mollusks have been reported from river Ganga from Harsil to Fraserganj during the period. Abundance wise the benthic organisms was observed at Haridwar > Farakka > Bhagalpur > Patna > Balagarh > Tribeni > Prayagraj > Ballia.

Awareness among stakeholders regarding sustainable fisheries

Mass awareness programmes were organized to create awareness among local fishers and other stakeholders for conservation and to develop sustainable fisheries in different stretches of river Ganga. ICAR-CIFRI under NMCG, carried out a total number of 102 awareness programmes at different states like Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. In the awareness programme a total no of 7,530 numbers of fishermen, fisherwomen, students, local populace and entrepreneurs participated and were sensitized.



Glimpses of awareness campaigns conducted on sustainable fisheries



Breeding of Gangetic wild IMC for conservation



Spawn produced after CPE injetcion



Netting for Mahseer brooder collection



Collected Mahseer brooder

In situ seed production of selected fish species and their ranching in the depleted river stretches

Successful breeding of wild Gangetic Indian Major Carps *(L. rohita*, *C. mrigala* and *L. calbasu*) was undertaken on 24 July, 2023 with a total production of 77 lakh spawns (95 % fertilization rate). For captive rearing and seed production, a total of 13000 fingerling and 32 prospective spawners of Mahseer (*Tor putitora*) were collected from Nayar River, Tehri and Koteshwar reservoir with the help of local and departmental fishermen.

Component II

To increase the natural stock of hilsa in River Ganga (upstream of Farraka Barrage) through ranching of wild collected hilsa seed/juveniles

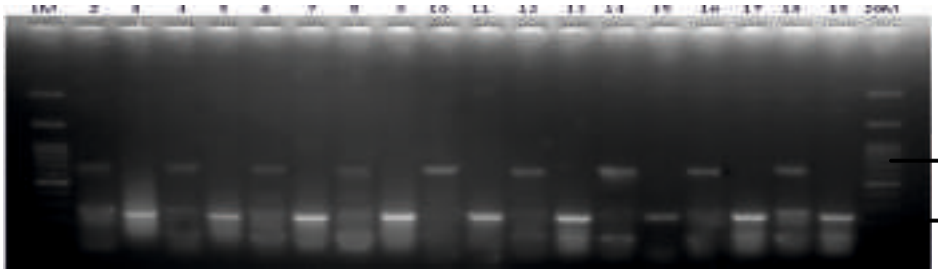
A total of 93,000 Hilsa brood fish were released in upstream of the Farakka barrage. However during the period, a total of 21,319 hilsa were released during the year 2023 with the average length and weight of 26.37±4.17 cm and 263.51±18.97 g respectively. Besides adult hilsa, 15.97 lakhs of fertilized hilsa eggs and 10,356 thousand spawns were also released during the period. A total of 12% (n=78) of juvenile hilsa were recovered upto Sahibganj (Jharkhand), Bhagalpur, Patna and Buxar (Bihar) showed the re-establishing of hilsa breeding habitat in the middle stretch of Ganga.

Expression kinetic study of HSP70 gene associated transportation stress of *Tenualosa ilisha* (Hamilton, 1822)

The stress gene Hsp70 Expression in brain tissue with respect to different distance interval was observed during the transport of Hilsa fish. In the study, during the transportation of Hilsa fish, the HSP70 gene expressed different trends depending on the distance. Understanding the different factors, and how they affect fish often leads to establishing a new protocol that reduces stress. Increased survival rates and the arrival of healthy fish depend on the transport, as well as the pre-and post-treatment procedures associated with the transport of fish for ranching.



Hilsa ranching in the upstream of Farakka barrage in West Bengal



HSP70 and β-actin expression in the Hilsa brain tissues



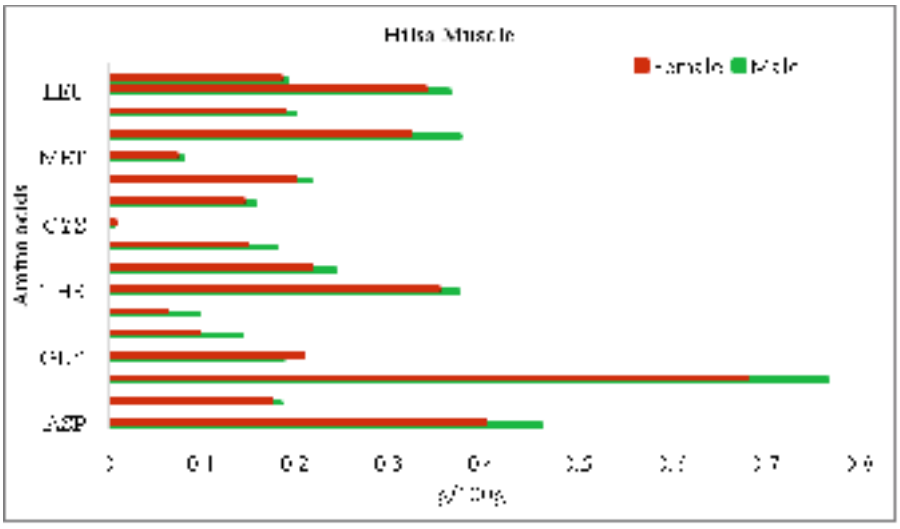
Striping eggs from oozing out female and the milt from male Hilsa followed by wet stripping method

Increase of natural stock of Hilsa in River Ganga (upstream of Farraka Barrage) through artificial breeding of Hilsa and growing and ranching the seeds/juveniles as well as developing captive brood stock

Artificial Breeding of Hilsa were carried out in Godakhali and Farakka regions of river Ganga with the goal of enhancing the Hilsa population in the middle stretches of the river. The collected oozing-out females had an average length ranging from 21.5 to 35.4 cm, with weights ranging from 108 to 705 g. Matured males, on the other hand, exhibited lengths of 18.5 to 29.5 cm and weights of 125 to 450 g. The fertilization rate of 72% to 80%, was achieved and the hatching rate was recorded at 57% to 60%.

Amino acids analysis of Hilsa

Amino acids of Hilsa were carried out and revealed the availability of 16 different amino acids in Hilsa muscle

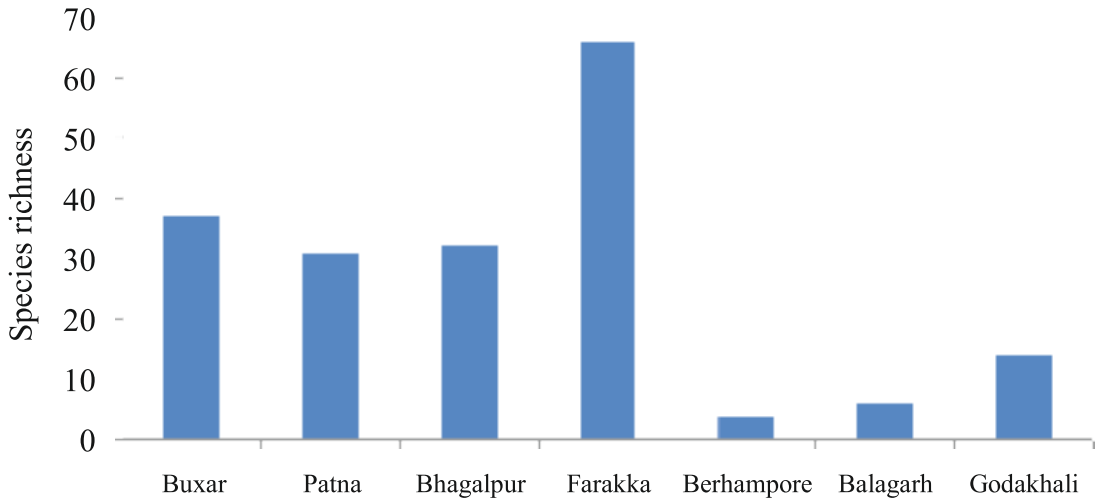


Amino acids analysis of Hilsa muscle

(weight ranges from 300 to 650g). The graph depicted here that Glutamic acid (0.77±0.57 g/100g body weight) was observed to be higher following Aspartic acid, Threonine, Lysine, Leucine, Alanine, Isoleucine, and Phenylalanine.

Biochemical evaluation of Hilsa milt

The antioxidant, amino acid, and fatty acid profile of Hilsa milt as well as Gonado Somatic Index (GSI) of male Hilsa was studied. The antioxidant assay indicated that DPPH radical scavenging efficacy of



Fish species richness at different sampling sites

the Hilsa milt was 66.5±2.5% which was closer to synthetic antioxidant Butylated hydroxyltolune and exhibited significant reducing power ability. The milt showed 15 amino acids and out of which Arginine was highest (0.7g/100g) followed by Glutamic acid (0.14g/100g).

Component III

Captive breeding of commercially important indigenous fish and ranching programme through livelihood enhancement and conservation in Arth Ganga concept

During the period, a total of 93 numbers (118.2 kg) of wild prospective spawners of Indian Major Carps were collected towards captive breeding and ranching programme from river Ganga. Out of the total collection, the average weight of the Catla, Rohu and Mrigal were 1.7 kg, 1.2 kg and 1.1 kg respectively.

A winter sampling was conducted in river Ganga to assess the fish diversity pattern of the main channel of the river extending from middle to the estuarine stretch. The sampling recorded 79 fish species belonging to 63 families. The highest fish diversity was accounted at the site Farakka (66 species) followed by Buxar (37), Bhagalpur (32), Patna (31), Godakhali (14). The lower species richness in the Berhampore to Balagarh stretch may be attributed to less fishing efforts owing to winter.

Component IV

Establishment of Hilsa stock in middle stretch of River Ganga through ranching of Hilsa seed bred through captive breeding

Hilsa ranching, tagging and stocking

A total of 3,468 adult hilsa weighing from 25.2-275.3 g were ranched at upstream of Farakka barrage in West Bengal, of which 57 fishes were tagged. During the period, a total number of 176 adult hilsa were stocked in the installed cage at Farakka, West Bengal.

Hilsa spawn ranching

A total of 15,000 spawn were ranched to the upstream of Farakka barrage



Hilsa tagging and ranching in the upstream of Farakka barrage



Hilsa spawn ranching in the upstream of Farraka barrage



Artificial breeding of Hilsa at Farakka

(West Bengal and Jharkhand) towards establishing Hilsa population.

Artificial breeding of Hilsa

Artificial breeding of Hilsa was performed in the lower stretch of the river Ganga at Farakka, West Bengal. A total number of 3 males (53.1g, 62.8g and 82.3g) and 1 female (125.4g) was utilized for breeding. The fertilization, hatching and survival rate were estimated to be 70-80% , 48-55% and 30-35% respectively. A total of 40,000 fertilized eggs were collected during the process.

Component V

Community sensitization on dolphin and fish biodiversity including Hilsa for improving livelihood for fishers

ICAR-CIFRI organized a total of 14 dolphin, hilsa and fish biodiversity awareness programs in different regions of river Ganga at West Bengal, Jharkhand and Bihar. It covers the areas downstream Farakka Barrage such as Kulidiar, Hossainpur, Beniagram and upstream of Farakka Barrage including Dear Forest, Neemshar, Pagla ghat of West Bengal and Shreeghar and Bhabanandpur of Jharkhand, Buxar, Patna and Bhagalpur of Bihar. In total 219 persons were actively participated, of which 217 men and 02 women.

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

Funding Agency: NICRA, ICAR

Duration: 2017 to 2023

Scientific Personnel: B. K. Das (P.I.), 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

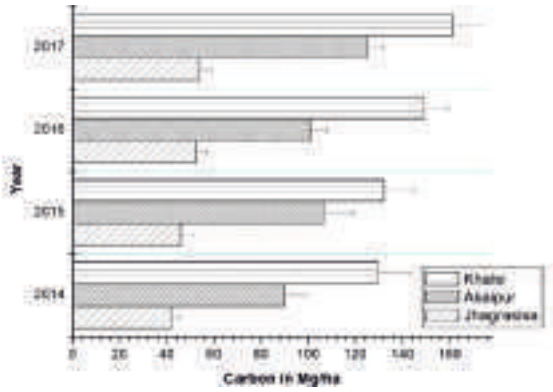
Summary

- Culture of *E. suratensis* recorded an average weight gain of 30g/month. It indicated a successful culture of the fish species and can be taken up by small-scale farmers associated with Vembanad wetland.
- GHG emission study was conducted in two different types of floodplain wetlands: open and closed. The low emission from open wetlands elucidates the importance of maintaining the link channel with the parent river.
- The methanogen detection efficiency in floodplain wetland was the highest compared to sewage fed and saline wetlands. Noticeably, Malencho has the higher methanotroph detection efficiency than the other two wetlands.
- The impact of the extreme climatic events in estuarine wetlands of West Bengal was carried out. After the frequent extreme climatic events many rivers associated with bheries in the coastal area of West Bengal were destroyed, resulting in the loss of fish production due to the escape of many stocked fishes (*Lates calcarifer, Mugil cephalus, Macrobrachium rosenbergii, Penaeus monodon* etc.).
- Ecological services provided by the 17 coastal wetlands of 3 districts, namely North 24 Parganas, South 24 Parganas, and Purba Medinipur of West Bengal were studied, and the score was developed in the context of climate change and resultant extreme events.

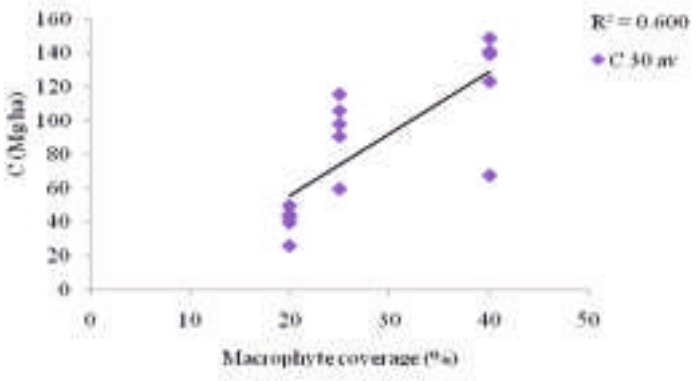
Climate change and associated stresors are impending global challenge to inland fisheries and ecology resulting in vulnerability. The institute has carried out research on different aspects of inland openwater fisheries, *viz.* vulnerability assessment, impact of extreme climatic events, demonstration of climate resilient strategies, assessment of carbon sequestration and greenhouse gas emission from wetlands.



Harvesting of pearlspot in CBF in Vembanad



Accumulation of Carbon up to 30-cm depth



Relation between macrophyte and C accumulation in 30-cm depth

Successful demonstration and Cull harvesting of *Etroplus suratensis* in CBFs in Vembanad wetland

Successfully demonstrated farming of *Etroplus suratensis* under NICRA SCSP programme. The fish farmers belonging to the SC community of Ochanthuruthu village in Vyppin (Ernakulam, Kerala) were provided with two batches of 1000 pearl spot *(E. suratensis*) seeds of 3-5 cm size to stock in CBF (400 sq.m area) and CIFRI HDPE climate resilient pens (400 sq.m area). Nearly 35 kg of *E.suratensis* (average weight being 200g) were size graded while cull harvesting. Fifteen kg of *E. suratensis* of size above 200g were sold at ₹550-600/kg and the miscellaneous fishes were sold at ₹ 200-250/kg. The cull harvesting and sales together earned ₹ 9600. The culture recorded an average growth rate of 30g/month and indicated that a successful culture of *E. suratensis* can be taken up by small-scale farmers associated with Vembanad wetland.

Assessment of C-sequestration potential and GHG emission from wetlands

The carbon accumulation and sequestration was studied in three different wetlands, one sewage fed, and two floodplain oxbow lakes in the West Bengal state of India. The carbon accumulation in the wetlands, which varied from 48.53 to 143.17 Mg/ha up to 30-cm depth of soil, was much higher than that in the corresponding upland sites. The difference was much higher in the floodplain wetlands. So the study revealed that wetlands are better carbon sinks than the corresponding reference sites and the carbon sequestration potential varies according to the type of wetlands. A positive correlation was also observed between macrophyte coverage and the amount of C stored in the wetlands.

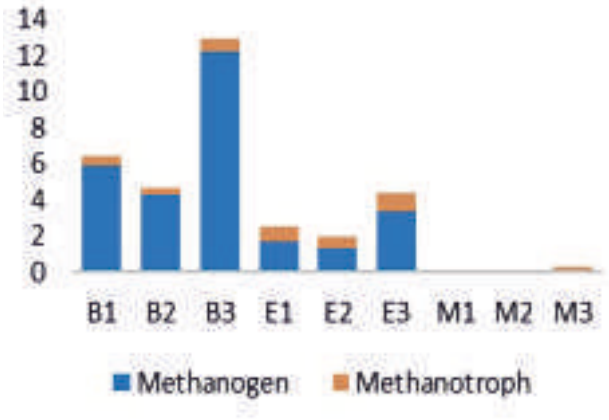


GHG sample collection

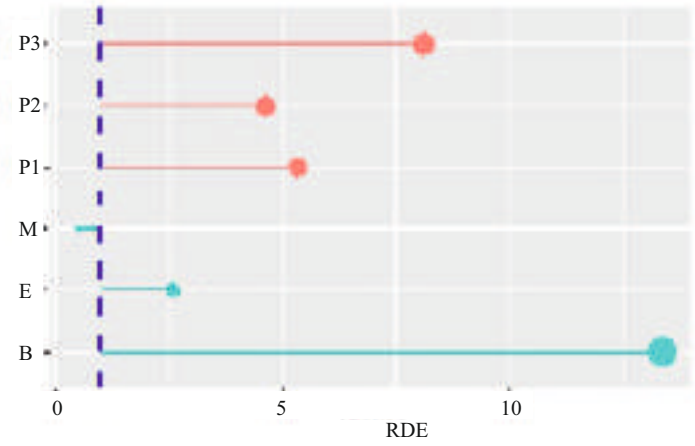
The status of emission of Green House Gas (CH_4, CO_2, N_2O) from two floodplain wetlands in West Bengal (Khalsi and Bhomra) in comparison to corresponding reference upland sites was studied in two seasons, winter (water temp. 19-22°C, upland soil temp. 18-22°C) and summer (water temp. 31-33°C, upland soil temp. 34-35°C). The study revealed that in all cases, emission was higher in summer than in winter.

Methanogen and Methanotroph in different wetland

Three prokaryote primer for the simultaneous analysis of methanogen and methanotroph have been taken. Methanogens accounted for 0.03-12.25% of total microbial community in the three wetland. Methanogens were the most dominant archaeal groups (4.35-12.25%) in the freshwater wetland Bhomra, decreased sharply (1.72-3.39%) in the sewage fed wetland EKW, and became almost negligible (0.03-0.12%) in the brackish water wetland Malencho. Methanotrophs exhibited lower abundance 0.077-1.01% of the total microbial community in the three wetlands. The abundance of



The percentage of Methanogen and Methanotroph OTU to total OTU



The relative detection efficiency (RDE) of methanogen with respect to methanotroph among of primers and in wetlands. The blue dashed line is the demarcation set at the value 1.

methanotroph were also negligible (0.07-0.18%) in the brackish water wetland, whereas in the other two wetland its dominance was comparatively more (0.36-1.01%). The dominance of methanogen was more than methanotroph in Bhomra and EKW whereas methanotroph was more compared to methanogen in Malencho.

The ratio of relative abundance of methanogen and methanotroph was used as a measure of detection efficiency of methanogen with respect to methanotroph. It clearly suggested the Primer 3 had the highest methnogen detection efficiency followed by Primer 1 and Primer 2. The methanogen detection efficiency in Bhomra was the highest followed by EKW and Malencho. Noticeably, Malencho has the higher methanotroph detection efficiency than the other two wetlands.

Ecological services of floodplain wetlands in the context of climate change

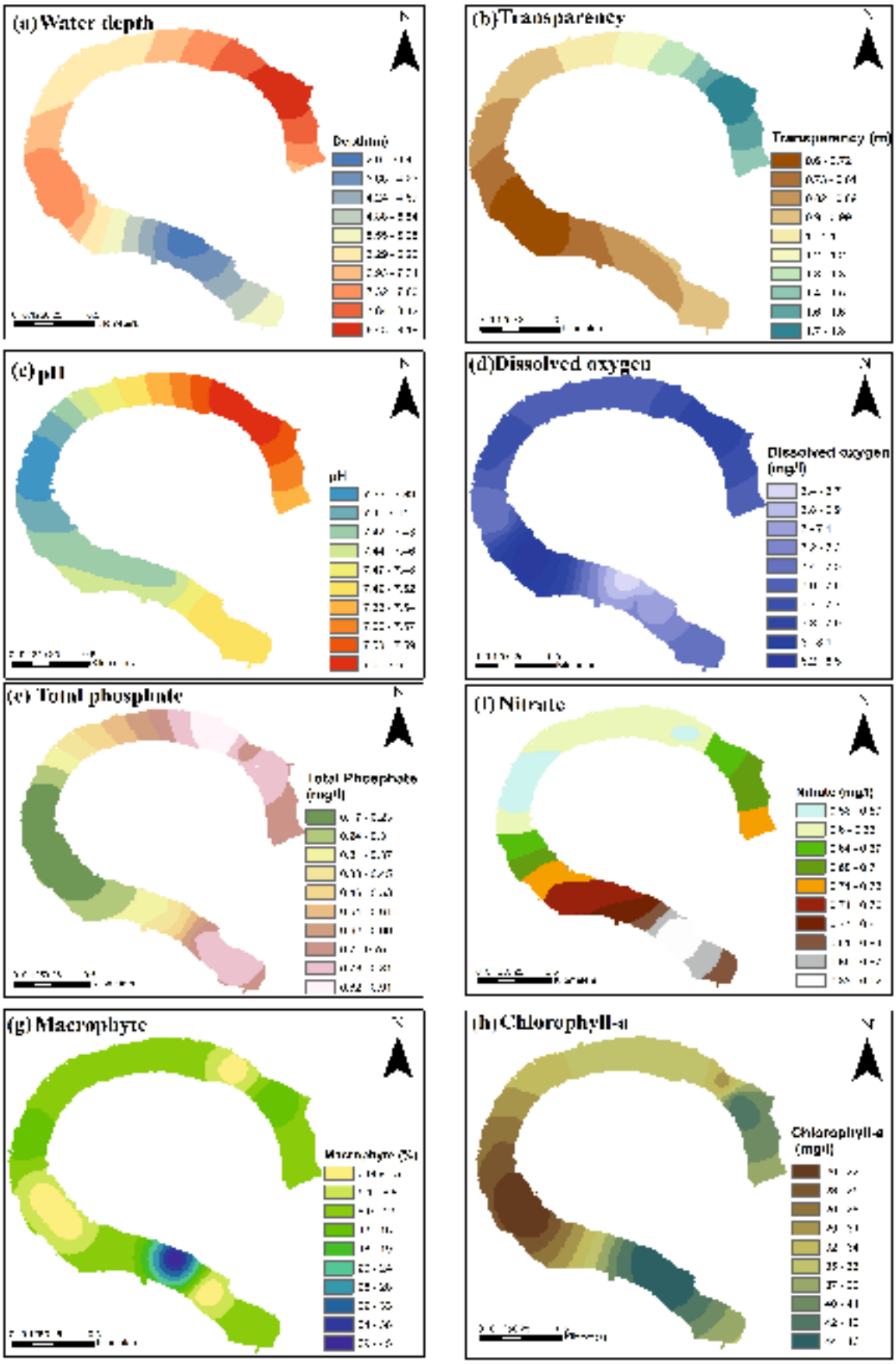
An interactive session was conducted with 100 stakeholders from 15 locations under 4 districts, *viz*., North 24 Parganas, Murshidabad, Nadia, and Burdwan of West Bengal, based on pre-designed questionnaires to identify ecological services which directly or indirectly affect the ecology as well as the livelihood of fishermen. Based on the fishermen's and experts' views, a scoring criterion was developed to assess the present ecological services of study areas. Wetland ecosystem services were classified into supporting, cultural, regulating and provisional services based on Mitsch and Gosselink's (2015) method.

Ecological assessment of wetlands using GIS tools in changing climate

Climate change, primarily caused by human activities, poses a significant threat to tropical wetlands, leading to reduced water connections and a decline in ecological functions. Historical data shows significant changes, including increased air temperature, decreased rainfall, and a reduction in wetland area. The study reported 45 fish species of which, 2 were endangered and 7 near threatened. The study also showed that provisioning ecosystem services is more abundant than supporting, regulating, and cultural services.



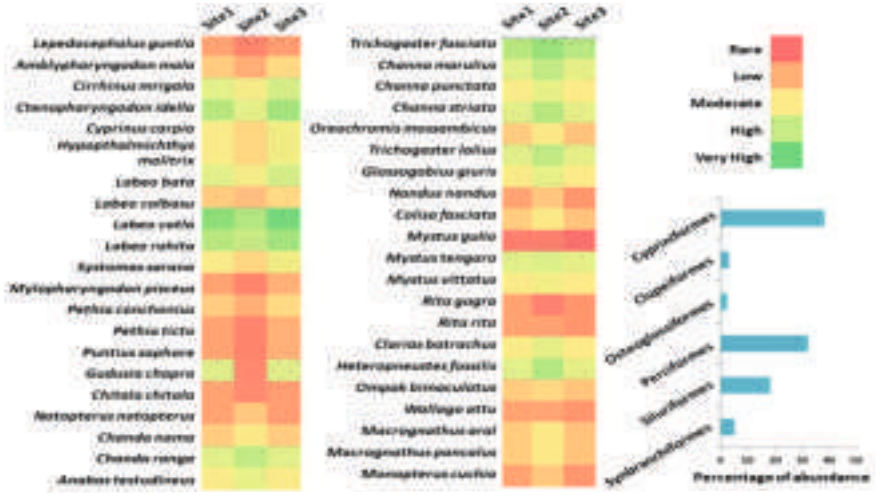
Different ecosystem services of wetlands



GIS map showing spatial variations of (a) water depth, (b) transparency, (c) pH, (d) DO, (e) total phosphate, (f) nitrate, (g) macrophytes, and (h) Chl-a in the Media wetland

Fishery livelihoods and adaptation to climate change in floodplain wetland

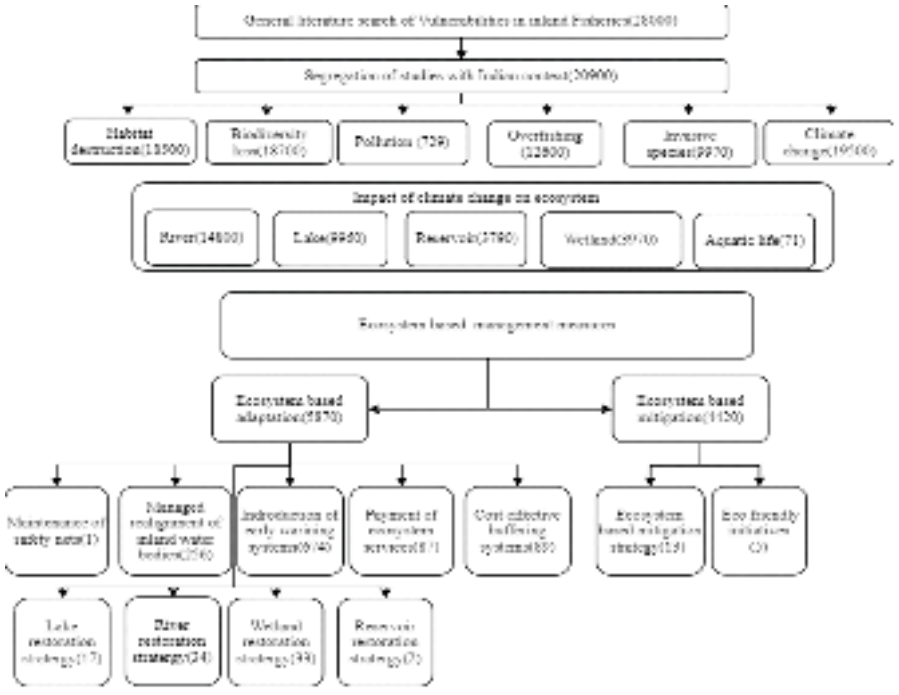
The study assessed the ecological status of Bhomra wetland, focusing on fisheries and ecosystem services. It found increasing temperature and decreasing rainfall over the last two decades, with Cypriniformes species dominating the wetland. The overall fish production in 2020 was below the last decade's average. A strong correlation was found between fish assemblage and ecological parameters, including total alkalinity and available nitrate. The wetland was suitable for carp culture, but the ecosystem's health has degraded over time. The study suggests climate-resilient strategies for sustainable use of wetland ecosystem services and increasing fishers' adaptive capacity. The communication also suggests climate-resilient strategies for sustainable utilization of wetland ecosystem services.



Heat-map showing relative abundance of different fish species and the bar diagram showing relative abundance of different orders of fishes along the three different sites of the Bhomra Wetland during 2020–2021

Vulnerabilities of inland fisheries to climate change

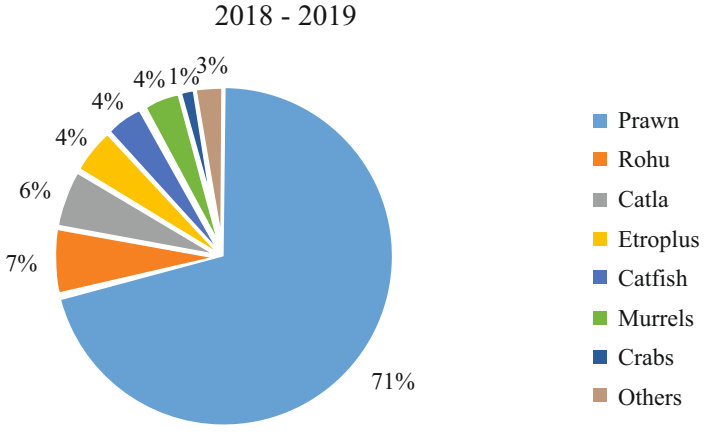
A critical bibliometric review of the climatic vulnerabilities faced by Indian inland fishery resources and various adaptive and mitigation strategies put forward by the country for the sustainability of the resources was carried out. The impact of climate change and other stressors on diverse inland ecosystems of the subcontinent and the ecosystem-based management strategies adopted in India to mitigate the effects have been identified and presented in the figure here.



Research priorities on various aspects of vulnerability assessment in inland fisheries

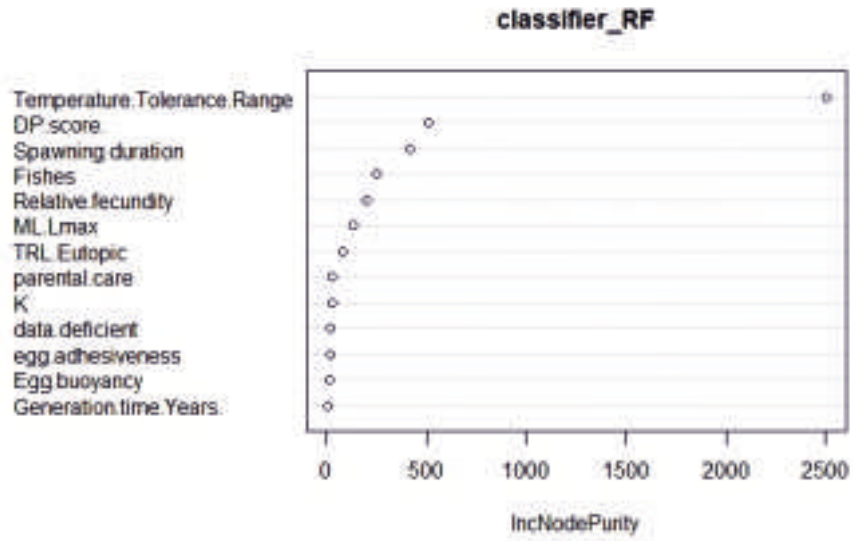
Resilience index of Vembanad fishery

The study indicated that there is a significant difference in temperature tolerance range (TTR), trophic level (TRL), relative fecundity (RF), Mean length/ Length at maximum age, generation time (GT) and K (growth co-efficient), with each variable scoring a mean rank of 423.5. The



Species composition (2018-2019) (DoF, 2020)

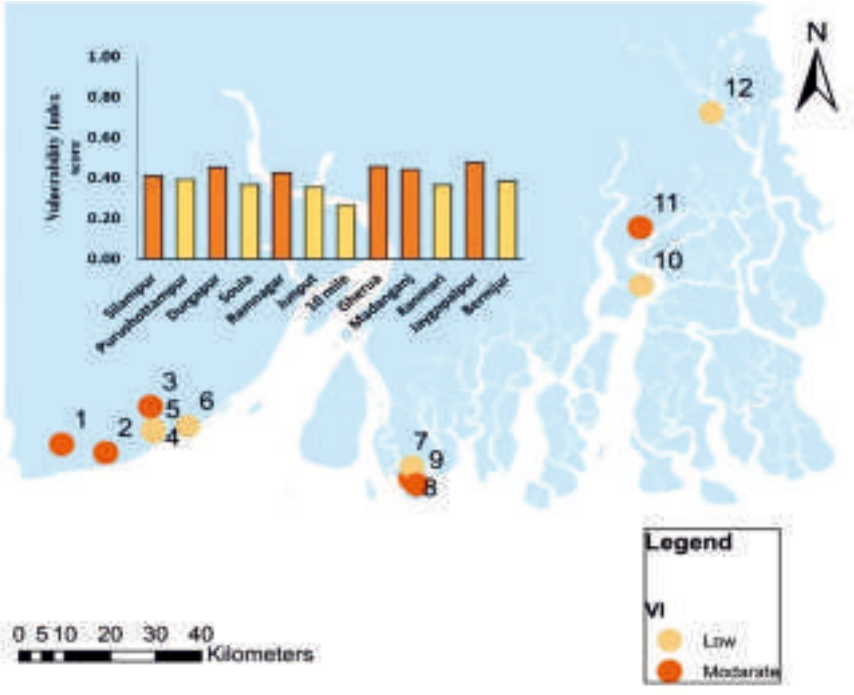
random forest method has been used to identify the most contributing factor to the resilience of the fishery. The analysis indicated that TTR (incNodePurity at 2822.753) followed DP (dietary plasticity with incNodePurity at 617.58). Thirty-five (35) fishes are found to have narrow thermal windows (22-34) compared to others, indicating very low resilience. The study stated that species with narrow dietary window is highly vulnerable. This study provides a self-assessment tool for stakeholders before harvesting the fishery in the lake.



Random Forest analysis of vulnerability index

Vulnerability status of coastal wetlands of West Bengal

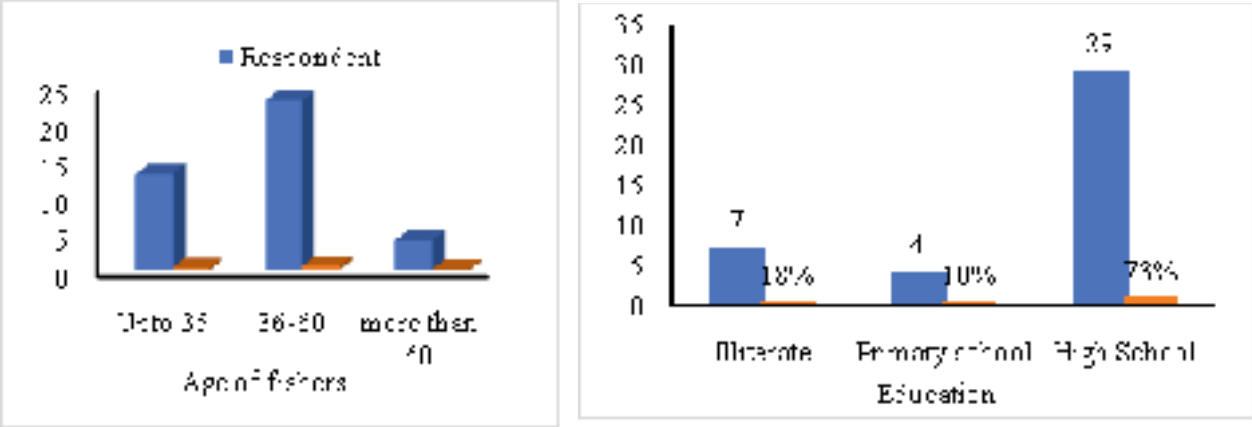
The study was conducted in 12 coastal wetlands from the Gangetic estuarine regions of eastern India. The results indicated anthropogenic stress has a greater influence on ecosystem services than climatic stress. However, the nature and degree of vulnerability of fishers to climate change varies with their capacity to adapt to such changes and alternate sources of livelihood. Altogether, 34 fish species belonging to 11 orders were documented and categorized as per the intensity of resilience using selected criteria. Perception-based climate resilient adaptation strategies have also been discussed. Developing appropriate adaptation policies and implementing climate-resilient practices and management can minimise vulnerability and increase the adaptive capacity of fishers, ensuring sustainable livelihood options.



Vulnerability index mapping of selected coastal wetlands of West Bengal, different colour indicates different categories of ESI (mustard=low, orange=moderate)

Vulnerability study of wetland fishers of Arunachal Pradesh

A study assessed the vulnerability of fishers residing in the Jona III village bordering Bor beel in Namsai district, Arunachal Pradesh. A total of 40 respondents were interviewed, and primary data was collected. According to the fishers, the beel surveyed reported fewer fish species now than that recorded 20-30 years back. The catch of a highly demanded snakehead *Channa aurantimaculata* increased recently as it bred twice a year, according to the majority (70%) of the respondents. According to data collected, the catches of *Trichogaster fasciata, Heteropneustes fossilis, Channa aurantimaculata* and *Clarias magur* increased (78% of respondents); however, *Amblypharyngodon mola, C. gachua* and *C. striata* decreased (56%). The average fishing experience of the respondents was 26 years. The age group of respondents was up to 30 years (33%), 30-60 years (58%), and more than 60 years (10%). The average monthly income of the respondents was – up to 10,000 (60%), 10,001-20,000 (28%), and 20,001-30,000 (13%). The educational status of the respondents was 18% illiterate, 10% had primary education, and 73% had high school.



Graph representing the age and income pattern of wetland fishers (40 nos) of Namsai, AP

Impact of high pre-monsoon flood in floodplain wetland fisheries in CBV Zone of Assam

Extreme climatic events such as flash floods have become frequent in recent years, affecting agriculture and allied sectors in Northeast India. Incessant rains caused a major untimely pre-monsoon flood in 47-Morakolong beel of Morigaon district, Assam, inundating its exposed and marginal areas, including human settlement areas. Morigaon district received 183.4 mm of rainfall against the corresponding normal of 172.3mm for the month. According to local stakeholders based, this type of flash flood during pre-monsoon had never been witnessed by them before. Reportedly, the release of excess water from the Kopili Hydro-electric Project dam created a flash flood in the river and its tributaries. However, rain-induced flash floods caused major damages and monetary losses in terms of infrastructure loss (destruction of watch & watch shed and pens), loss of fish feed stored near the beel and escapement of stocked fish to the adjoining river. The ecological condition of the wetland was also affected by the flood. The average values of salient water quality parameters were: turbidity 291.70 NTU (high), dissolved oxygen 3.40 mg/l (low), free CO_2 4.20 mg/l (high), alkalinity 54.70 mg/l, pH 6.9, conductivity 109.50 µS/cm, TDS 54.10 mg/l, transparency 18.40 cm (low) and maximum depth 6.5 m. Early floods leading to inundation of floodplain wetlands are likely to help in the high spawning success of wetland fishes.



Morakolong Beel, Morigaon affected by flood

Project Title: National Surveillance Programme on Aquatic Animal Diseases Phase-II

Funding Agency: Pradhan Mantri Matsya Sampada Yojana (PMMSY)

Duration: 2022 to 2025

Scientific Personnel: B. K. Das (PI), Vikash Kumar

Summary

- In last one year, more than 100 fish, shrimp and ornamental fish farms have been surveyed across Purba Medinipur, South 24 Parganas and Howrah of West Bengal, India.
- The finfish screened were infested with microbial pathogens and samples exhibited positive results for *Aeromonas veronii*, *A. hydrophila*, *Enterobacter cloacae*, *Citrobacter freundii*, *Edward siellatarda*, EUS, TiLV, TiPV, *Aphanomyces invadans*, *Ichthyophthirius multifiliis, Argulus* sp., *Lernaea* sp., *Thelohanellus* sp. and *Gyrodactylus* sp. infection.
- While, negative results were obtained for KHV, and SVCV infection.
- The tested shrimp samples were negative for WSSV, EHP, YHV and AHPND.
- Positive results for microbial pathogens like *Enterocytozoon hepatopenaei*, WSSV, *Morganella morganii* and *Shewanella algae* infection.
- The investigation highlights the need for a holistic approach to control virulence and risk factors in fish farming.

A national project on the National Surveillance Programme on Aquatic Animal Diseases (NSPAAD) Phase-II, funded by Pradhan Mantri Matsya Sampada Yojana (PMMSY), is ongoing with an aim to enhance fish production in the country through effective fish disease surveillance. Under the project, ICAR-CIFRI is working in Purba Medinipur, South 24 Parganas and Howrah districts of West Bengal for the detection of new and exotic infectious diseases in aquatic animals, implementation of national information management system for aquatic animal diseases of national concern and reporting requirements to world organization for animal health and regional; quarterly aquatic animal disease reporting system and enhance compliance to OIE standards.

In last one year, more than 100 fish, shrimp and ornamental fish farms have been surveyed across Purba Medinipur (Muradpur, Tatulbani, Sasiganty, Narayanchak, Tena-pekhya), Gopalchak (Nandigram), Gurugram, Kakna and Urururi (Chandipur) and Rasulpur (Contai), South 24 Parganas (Panakua (Nepalganj) and Altaberia (Gangrai)) and Howrah (Eksara and Khaliya (Ballyjagachha)). The finfish screened samples exhibited positive results for *Aeromonas veronii*, *A. hydrophila*, *Enterobacter cloacae*, *Citrobacter freundii*, *Edwardsiella tarda*, EUS, TiLV, TiPV, *Aphanomyces invadens*, *Ichthyophthirius multifiliis, Argulus* sp., *Lernaea* sp., *Thelohanellus* sp.and *Gyrodactylus* sp. infection. Negative results were obtained for KHV, SVCV infection. Similarly, the tested shrimp samples were negative for WSSV, EHP, YHV and AHPND.

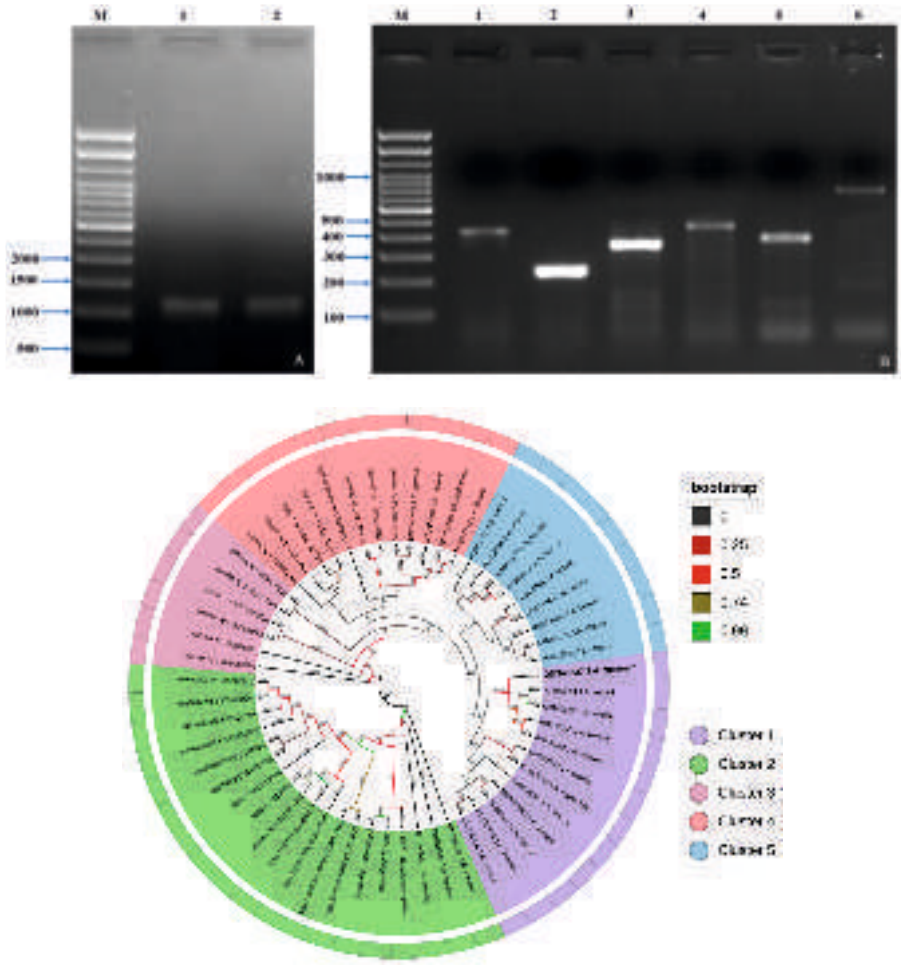


Diseased fish sample of *Labeo rohita* collected from East Medinipur, West Bengal, India, indicating a hemorrhage on the body surface (arrow in red color).

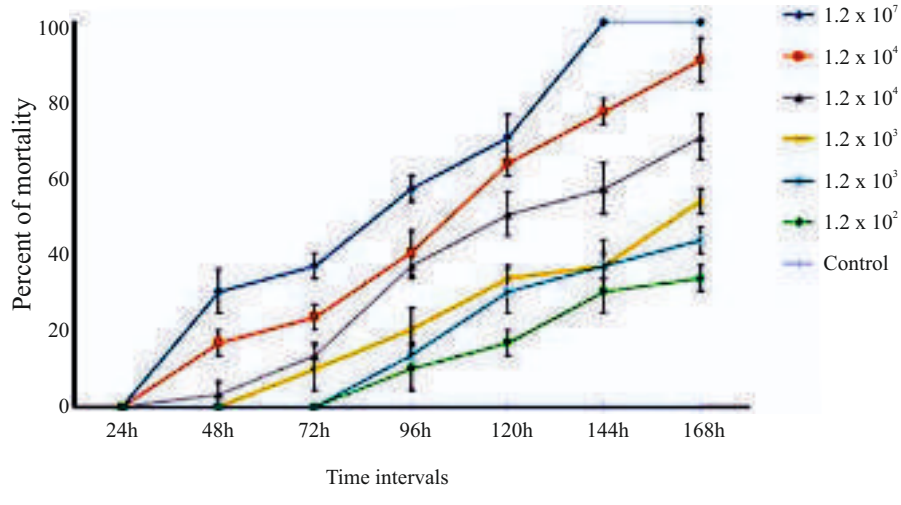
While, positive results for microbial pathogens like *Enterocytozoon hepatopenaei*, WSSV, *Morganella morganii* and *Shewanella algae* infection.

A case of severe mortality in farmed *Labeo rohita* was investigated to characterize the causative agent. We identified the bacterial strain as *Aeromonas veronii* isolated from of infected *L. rohita* by biochemical assay, scanning electron microscopy and 16S rRNA gene sequence analysis. The isolated strain was resistant to two antibiotics (ampicillin and dicloxacillin) while susceptible to 22 other antibiotics. The study further revealed that *A. veronii* induced both stresses along with non-specific and specific immune responses marked by elevated cortisol HSP70, HSP90 and IgM levels in the treated *L. rohita* fingerlings. Although the bacterial pathogen enhances the immune response, the negative effect on fish, including stress, and high mortality, create concern and a need for *A. veronii* management in *L. rohita* farms.

Intestinal parasites are among the most important infectious agents contributing to global morbidity and mortality. The composition and diversity of the gut microbiota were determined in the intestine of a fish, *Channa punctatas*, infected with nematode species, *Aporcella* sp., *Axonchium* sp., *Tylencholaimus mirabilis*, and *Dioctophyme renale*. A total of 12 bacterial strains across four major bacterial families were differentially abundant in nematode infected fish gut samples, including Enterobacteriaceae, Morganellaceae, Flavobacteriaceae, and Pseudomonadaceae. Infection with the nematode species had a significant effect on the gut microbial diversity and their virulence level. It was demonstrated that the gut bacterial microbiota is shaped by intestinal parasitic infection, with nematode infected fish more likely to be pathogenic, with increased



Molecular Identification of Bacteria



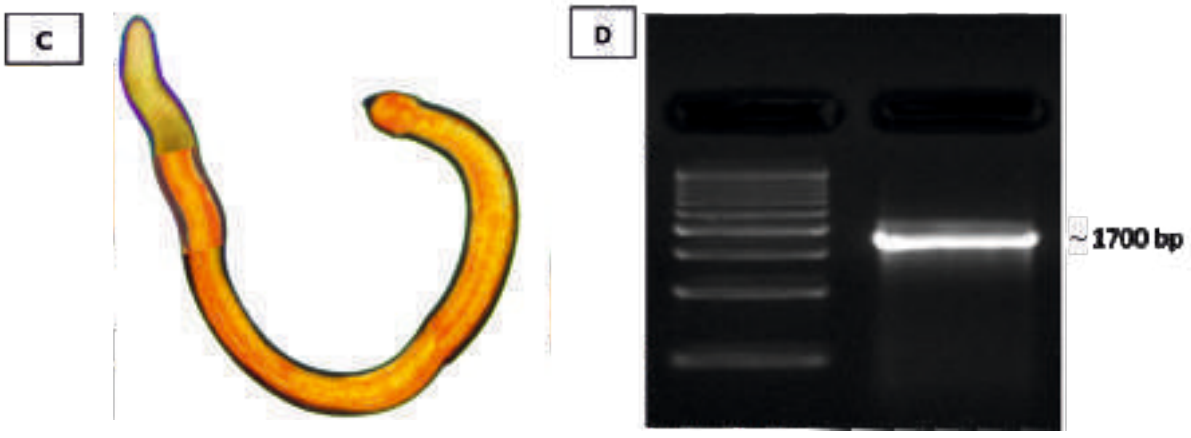
Cumulative mortality of challenged *L. rohita* fingerlings after intraperitoneal injection of pure culture of *A. veronii* at different concentrations



A) *Channa punctatus* collected from fish farm



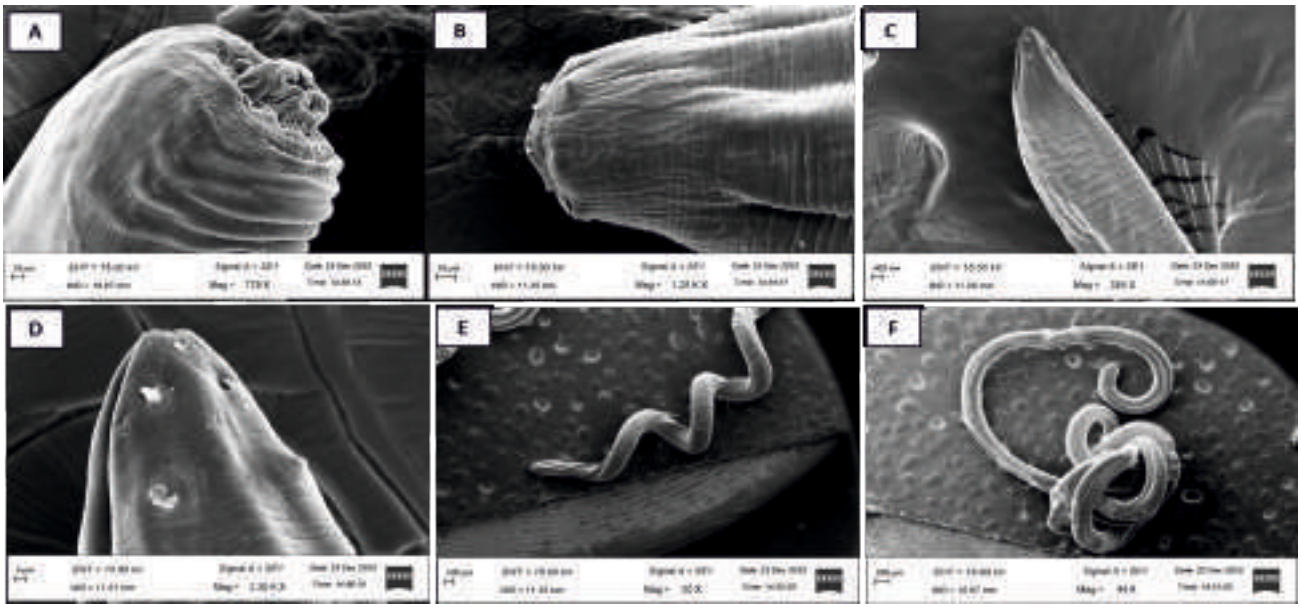
B) Presence of Nematode parasite in the abdominal cavity of fish



C) Microscopic observation of parasite

D) Molecular characterization of parasite through 18S rRNA gene analysis

Isolation and characterization of parasite from the gut of *Channa punctata*



A) *Aporcella* spp B) *Axonchium* spp. C&D) *Tylencholaimus mirabilis* E&F) *Dioctyphyme renale*

Scanning electron micrographs (SEM) of endoparasitic nematodes isolated from gut samples of *Channa punctata*

haemolytic activity, biofilm formation, causing high rates of fish mortality. In contrast, isolates recovered further from the non-infected *C. punctata* were observed to be non-pathogenic and have negligible haemolytic activity and biofilm formation. Antibiogram assays of the recovered isolates showed a relatively high rate of multidrug resistant or marginally resistant bacteria, suggesting parasitic infection induced stress modulates the gut microenvironments and enables possible colonisation by antibiotic resistant strains.

Project Title: Microbiome metatranscriptomics assessment of Indian River Basins for ecosystem health monitoring

Funding Agency: CABin, ICAR, New Delhi

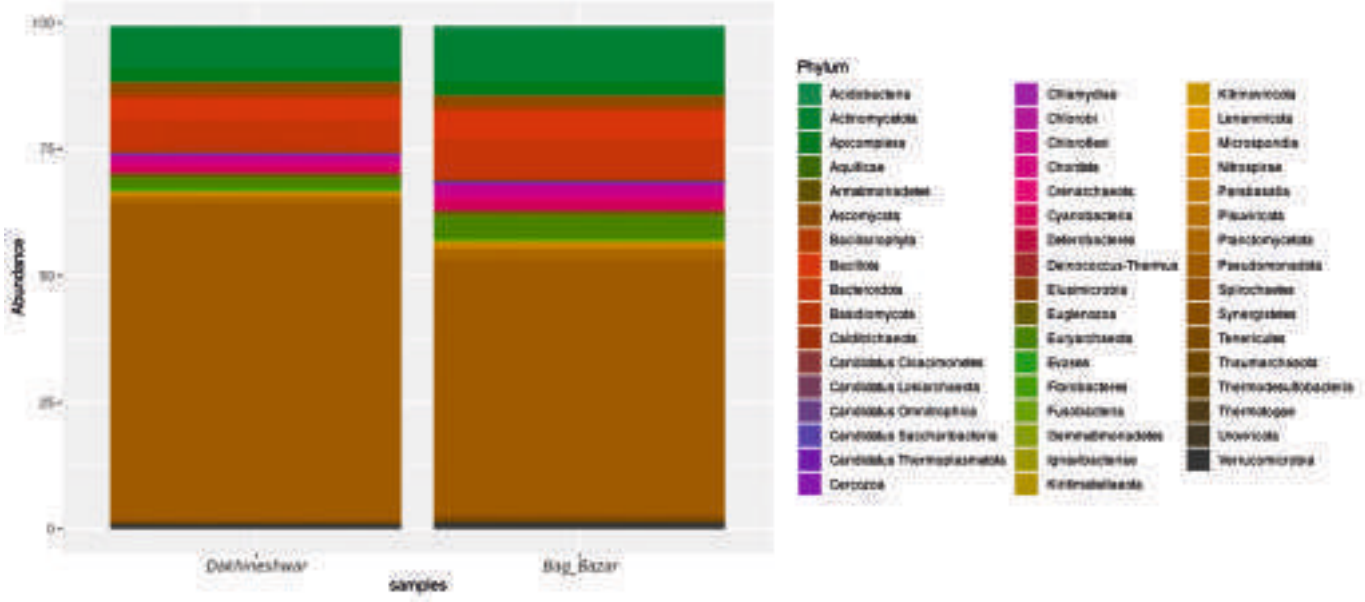
Duration: 2020 to 2025

Scientific Personnel: B. K. Das (Project leader), D. J. Sarkar, Suvra Roy, Vikash Kumar

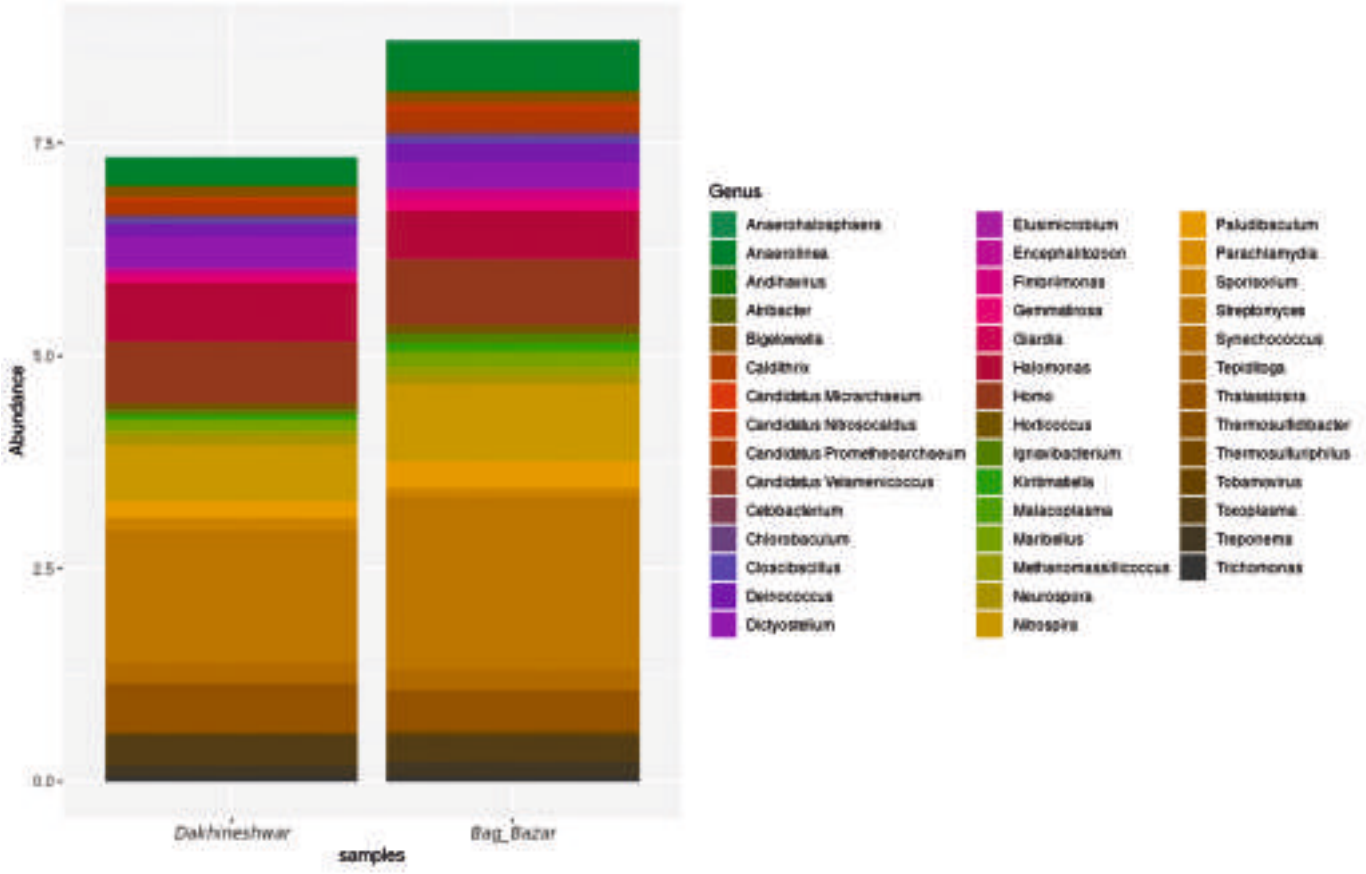
Summary

- The microbiome diversity of Ganga River sediment was evaluated from urban Kolkata sites using metatranscriptome analysis.
- Functional profiling of Ganga River sediment was done from urban Kolkata waste water discharge sites using metatranscriptome approach
- The analysis revealed a total of 18,381 unigenes; among these 9473 genes were down-regulated and 8823 genes were up-regulated and 393 DEGs in both obtained samples.

The river Ganga is recognized as the most important river system of India which originates in the Uttarakhand hills and flows to its delta in West Bengal. Rapid urbanization, uncontrolled discharge of untreated domestic sewage, industrial effluents, agricultural runoff and other anthropogenic activities have significantly impacted the water quality of the entire Ganga River basin influencing habitat characteristics of both micro/macro flora and fauna. Microbial communities play a crucial role in various biogeochemical processes and are essential for the sustenance of this river system. Assessing the microbial diversity and functional profiling of nutrient-rich sediments from polluted sites would help to understand the critical pathways and genes involved in pollution remediation and pollutant-degrading microbes that might be utilized in the future for developing management measures. Metatranscriptomics hold significant promise for elucidating the functional roles played by critical genes in disparate environmental contexts. Thus, to understand the impact of anthropogenic activities on the microbial communities of river Ganga, we aimed to determine the microbial diversity and functional profiling of the river sediment samples near urban Kolkata using meta-transcriptomics approaches.



Taxonomic abundance of microbial community (at phylum level) in the Ganga River at selected sites, Bag Bazar & Dakhineshwar



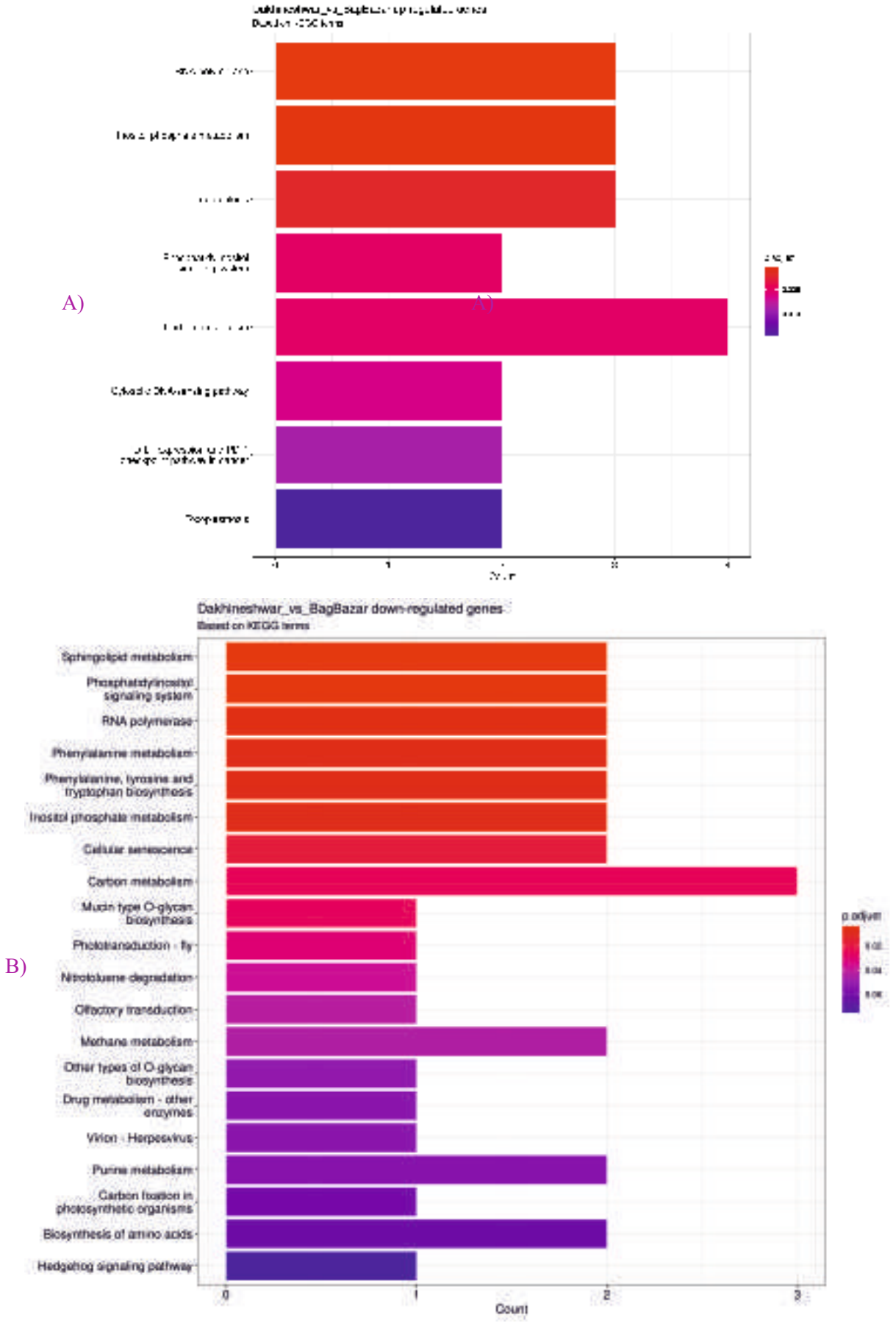
Taxonomic abundance of microbial community (at genus level) in the Ganga River at selected sites, Bag Bazar and Dakhineshwar

Taxonomic abundance of microbial community in the Ganga River sediment

High diversity of microbes found in the sediment microbiome at two investigated Ganga River sites *i.e.*, Bag Bazar and Dakhineshwar. Taxonomical classification showed that the occurrence of bacteria is higher than the other groups of microbes. According to that high presence order, *Pseudomonadota* (49.98%), *Actinomycetota* (10.13%), *Bacteroidota* (7.36%), *Bacillota* (5.47%), *Euryarchaeota* (4.33%), *Apicomplexa* (2.56%), and *Planctomycetota* (2.29%) were the top phyla at Bag bazar sampling site. At Dakhineshwar sampling site, the predominant phyla are *Pseudomonadota* (49.98%) followed by *Actinomycetota* (7.69%), *Bacteroidota* (5.69%), *Bacillota* (4.03%), *Apicomplexa* (2.86%), *Ascomycota* (2.12%), and *Euryarchaeota* (1.88%). According to the high presence order, top seven genera at Dakhineshwar site were *Methylomicrobium* (2.96%), *Streptomyces* (1.54%), *Homo* (0.72%), *Nitrospira* (0.65%), *Thalassiosira* (0.56%), *Dictyostelium* (0.35%), and *Toxoplasma* (0.34%). The most abundant genera at Bag Bazar were *Streptomyces* (2.03 %), *Methylomicrobium* (1.33 %), *Nitrospira* (0.90%), *Methanoregula* (0.79 %), *Homo* (0.76 %), *Anaerolinea* (0.53 %), and *Thalassiosira* (0.46%). The results suggest that there is a difference in the microbial communities found at the Bag Bazar and Dakhineshwar sampling sites. These differences in microbial communities may be due to a number of factors, including the different environmental conditions at two sampling sites. Since Bag Bazar is more urban environment, while Dakhineshwar is rural environment. The higher abundance of *Methylomicrobium* may help to reduce greenhouse gas emissions and higher abundance of *Nitrospira* may help to improve soil fertility. Moreover, some microorganisms may have implications for human health, such as *Streptomyces* that includes many species which produces antibiotics. So, this study provides a valuable contribution to our understanding of the sediment microbiome of the Ganga River.

Functional profiling of Ganga River sediment

Furthermore, de novo assembly was conducted for each sediment sample to determine the differentially expressed genes.The analysis revealed a total of 18,381 unigenes; among these 9473 genes were down-regulated and 8823 genes were up-regulated and 393 DEGs in both obtained samples. This shows that, the downregulated genes are more than upregulated genes in pollution-induced water ecosystems. Pathway enrichment analysis indicated high expression of transcripts associated with RNA polymerase, Inositol



Functional enrichment KEGG pathway analysis (A) up and (B) down regulated genes in the Ganga River at selected sites Dakhineswar vs Bagbazar

phosphate metabolism, carbon metabolism, and phosphatidylinositol signalling system. Inositol phosphate metabolism involved in eutrophication which is mainly visible in aquatic ecosystem. Hedgehog signaling pathways, biosynthesis of amino acids, and purine metabolism are involved in down regulated genes were revealed using KEGG analysis. This research highlights the vast potential of next-generation metatranscriptomic tools in enhancing our comprehension of the biologically active components of microbiomes and their associated pathways. Overall, meta-transcriptomic analysis of sediment samples from two sites of the Ganga River provides new insights into the functional aspects of pollution-induced river ecosystems.

Project Title : All India Network Project on Fish Health

Funding Agency: ICAR

Duration: 2015 to 2026

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

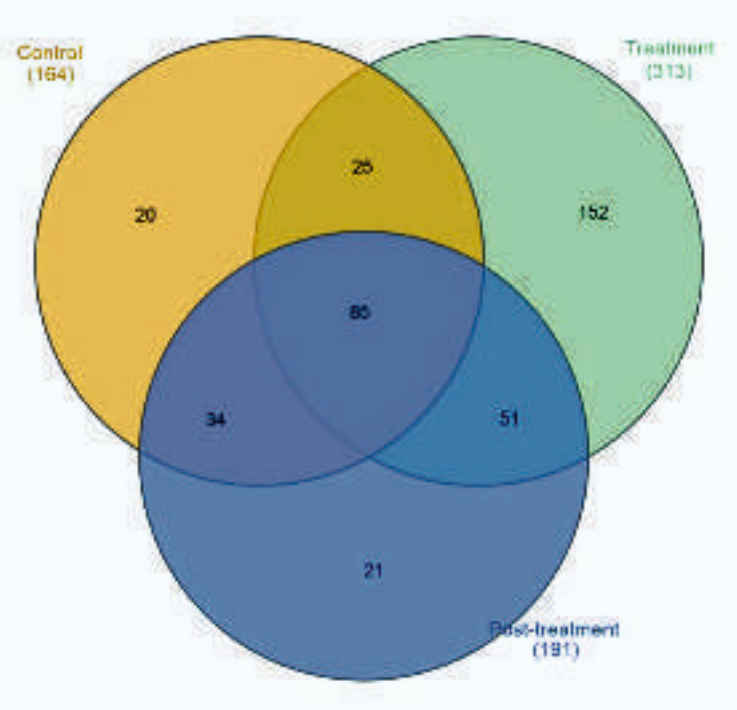
Summary

- The antibiotic florfenicol induces significant increase in bacteria diversity of gut of *Pangasianodon hypophthalmus*, which, however, partially recovered within 10 days of drug withdrawal. Relative abundance of Campilobacterota, Fusobacteriota, and Firmicutes reduced while that of Bacteroidota and Proteobacteria increased in antibiotic-treated fish.
- Following in-feed administration in recommended dose for 5 days the antibiotic oxolinic acid is rapidly cleared from *P. hypophthalmus* muscle, reaching concentration below MRL in 3 days suggesting required withdrawal period of 3 days in summer for consumer safety.
- Pharmacokinetics study of antibiotic enrofloxacin following bolus oral administration showed longmean residence time and half-life of the drug in blood which corroborated with prolong withdrawal period of the drug in *P. hypophthalmus*.

Gut microbiota profiling of florfenicol-treated *Pangasanodon hypophthalmus*

Florfenicol (FFL) is one of the approved and widely used antibiotic in aquaculture sector. Effect of in-feed florfenicol adminstration on gut microbiota of catfish *P. hypophthalmus* was investigated. Following 10 days of antibiotic adminstration @ 10 mg/kg fish /day and subsequent 10 days of withdrawal bacterial diversity of whole gut was studied by metagenomic approach and compared with sham control.

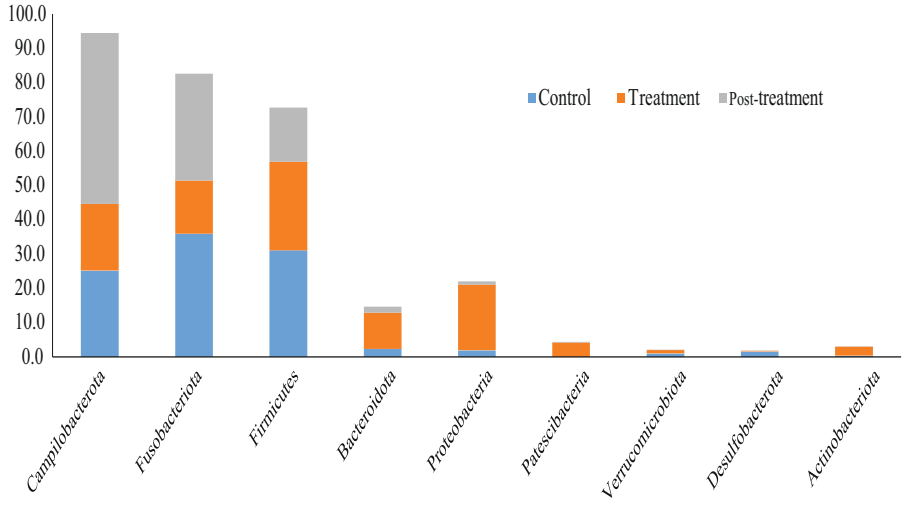
A total of 164, 313, and 191 OTUs were observed for the gut bacteria in control, treatment and post-treatment groups, respectively. Among the 668 total OTUs observed, 110 OTUs (16.46%) were shared between the



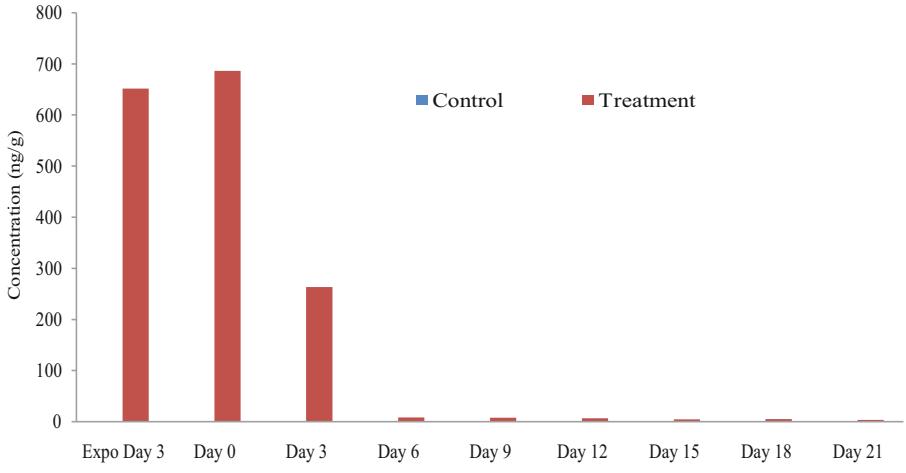
Venn diagram depicting shared and unique gut bacterial populations

control and treatment groups showing the group of FFL-resistant bacteria in the fish gut. Further, 119 OTUs (17.81%) were shared common between control and post-treatment, marking the recovery of the biota post-withdrawal of the antibiotic. A 20.35% of OTUs similarity was noted between treatment and post-treatment groups. Only 85 OTUs, comprising 12.72% of the total OTUs were found to be concurrent to all the three groups. There was a significant increase in alpha diversity in fish receiving the drug compared to that in control.

Three phyla, *viz*., Campilobacterota, Fusobacteriota, and Firmicutes accounted for 92.2% of the overall abundance in the gut of untreated fish. Relative abundance of Campilobacterota, Fusobacteriota, and Firmicutes reduced to 19.4%, 15.5%, and 25.8%, respectively, while Bacteroidota and Proteobacteria increased to 10.5% and 19.1%, respectively in FFL-treated fish. Relative abundance of Patescibacteria increased from zero in control to 4.2% in treated fish. After 10 days of drug removal, the relative abundance of Campilobacterota increased to 49.9%, Firmicutes declined to 15.8%, and Fusobacteriota, Bateroidata, and Proteobacteria decreased to match their respective levels in control.



Relative abundance (%) of gut microbial community at Phylum level. Only major groups are depicted.



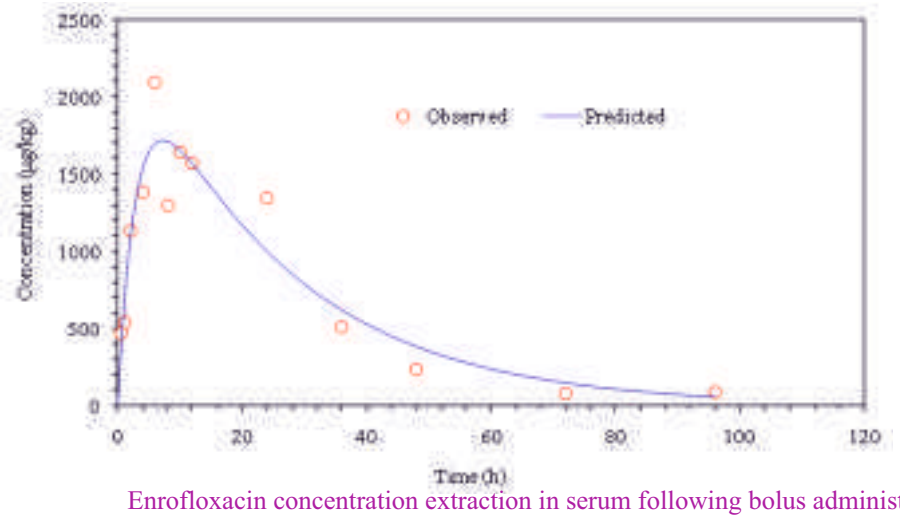
Depletion of oxolinic acid from Pangasius flesh

Withdrawal period of antibiotic oxolinic acid

Withdrawal period of approved and widely used aqua drug Oxolinic acid (OA) was studied in catfish *Pangasianodon hypophthalmus*, a finfish with huge aquaculture significance, for human health safety. Acclimatized fish were in-feed administered at therapeutic dose of 12mg/kg body weight for 5 days and the drug residue in fish flesh and liver were monitored in LC-MS/MS for another 21 days. Results showed that residue level of OA gradually declined upto 3 days and 6 days of withdrawal in muscle and liver respectively. After 3 days residue concentration sharply fell from 263.1 µg/kg to 7.74±0.52 µg/kg in muscle, quite lower than the MRL value. Thus, the data suggests that OA shows fast depletion from muscle. However, considering high amounts of hepatic accumulation 6 days of withdrawal is recommended for consumer safety.

Study of pharmacokinetics of antibiotic enrofloxacin in *Pangasianodon hypophthalmus*

Enrofloxacin is one of the widely used antibiotic in aquaculture. Our previous study showed very long withdrawal period of the drug in fish flesh, casting doubt of its use in food fish. Here, pharmacokinetics of enrofloxacin was studied in aquaculturally important catfish *P. hypophthalmus*. Following single bolus administration of the antibiotic @ 10 mg/kg fish the drug concentrations in blood were measured at various time points by LC-MS/MS. Results showed a high drug concentration (C_{max}=1720.05 mg/kg) in blood but Mean Residence Time (MRT) of 28.02 h and half-life ($t_{1/2k10}$) of 17.32 h from blood which corroborated with long withdrawal



Enrofloxacin concentration extraction in serum following bolus administration

period of the drug. Due to long persistence of the drug in fish tissue, the study suggested strictly-monitored use of enrofloxacin in Pangasius towards assuring consumer safety.

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

Funding Agency: ICAR-NASF

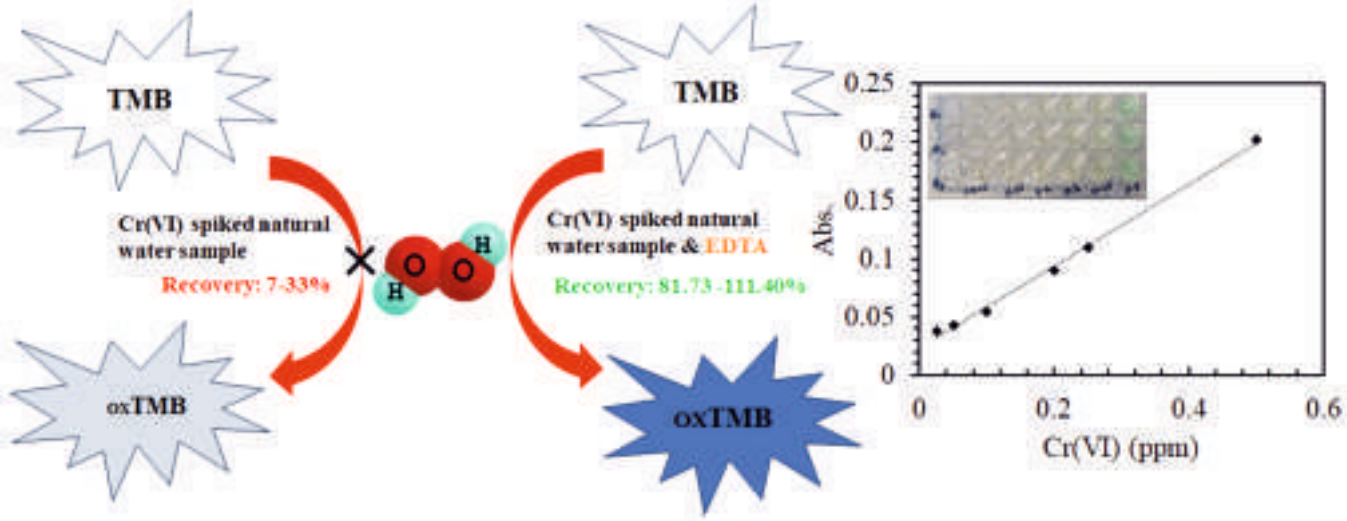
Duration: 2020 to 2024

Scientific Personnel: D. J. Sarkar (PI), B. K. Das

Summary

- A prototype device for colorimetric detection of Cr (VI) in natural water was developed with a modification of using EDTA.
- Under the optimized conditions, the method obtained a good linear response over the range of 0.025-0.5 ppm range (correlation coefficient r = 0.9952). The LOD and LOQ are found to be 0.023 ppm and 0.071 ppm, respectively.

The colorimetric detection of Cr(VI) in natural water based on its peroxidase mimicking activity was found with some limitation. This technique was found to be inadequate in detecting Cr(VI) in natural water samples evident from low recoveries (7 to 33%) in the spiked water samples (0.1 to 0.5 ppm). Hence, the present study deliberates the use of EDTA in the Cr(VI) detection protocol and found that its use leads to increase in average recoveries of Cr(VI) at different fortification levels (0.1 to 0.5 ppm) from 81.73 to 111.40%. Under the optimized conditions, the method obtained good linear response over the range of 0.025-0.5 ppm range (correlation coefficient r = 0.9952) of Cr(VI) concentration. The LOD and LOQ



Colorimetric estimation of Cr (VI) using TMB and H_2O_2

Table: Recovery analysis of Cr(VI) in Ganga river water

Parameters	Spiked Cr(VI) (ppm)	Detected by proposed method (ppm)	Recovery (%)	RSD (%)
Without EDTA (1%)	0.10	0.034±0.000	33.95	4.70
	0.25	0.067±0.055	26.89	82.09
	0.50	0.049±0.019	9.83	38.64
With EDTA (1%)	0.10	0.094±0.002	93.87	3.04
	0.25	0.263 ±0.023	105.25	9.03
	0.50	0.557 ±0.014	111.40	2.53

are found to be 0.023 ppm and 0.071 ppm, respectively. Furthermore, a total of 14 water samples, collected from different natural water bodies, were analysed using the present technique and compared with data analysed through ICP-MS. It was found that the Cr(VI) concentrations in the target natural water samples were below the LOQ level of the present detection method. Based on water sample data, the developed colorimetric sensor showed potential for effective environmental monitoring.

Project Title: Captive Breeding of Hilsa, *Tenualosa ilisha* (Phase II)

Funding Agency: National Agricultural Science Fund (NASF)

Duration: 2021 to 2024

Scientific Personnel: S. Samanta (Consotium P.I.), R. K. Manna, A. K. Sahoo, Suvra Roy

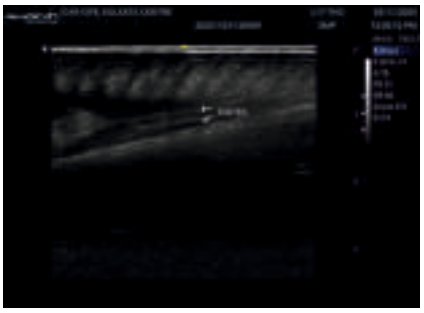
Summary

- Hilsa fry of (5.72 ± 0.12 g and 7.28 ± 0.35 cm) were stocked in ponds at Kolaghat during 2022. Fishes were fed with Hilsa^{Plus}, groundnut oil cake and mustard oil cake. To maintain proper plankton growth, Plankton^{Plus} applied at a regular interval of 15 days. In addition, organic juice (mixture of mustard oil cake and groundnut oil cake along with yeast and molasses) was also used fortnightly as plankton booster. After 19.6 months of rearing, the fishes were of 395.14 ± 31.4 g / 31.8±1.06 cm.
- An anaesthetic agent based on MS-222 has been developed by the partner Institute ICAR-CIFE and was successfully utilized during handling procedures at Kolaghat.
- Artificial breeding of hilsa conducted on-boat using wild collected broodstock at Godakhali in Hooghly estuary, West Bengal through dry stripping.
- Assessed the possibility of imaging hilsa gonad through ultrasonography by the partner Institute ICAR-CIFE. The GSI and the stage of ovary and testis has been determined with the fishes grown at Kolaghat.

At Kolaghat, hilsa fingerlings of 8.21 ± 1.73 g / 8.85 ± 1.50 cm were released in pond in July, 2021 with stocking density of 2000 numbers/ha. After 30 months of rearing, the fishes were in the size of 525.0 ± 18.61 g / 35.2 ± 0.43 cm. In 2022, hilsa fry (5.72 ± 0.12 g and 7.28 ± 0.35 cm) were stocked. After 19.6 months of rearing, the fishes were of 395.14 ± 31.4 g / 31.8±1.06 cm. Fishes were fed with Hilsa^{Plus}, groundnut oil cake and mustard oil cake. To maintain proper plankton growth, Plankton^{Plus} applied at a regular interval of 15 days. In addition, organic juice (mixture of mustard oil cake and groundnut oil cake along with yeast and molasses) was also used fortnightly as plankton booster. To maintain sufficient zooplankton density (about 1000 nos./l) in ponds, need-based supplementation of zooplankton was performed.

Circular cage designed at ICAR-CIFRI having 16 m diameter installed above Farakka Barrage during March-April, 2022. 181 individuals of hilsa juveniles (27-206 g; 14.4-27.6 cm) were released to check survival and growth. Due to influx of floating macrophytes and garbage from upstream of the river, particularly during monsoon, the activity was discontinued and a fresh initiative has been taken to restock the cages.

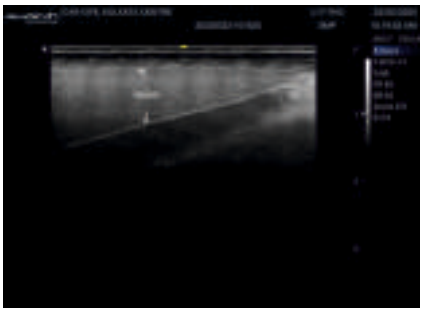
The gonad histology study of fish collected from ponds at Kolaghat during May 2023 (22.4 months age) indicated that the oocytes reached to the average size of 607 µm. Males attained maturity at 14 months of age.



A: USG image of captive reared hilsa testes



B: Captive reared hilsa ovary (Wt: 72 g & Lth: 13-15 cm)



C: USG image of captive reared hilsa ovary



Monitoring of gonadal maturation by USG



Review meeting of Advisory members of NASF Hilsa Phase II

An anaesthetic agent based on MS-222 has been developed by the partner Institute ICAR-CIFE. During the handling procedures, the anaesthetic agent was successfully utilized at Kolaghat.

Attempted assessing the possibility of imaging gonad in hilsa through ultrasonography by the partner Institute ICAR-CIFE. The GSI and the stage of ovary and testis has been determined with the fishes grown at Kolaghat.

In the month of February and March, 2023, artificial breeding of hilsa conducted on-boat using wild collected broodstock at Godakhali in Hooghly estuary, South 24 Parganas (22°39′N, 88°14′E), West Bengal through dry stripping.

The project output at Kolaghat was reviewed on 26.12.2023 and that of the entire project on 28.12.2023 by the Advisory Committee Chairman Dr. K. K. Vass and members.

Project Title : Environmental & aquatic animal health monitoring in Hirakud Reservoir under cage culture programme

Funding Agency: Directorate of Fisheries, Govt. of Odisha

Duration: 2021 to 2026

Scientific Personnel: B. K. Das (PI), S. K. Koushlesh, C. Johnson

Summary

- "Environmental & Aquatic Animal Health Monitoring Laboratory" was established at Sambalpur.
- The study revealed favorable water and sediment quality for ichthyofaunal communities. The reservoir exhibited moderate productivity, with nutrient concentrations indicating transitions between medium and high productivity phases.
- The annual potential fish yield was estimated to be over 70 kg/ha, with variations

Summary

attributed to depth measurements. Catch Per Unit Effort (CPUE) varied across fishing methods and seasons, with dominant fish catch groups. Carps constituted a significant portion of the catch, with a slight increase observed compared to previous years.

- Overall, the study highlights the reservoir's potential for enhanced fish production and the importance of monitoring ecological and health parameters to sustainably manage fisheries resources.
- The study also uncovered the emergence of Parvovirus infection for the first time in the reservoir, along with various bacterial infections affecting the fish fauna. The presence of Parvovirus infection suggests the introduction of a new pathogen into the reservoir ecosystem, which could have serious implications for fish health and overall ecosystem stability.

Hirakud Reservoir plays a strategic role in the economic and social structure in Eastern India and offers to mitigate food, nutritional and livelihood security in Odisha. Odisha has 138 reservoirs with a water spread of nearly 1.4 lakh hectares, which are underutilized from a fish production perspective. Therefore, it could be used for optimal fish production by adopting advanced fisheries enhancement protocols including cage culture and pen culture. The Directorate of Fisheries, Odisha is leasing out cage culture sub-zones to private entrepreneurs in Hirakud Reservoir through the expression of interest (EoI) process. To evaluate potential impact of these cage culture operations on Hirakud Reservoir's ecology and to monitor the health of the fish fauna in the fish production units to devise a management plan, the Directorate of Fisheries, Govt. of Odisha has entrusted ICAR-CIFRI, Barrackpore to establish and operate "Environmental & Aquatic Animal Health Monitoring Laboratory at Sambalpur under project entitled "Environment and aquatic animal health monitoring in Hirakud Reservoir under cage culture programme".

To carry out the project activities ICAR-CIFRI Barrackpore with support from the Fisheries Department, Odisha has established "Environmental & Aquatic Animal Health Monitoring Laboratory" at Sambalpur and recruited two Scientific Personnel (Skilled Technical Officer-01 post; Technical Assistant-01 post) and one Field Assistant at the facility. The building facility consisting of two rooms has been allocated by the Department of the Fisheries, Odisha at DDF office in Sambalpur District. The seasonal sampling was carried out during 2023 at eleven sites and three designated cage culture zones (zone 1, zone 2 and zone 3) in Hirakud reservoir to study the water and sediment quality, ichthyofaunal communities, surveillance for fish disease in cage reared fish and fishes in the reservoir.

Reservoir environment and productivity estimates and Fisheries

The analysis of water samples indicated congenial environment for



Parvovirus infected Tilapia samples collected from cage farms and wild fish of Hirakud Reservoir

ichthyo-faunal communities with moderate Dissolved Oxygen levels (range 5.2 to 8.2 mg/l ; mean 6.7±0.6 mg/l); moderate to high total alkalinity (range 48 to 140 mg/l; mean 88±23.02 mg/l), pH near neutral to slightly alkaline (range 6.3 to 8.8;mean 7.4±0.7), moderate specific conductivity (mean 201.7±86.2 µS/cm) and warmer mean annual water temperature (range 26.4 to 32.5 °C; mean 28.9 ± 1.67°C). The Secchi depth varied from 10 to 259 cm with mean at 109.3 ± 75.4, The depth of water column sampled ranged between 2.3 to 16.5 m with mean depth at 7.61 ±3.52 m. The primary productivity estimates for Hirakud Reservoir indicated moderate productivity (GPP range; 77.08 to 133.2 mgC/m^3/hr; mean GPP 99.81±23.7 mgC/m^3/hr; mean NPP 38.47 mgC/m^3/hr). The NPP was noted relatively lower in monsoon than pre monsoon and post monsoon (34.97 vs 43.75 & 43.89 mgC/m^3/hr respectively).

The zone wise analysis of nutrient concentration of the reservoir water revealed that available Nitrogen concentration varied from 0.011±0.005mg/l during post monsoon to 0.051±0.081 mg/l during pre-monsoon in lentic zone while the mean available phosphate concentration varied between 0.006±0.002 during monsoon in intermediate zone to 0.197±0.032 mg/l during pre-monsoon in lotic zone. These results indicate occurrence of dynamic transition among medium and high productive phases in the reservoir zones.

The mean Nitrate-N and Phosphate-P concentration was 0.216±0.029 and 0.104±0.077 respectively, thus indicating overall medium productive nature of the reservoir. However, the spatio-temporal variation in Nitrate-N and Phosphate-P concentration within the study sites in the reservoir water varied between 0.005 to 0.216 mg/l and 0.002 to 0.246 mg/l respectively indicating occurrence of seasonal phases of





Interacting with fisher group operating seine net in Hirakud Reservoir

short-time high productivity at some sites. The trophic state index showed that the reservoir varied from oligotrophic to mesotrophic state. The annual potential fish yield based on MEI (Sugunan, 2002) was found to be more than 70 kg/ha which was found to be in proximity with the previous estimate (72.04 kg/ha in year 2021; 76 kg/ha in 2022). The primary reason for the slight variation in the estimates were variation in the depth measurements recorded during the study period.

The Catch Per Unit Effort (CPUE) varied from 1.5 to 28.4 kg/day per fisher for gill net fishing, and it was between 90 and 200 kg/day for drag nets. In the flowing part of the reservoir, especially during monsoon season hooks and lines were used with observed CPUE that fluctuated between 0.15 and 0.45 kg/hr. The dominant fish catch groups include carps, catfish, clupeids, barbs and minnows, featherbacks, freshwater eels and perches. Carps, catfishes, and clupeids made up approximately 75 % of the fish caught, whereas carps, including Indian Major Carps (IMC), accounted for about 38.4% of the fish catch in the Hirakud Reservoir. A slight increase in the carp while a slight decline in the catfish landing was recorded than previous years however the interannual variation of these fishes was also noted in previous studies in many peninsular reservoirs. There were no changes in the cumulative fish diversity recorded from commercial catches in the Hirakud Reservoir, which comprised a total of 68 fish species from 18 families and 8 orders, which is significantly more than the 54 species reported in earlier studies. The indigenous species

included carps, catfishes, freshwater eels, among others. Exotic species recorded from the reservoir included *Oreochromis niloticus, Clarias gariepinus*, *Pangasianodon hypophthalmus*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Cyprinus carpio*, and *Pterygoplichthys disjunctivus*.

Disease surveillance under cage culture programme

During 2023, a case of severe mortality was observed in Tilapia (*Oreochromis niloticus*) The investigation was conducted in cages (Zone 3) of Hirakud Reservoir, causing high mortality (> 70%) of Tilapia (*Oreochromis niloticus*) in September 2023. A total of 190 fish tissue samples (gill, liver, kidney, spleen) were collected from healthy and infected Tilapia for DNA extraction. Molecular analysis confirmed that TiPV can infect and cause morality in different age group tilapia. The collected tissue samples were subjected to PCR amplification using the universal primer. Subsequent sequencing was performed to confirm the presence of the virus in the sampled fish. The expected PCR products at 534bp demonstrated positive results for Tilapia Parvovirus. Tilapia Parvovirus (TiPV) is a newly identified virus that affects tilapia species, causing high mortality rates and economic losses. Interestingly, the TiPV can infect and cause morality in different age group tilapia. PCR analysis confirmed the presence of TiPV in the spleen, which appeared to be good for TiPV screening of sampled tilapia populations, indicating a significant threat to tilapia aquaculture in the region. The negative effect on fish, including stress, and high mortality, create concern and a need for Tilapia Parvovirus (TiPV) management in cages.



A fisher group operating seine net in Hirakud Reservoir



Interaction with gill net fishers of Hirakud Reservoir



Sample collection from Hirakud Reservoir

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 Window-3

Duration: 2019 to 2023

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

Summary

- Pen culture trials were undertaken at Chamta wetland with IMCs, grass carp and SIFs *Labeo bata* and *Systomus sarana* achieving significant economic feasibility with a B:C ratio of 1.92
- Monoculture of *Systomus sarana* in pens at Chamta and Sindrani wetlands demonstrated potential of pen culture integration for successful production and conservation of this valuable small-indigenous-fish species.
- Drone-based macrophyte assessment and community-based management led to significant reduction in macrophyte coverage promoting ecosystem resilience.
- A collaborative workshop between ICAR and WorldFish in Egypt discussed project achievements and outlined future research plans for sustainable small-scale fisheries in wetlands, focusing on livelihood and nutritional security.

Pen culture of major and minor carps for production enhancement

Stakeholder-driven implementation of pen culture was taken up for raising of fish seed for culture-based fisheries at Chamta wetland, through polyculture of Indian major carps *Labeo catla, Labeo rohita* and *Cirrhinus mrigala* with small indigenous fishes *Labeo bata, Systomus sarana* and grass carp, *Ctenopharyngodon idella* in co-management mode. In the first polyculture trial IMCs and minor carps were cultured in 4 HDPE pens (0.1 ha each) at a stocking density of 25 Nos. m^{-3} in equal numbers for 90 days. In the second polyculture trial IMCs were cultured with grass carp at a density of 25 Nos. m^{-3} in 4 HDPE pens in the ratio of 1:1:1:2 for 90 days. The same set of pens was utilized for both trials during different times of the year. Net yield of 682.3 and 413.9 kg per pen was achieved through polyculture of IMCs and SIFs and polyculture and for IMC and grass carp, respectively. The survival percentage varied with species and culture period with overall survival of 77 to 85% (IMCs + grass carp). Considering both crops, the polyculture was economically feasible with a BC ratio 1.92. All the seeds produced in the pens were released to the wetland as input for culture-based fisheries. The study indicated the potential of grass carp fishery in macrophyte-infested wetland. The species could attain 1.5-2 kg in 6 months and up to 3-3.5 kg weight within 1 year, utilizing macrophyte resources of the wetland. SIFs *S. sarana* and *L. bata* were observed to attain maturity in wetlands. The integration of pen culture into CBF can enhance production and promote sustainable fisheries in these floodplain wetlands. Enhancing species diversity and production will contribute towards ecosystem resilience and reduce vulnerability in the climate change scenario. Further use of macrophyte utilising species like grass carp can serve the dual purpose of enhancing fish production and macrophyte management in the wetlands.



Stocking of fish in pen at Chamta wetland

Pen culture for production enhancement and conservation of SIF *Systomus Sarana*

Systomous sarana, known locally as "Sarputi" in West Bengal, India, is a popular high-valued small-indigenous-fish (SIF). Over the years, the natural stock of *S. sarana* has reduced due to habitat perturbations and overexploitation, making it a vulnerable species in India. It is a highly preferred SIF in India's eastern and northeastern states, fetching up to 300-400 INR/kg. To promote and conserve the species, monoculture of *S. sarana* was taken up in pens at Chamta and Sindrani wetland in West Bengal. The fish (8.68 g) was stocked in 0.1ha pen units in triplicates at the rate of 10 Nos. m^{-3} in triplicates. The fish were fed with pelleted feed twice a day at the rate of 5% of body weight in two equal installments for a period of 90 days. The fish reached harvest size of 80.08 and 88.12 g with a net yield of 640 kg/pen and 748 kg/pen in 90 days with a survival rate of 80 and 84% in Sindrani and Chamta wetland, respectively. The fish matured in the pens and were simultaneously released into the wetland to promote its natural recruitment. SIFs are an integral part of the wetland fisheries. Although low yielding, these species fetch high prices in the local markets and contribute to fisher family's household nutrition requirements. The production of SIFs in wetlands in pens or through stocking will aid in their production enhancement and conservation, especially in closed wetlands, where their natural stocks have depleted owing to the loss of connection with the parent river.



Harvesting of *S. sarana* from pens at Chamta wetland



Growth monitoring of *S. sarana* reared in pen

Community based macrophyte management

Drone based survey was conducted to assess macrophyte infestation in Beledanga wetland RGB sensors were used for macrophyte/vegetation coverage area and algal bloom area estimation. Multispectral sensors were used for detection of spectral profile of macrophyte species, algal bloom identification and water quality estimation. Macrophyte coverage was more than 50%. Macrophyte clearance was done manually in the wetland through community participation (270-man days) with a focus on *Eichhornia* management. After the manual removal, the macrophyte area reduced to 26.67%.

"Ecopath" mass balanced model of Beledanga Wetland

Ecopath analysis in Beledanga wetland was carried out to study the food web structure for a better understanding of the ecosystem functioning of the wetland, to evaluate optimum grass carp biomass to control the macrophyte population through different scenarios and for impact assessment of *Eichhornia* in the ecological organization of this wetland ecosystem. The functional groups included one group for birds, six fish groups (Murrels, Major carps, Grass carp, Exotic carps, Carnivore fishes, Omnivore fishes, and Planktivore fishes); Benthos, Zooplankton, *Eichhornia*, Other macrophytes, Phytoplankton and the Detritus. These functional groups were categorized according to their catch availability and diet information. The basic inputs for functional groups are biomass, Production/Biomass ratios (P/B) estimations, Consumption/biomass



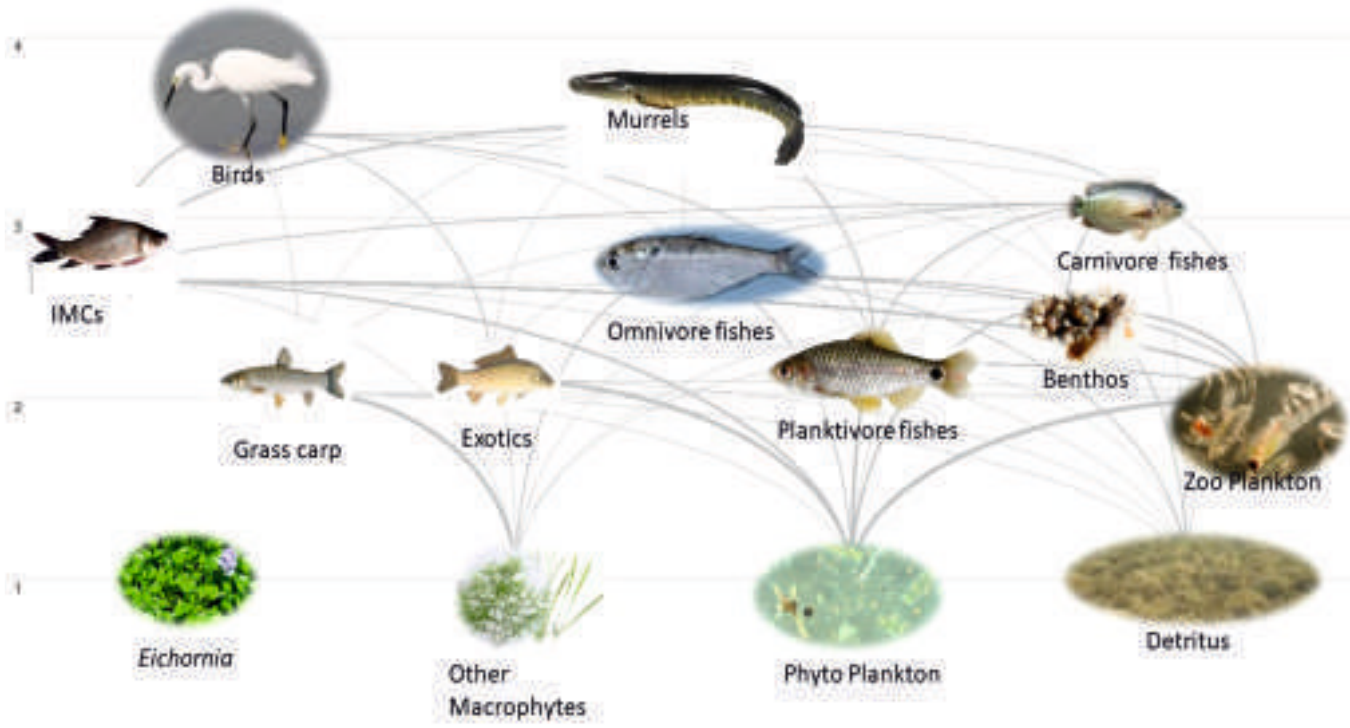
Drone based assessment of macrophyte coverage

(Q/B) and diet matrix. According to the EE value groups like aquatic birds and the Eichornia macrophytes were the least utilised, whereas the primary consumers, benthos and zooplankton were the most utilised groups of the system having the EE values of 0.8 and 0.79, respectively. The two most utilised ecological groups benthos and zoo plankton placed at 2.5 and 2, respectively. Based on the diet preference of functional groups, the highest preference or electivity index (0.999) was achieved by zooplankton towards the phytoplankton; also, the zooplankton was one of the most preferred foods for major carps, grass carp, exotic carps, omnivore, planktivore and benthos group. Whereas *Eichhornia* was found to be the most avoided functional group of the ecosystem as the electivity index value was -1 for all groups. Considering to 10% overlap, about 18 groups were found that fall in this category. In particular, the omnivore and planktivore were found to be the most niche-sharing functional groups with 6 numbers of pairs each. The system is found to be immature or a developing system, as its total primary production per total respiration (TPP/TR) value is 10.845. The system shows a low cycling index (Finn's cycling) of 0.224% of total throughput with Finn's mean path length of 2.082. The amount of throughput cycled excluding detritus and including detritus was 38.64 and



Beledanga wetland fishers removing *Eichhornia* sp.

142.3 $t(km^2)^{-1}yr^{-1}$, respectively. The bird group was found to be the keystone species. Owing to grass carp stocking for controlling the macrophyte infestation of this wetland, the virtual mass-balanced model was created to know optimum grass carp stocking required for sustainable production. Considering its average growth of 1.8 kg in a year in natural water bodies like wetlands with survivability of 40% (calculated from other than fishing mortality from Ecopath), the required number of fish seeds is 62,000 nos. of fingerling per sqkm of > 80 mm size. Besides, the generated information also narrates the negative impact of the invasive *Eichhornia* population on the ecology and ecological process of the wetland. These macrophytes contribute more towards detritus inflow, which is negatively affecting the system maturity as well as the cycling process of the matter in the wetland. This Ecopath based wetland management strategy would be an



Ecopath module based food web of Beledanga wetland

example of sustainable fish production through a cleaner approach without adding any external food to the system rather than utilizing the natural resources of the system in maximizing the production.

Project Title: Assessment of Endocrine Disruption in Fish Reproduction

Funding Agency: Department of Biotechnology (DBT), Ministry of Science and Technology, Govt. of India

Duration: 2019 to 2023

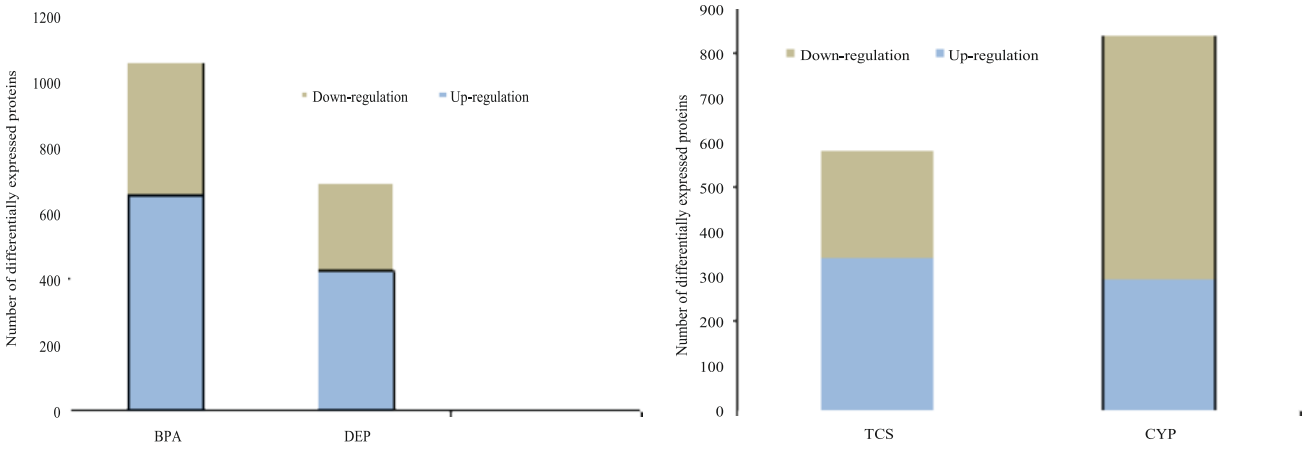
Scientific Personnel: B. K. Das, Principal Investigator (PI), S. K. Nag, Kavita Kumari

Summary

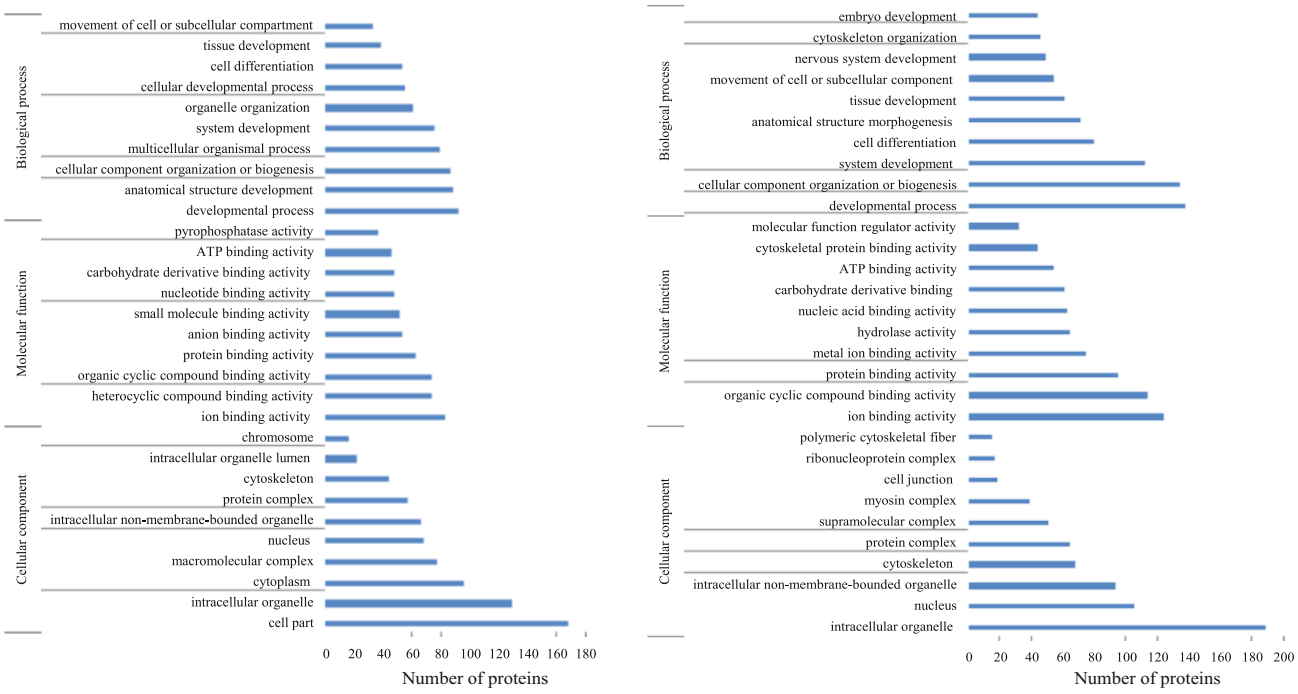
- Comparative LC-MS/MS based proteomic studies after chronic exposure to sub-lethal dose of Lc_{50} of Bisphenol-A (BPA), Diethyl phthalate (DEP), Triclosan (TCS) and Cypermethrin (CYP) to Catla revealed dyanamic changes in protein level in response to low dose of toxic exposure.
- Screening of BPA concentrations (ng/L) in surface water collected from different sampling sites across river Ganga.

Exposure to sub-lethal ($1/10^{th}$) doses of LC_{50} of the endocrine disruptors - BPA, DEP, TCS and CYP

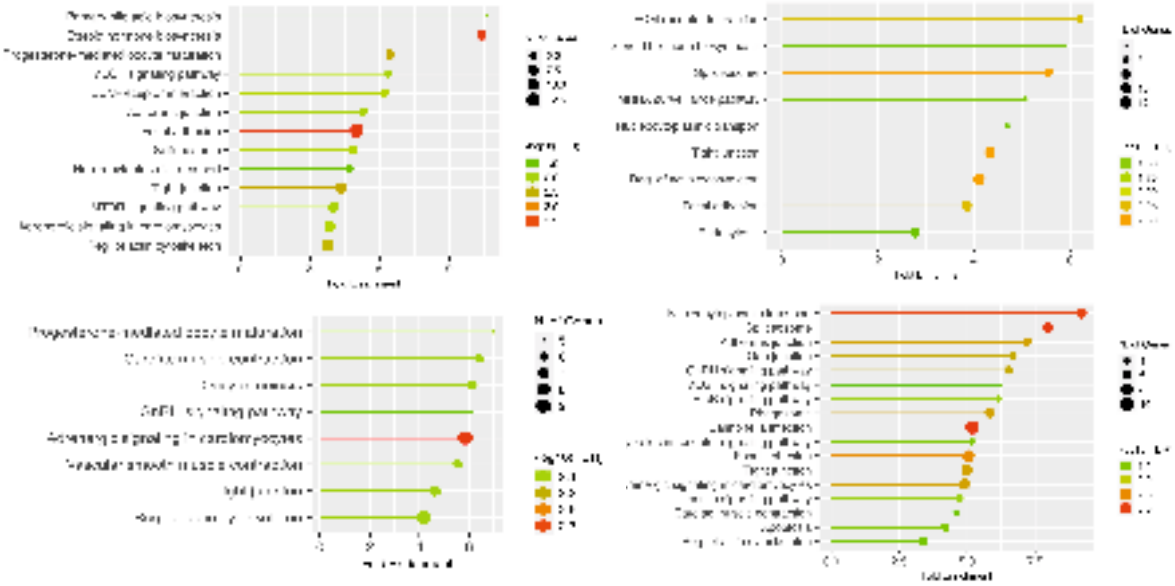
The chronic exposure of the EDCs elicited changes at protein levels in the teleost, Catla as revealed by proteomics studies by LC/MS-MS. Gene ontology (GO) analysis showed that the proteins involved in developmental processes, development of anatomical structures and cellular component organization comprised the top three GO terms in biological processes following exposure to TCS. Analyses of molecular function revealed proteins to be involved in binding to ions, heterocyclic compounds and organic cyclic compounds and cell part, intracellular organelle and cytoplasm were the top three GO terms in the cellular component category in carps exposed to TCS. Likewise, proteins involved in developmental processes, cellular



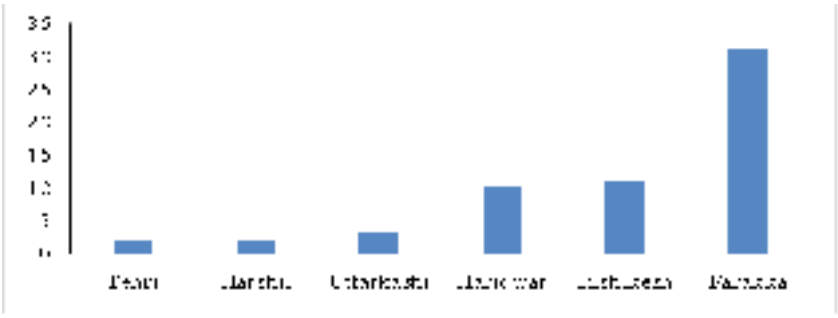
Upregulated and downregulated proteins on exposure to BPA, DEP, TCS and CYP



Gene ontology (GO) of proteins identified on TCS and CYP exposure, respectively



Pathway enrichment analysis by BPA, DEP, TCS and CYP



Concentration of BPA (ng/L) in surface water collected from sampling sites across River Ganges.

component organization and system development comprised the top three GO terms in biological processes following exposure to CYP. Analyses of molecular function revealed proteins to be involved in binding to ions, organic cyclic compounds, protein binding. Considering the cellular component category, the top three GO terms were intracellular organelle, nucleus and intracellular non-membrane bound organelle in carps exposed to CYP.

Pathway enrichment analyses depicted primary bile acid biosynthesis and steroid hormone biosynthesis to be the most enriched pathways after exposure to BPA, nucleocytoplasmic transport and spliceosome by DEP, progesterone-mediated oocyte maturation and cardiac muscle contraction by TCS and ECM-receptor interaction and steroid hormone biosynthesis by CYP. GO ontology in terms of biological processes, molecular function and cellular component of the identified proteins revealed proteins to be involved in essential physiological processes within the cell.

Screening of BPA concentration

As per the suggestions of the members of the TEC meeting held on 20th-21st July.'2022, checking the BPA levels in the aquatic environment would help to understand if they are present in dangerous levels in water. In this context, the concentration of BPA (ng/L) in surface water collected from sampling sites across river Ganga.

Project Title: Empowering women of wetland-dependent fisherfolk community of lower Gangetic plain through cost-effective technologies

Funding Agency: DBT

Duration: 2020 to 2023

Scientific Personnel: Aparna Roy, Arun Pandit, Asit Bera

Summary

- Limited resource and lack of prior exposure were found to be two major constraints. The production from the kitchen gardening and mushroom cultivation were just sufficient for consumption within the household which ensured nutritional security of the household but did not left much excess that could be sold. However, with the backyard poultry farming supplementary income could be generated by selling both eggs and mature poultry birds. After household consumption, surplus eggs and meat could be sold at local markets, earning the women farmers an income thereby generating an alternate source of livelihood and a sense of entrepreneurship among them.

A comprehensive system is required for successful developmental programme. As per the classical "extension method" first step to any developmental programme or introducing any innovation is to create an awareness and sensitize the target populace that such possibilities exist. Approaches may also include mass meetings, information dissemination through leaflets, on farm demonstrations media

programme etc. And working with the target group, giving priority to their needs have always been proven as practical and efficient approach. In Khalsi beel area for diffusion of farm innovations Farmer Field School approach was also adopted along with awareness and sensitization, group meetings, exposure visit, on farm trainings and demonstration.

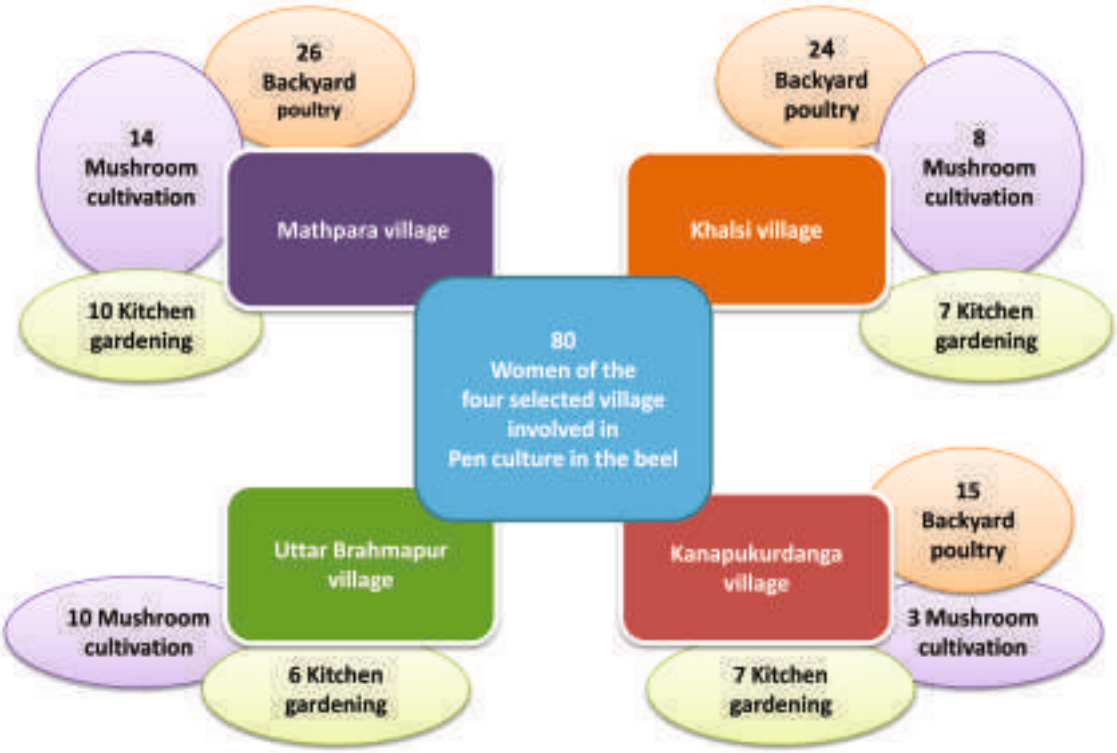
The aim of this project was the empowerment of the women of the fisher-folk communities and keeping this prerequisite in mind various easy to adapt cost effective technologies have been imparted to the beneficiaries and the technologies employed this year were:

- Pen culture technology
- Backyard poultry farming
- Kitchen gardening
- Mushroom cultivation

It was found self employment generation 62 mandays/family/annum and 42.5% of the beneficiaries have produce marketable surplus.

Visible impact of the project

- The empowerment initiative of the rural women has mass appeal within the populace both within and outside the fisherfolk community.
- Farmers shared their excess vegetable or mushrooms produce with their neighbors- reflecting the kinship observed in a rural environment. In addition to encouragement to start similar cultivation practices and consumption of mushroom made aware of its nutritional benefits and market value to these women, also showed interest in its cultivation.
- The backyard poultry farming component generated the most amount of interest due to its better production and quick financial gains. People showed interest in rearing Rhode island red chicks by following scientific management practices.
- Introduction of the fishers' field school approach is going to be a catalyst in this process as through this practice the performing candidates are going to share their experience and knowledge with the others.
- The study area selected for this project being mostly inhabited by people belonging from the backward communities and not well connected. As a result, this project is a means for them to inform about the possibilities and adopting similar endeavors in future for a sustainable income source.



Number of self-employment generated/entrepreneurship developed under the project through scientific interventions in the selected four villages

Project Title: The changing dynamics of labour migration on employment, livelihoods and resource productivity patterns in Indian marine fisheries sector

Funding Agency: ICAR-NASF

Duration: 2023 to 2026

Scientific Personnel: Aparna Roy (CC-PI)

Summary

- Labour migration/labour mobility is a balancing act bridging the labour demand-supply gap and resource inequalities. Under this project by assessing the present labour demand-supply scenario and the gaps therein, the study would evolve pathways to build skill sets and capacities of migrant labours.
- This year, survey tools have been developed and 'Pilot study' of the particular research instrument questionnaire / interview schedule was conducted in the selected sites. The labour welfare schemes and fishers welfare schemes available in West Bengal was documented.

Over the years there has been a change in the fishing operations, a paradigm shift from single day fishing to multiday fishing and targeted fishing, with the demand for fish as an animal protein rising with the days there exist "Employment imbalance", making the sector labour intensive. Labour migration/labour mobility is a balancing act bridging the labour demand-supply gap and resource inequalities. The process has both positive and negative externalities in the socio political and economic arenas of origin and destination places. However, the complex linkages associated with migration and resulting socio-economic challenges need to be analyzed in a comprehensive manner, which is more significant when considering a marginalized group such as migrant. The project is an attempt to understand the labour migration pattern in the marine as well as inland fisheries sector and its subsequent consequences. The project started in the month of June, 2023. The survey tools has been developed through several discussions. 'Pilot study' of the particular research instrument - questionnaire / interview schedule was conducted in the following sites : Inventory of Harvest centres was done at Kakdwip landing Centre; Inventory of Market Centres was done at Diamond Harbour Market; Gender Mainstreaming was done at Diamond Harbour ; Labour Social Standards at Kakdwip landing Centre. During the pilot survey data was collected from Government Officials, Retailers, Wholesalers, Labourer and Women labourer During the pilot survey it was Government Officials (DFO/Labour Officer) were active and enthusiastic to provide inputs to survey schedule. The wholesalers also gave sufficient time to fill up the schedule. The Retailers gave less time. About 86.6% actively participated in the survey, however Male labourer were reluctant to response all the questions. The general observation of the pilot testing were:

- Interview schedules were ready for implementation for field study
- Gave Insight into the true scope of the project- inter district migration was found in landing centre and market
- Fishers (originally from Bangladesh) were involved in fishing activities as labourer
- No inter-state migration was found
- Women labourer were mostly involved in net repairing/making and fish sorting and grading
- Language barrier may occur in case of migrant labours from other states

A Review meeting was conducted on 07 November 2023 at 10.00 am -5.00 pm through offline mode at CMFRI, Kochi. The meeting was to discuss the progress/ orientation of the project, finalize the schedules from the reflections of the pilot survey. Finally, the five survey instruments were finalized and smapling centres has also been finalized. ICAR-CIFRI will also document the migration pattern of the inland fishers.

The labour welfare schemes and fishers welfare schemes available in West Bengal was documented

- BMSSY (Bina Mulye Samajik Suraksha Yojana)
- West Bengal Building and Other

Number of sampling stations in Odisha, West Bengal and Andaman

States/UTs	Harvest centers	Markets	Post-Harvest centers	Total
Odisha	5	2	1	8
W. Bengal	4	2	2	8
Andaman	2	2	1	5
Total	11	6	4	21

Construction Workers Social Security Scheme (BOCWA)
- West Bengal Transport Workers Social Security Scheme (WBTWSSS)
- West Bengal Migrant Workers Welfare Scheme
- Financial Assistance to the Workers of the Locked-out Industries (FAWLOI)
- Old Age Pension for Fishermen under Jai Bangla
- Fishing nets and fishery requisites in inland and marine fisheries sector
- Development of Infrastructural facilities in marine fishing villages
- Infrastructure setting for better communication with the marine fishers

Under this project by assessing the present labour demand-supply scenario and the gaps therein, the study would evolve pathways to build skill sets and capacities of migrant labours and fisher welfare as well as enhancing productivity in fisheries sector through appropriate policy interventions and strategies.





Migrant labourers at Kakdwip landing centre (a & b)

Project Title: IoT based precision enclosure culture and fisheries management in inland open waters

Funding Agency: ICAR [under NePPA (Network Program on Precision Agriculture) project]

Duration: 2021 to 2025

Scientific Personnel: B. K. Das (PI), S. Samanta, M. A. Hassan, D. K. Meena, Chayna Jana

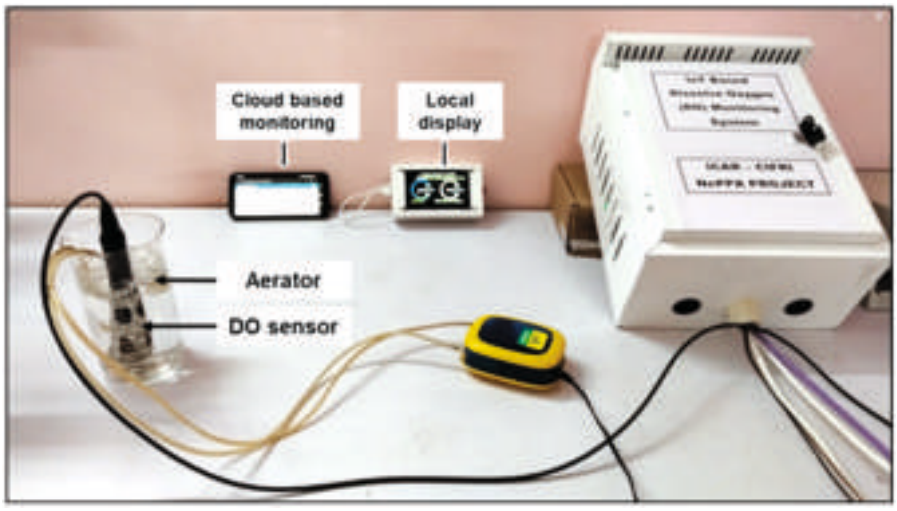
Summary

- An IoT based DO management system has been developed which continuously measures the DO level in the water body as well as operate the aerator automatically in case of low DO level to manage the stress condition.
- A Drone based vertical water sampler has been developed to collect water samples from inaccessible areas of Inland open water bodies like difficult terrains, highly polluted sites, etc. using a remote controlled water sampler.
- To identify and estimate the macrophyte coverage area of wetlands using aerial drone with RGB sensors, 5 wetlands of West Bengal were surveyed. The macrophytes area were then identified and delineated based on visual interpretation for its coverage area estimation.

Development of DO monitoring and management system

Water quality parameters have significant influence on aquatic organisms. Among different water quality parameters, role of dissolved oxygen (DO) is important and well known. Farmers used to take suitable remedial measures to minimize the stresses caused by the deviation of the water quality parameters from the optimum or congenial range. Therefore, an IoT based DO management system has been developed which continuously measures the DO level in the water body as well as operate the aerator automatically in case of low DO level to manage the stress condition. The system was tested in different water bodies and validated the DO reading with other commercially available DO sensor and lab tested results which was found satisfactory.

The device is connected to the cloud via Internet. It senses the DO level and temperature at particular interval and uploaded the data in the cloud in real-time. The continuous DO and temperature data can be accessed through any devices via internet.



DO management system in Lab condition

Drone based vertical water sampler

A Drone based vertical water sampler has been developed to collect water samples from inaccessible areas of inland open waterbodies like difficult terrains, highly polluted sites etc. using a remote controlled water sampler. The water sampler can collect one litre of water in a single attempt. The system will help in minimizing the risk, manpower cost, boat/vessel and labour hiring cost and time etc.

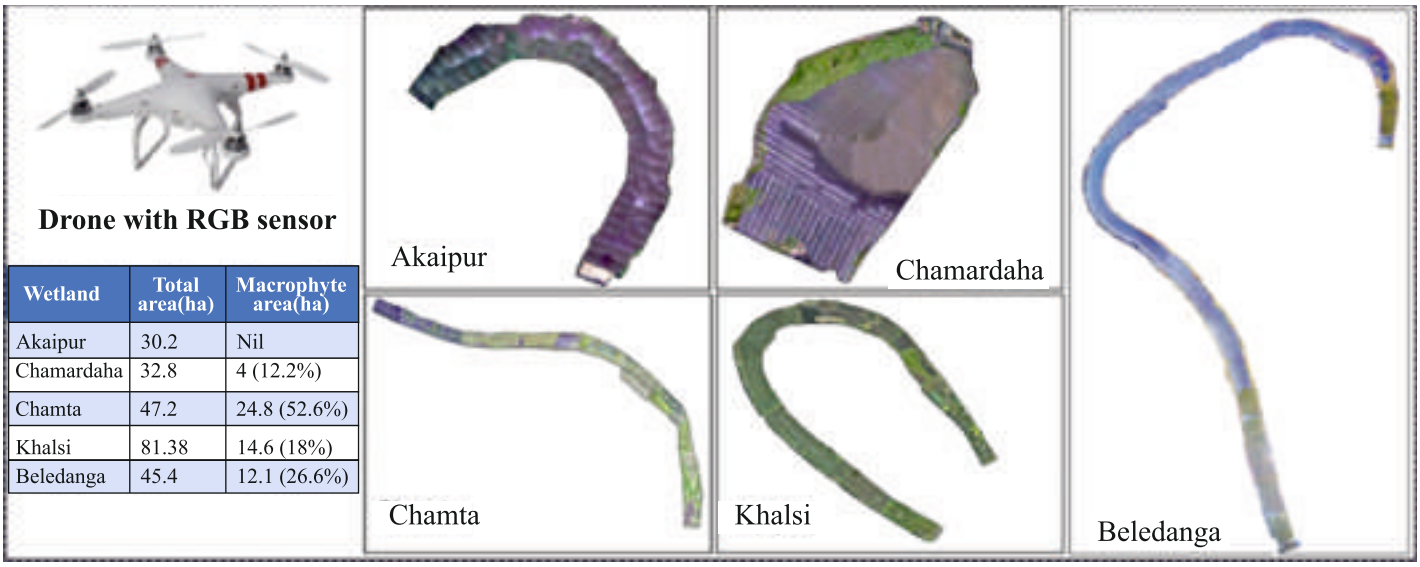
It will be useful for inland aquatic ecosystem health monitoring programs of Government, Non-Governmental agencies and research organizations. The patent application for the system has been filed in Indian Patent Office.

Estimation of macrophyte coverage area of wetlands using RGB sensor mounted on aerial drone

The change in water quality due to pollution or high infestation of



Drone based water sampling in River Ganga



Wetland	Total area(ha)	Macrophyte area(ha)
Akaipur	30.2	Nil
Chamardaha	32.8	4 (12.2%)
Chamta	47.2	24.8 (52.6%)
Khalsi	81.38	14.6 (18%)
Beledanga	45.4	12.1 (26.6%)

Estimated macrophyte coverage area of wetlands using aerial drone

macrophytes may deteriorate aquatic life as well as its primary productivity. An attempt has been taken to identify and estimate the macrophyte coverage area of wetlands using aerial drone with RGB sensors. Five wetlands of West Bengal were surveyed and captured the RGB images of the water area using aerial drone mounted with RGB camera in December, 2022. The macrophytes area were then identified and delineated based on visual interpretation for its coverage area estimation. The RGB sensors are less costly than multispectral sensors. Therefore, the applications of drone based high resolution RGB images may serve as an affordable solution to monitor the real-time macrophytes area in large open water bodies like rivers, wetlands and reservoirs and plan the probable management strategies in effective manner.

Project Title: 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

Funding Agency: NTPC, Farakka

Duration: 2022 to 2025

Scientific Personnel: B. K. Das (PI), A. K.Sahoo, D. K. Meena

Summary

- Under the Corporate Social Responsibility (CSR) activityof National Thermal Power Co-corporation (NTPC), Farakka, the project objectives were to i) develop state of art knowledge centre (small scale) on fish breeding and rearing units for IMC for ranching ii) to provide hands on training to the local fishermen on fish breeding and rearing for livelihood improvement iii) to ranch the native fish fingerlings developed through captive breeding into the river Ganga.

Under the Corporate Social Responsibility (CSR) activity of National Thermal Power Co-corporation (NTPC), Farakka, the project objectives were to i) develop state of art knowledge centre (small scale) on fish breeding and rearing units for IMC for ranching ii) to provide hands on training to the local fishermen on fish breeding and rearing for livelihood improvement iii) to ranch the native fish fingerlings developed through captive breeding into the river Ganga.

Brood stock development in cages

Fingerlings of *Labeo rohita*, and *Catla catla* with average 120.5 gm weight and 16.2 cm length were stocked in the circular cages of 16m dia and 8 m depth with 10,000 no. Proper feeding @ 2-3%/kg body-weight twice in a day was performed. Daily monitoring of health through feeding behaviour and movement were recorded. Growth was monitored through regular sampling through measuring length and weight once in a month. Six-month growth



Grow-out cage for IMC



Cage reared Catla for growth monitoring



Injection of synthetic hormone (Spawn-pro)



Collection of fertilized eggs



A: Awareness programme on major carps production B: Ranching of IMC fingerlings

period showed a weight increase of 866.2 gm.

Breeding of IMC in FRP portable hatchery

For induced breeding, brooders (1:2 ratio female:male) with average of weight 900 gm were selected based on their gonadal development through external observations and transported from cages to breeding pools. These selected brooders were kept for 4 hrs for conditioning with continuous water circulation. After proper conditioning, brooders were injected with the synthetic hormone Spawn-pro with prescribed dose as indicated in the instruction (0.5 ml/kg for female and 0.3 ml/kg for male). After 6-8 hrs of injection, eggs were collected and transferred to the hatching pools. The hatching rate was 85%. Larval rearing was done in the flow through earthen system taking Ganga River water.

Hands on training, awareness programme to the local fishermen

A total of 88 awareness programmes and hands on training on Indian Major Carp (IMC) breeding and culture were held in different locations of Farakka, Jharkhand, Malda and Dhuliyan. 1252 fishermen were provided awareness on modern fish aquaculture, pond preparation, artificial breeding,hatchery management, seed raising, creating natural and artificial feed preparation. In addition, 50000 of IMC fingerlings produced from the river Ganga Stock were ranched in the river Ganga at Farakka.

Project Title: Cage culture in Kangsabati reservoir

Funding Agency: DoF, Govt. of West Bengal

Duration: 2023 to 2024

Scientific Personnel: B. K. Das, M. A. Hassan, D. K. Meena, Rahul Das, Gunjan Karnatak

Summary

- In partnership with the West Bengal Government's Directorate of Fisheries, the ICAR-CIFRI launched a major developmental project. The initiative's goals were to increase table fish production and strengthen the local fishing community in Bankura, West Bengal's Kangsabati Reservoir by introducing cage culture techniques.
- The objectives of the project were to disseminate cage culture technology, strengthen the capacity of Directorate of Fisheries, the resource user communities and cooperatives.
- The project was undertaken in co-management mode with fishermen group. A battery of 32 cages were installed at the reservoir and stocked with *Pangasius* seed with a target to produce 80 tons of fish in 8-9 months of duration.
- In less than six months, 48-tonnes of fish (60% of the target) was produced, with around 15% stock reaching market size of more than 500g.
- The cage culture initiative in Kangsabati Reservoir has demonstrated remarkable progress in a short span, showcasing the potential for sustainable aquaculture practices and socio-economic development in the region. The collaborative efforts between ICAR-CIFRI, the Directorate of Fisheries, and local fishing communities have laid a strong foundation for future endeavours in enhancing fish production and livelihoods.

On 01 March 2023, the ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI) embarked on a significant developmental project in collaboration with the Directorate of Fisheries, Government of West Bengal. The initiative aimed to introduce cage culture technology in Kangsabati Reservoir, Bankura, West Bengal, to enhance table fish production and empower local fishing communities.

As part of this MoU, Cage culture activities were initiated at Kangsabati Reservoir for table fish production. The objectives of the project were dissemination of cage culture technology, strengthening the capacity of Directorate of Fisheries, the resource user communities and cooperatives.

Cage culture program was inaugurated on 16 May 2023 with releasing of fingerlings by Chief Guest Shri Biplob Roy Choudhury, Honorable Minister of Fisheries, Govt. of West Bengal and Guest of Honour Smt Jyotsna Mandi Honorable Minister of State, Food and Supplies, Govt. of West Bengal in presence of Sh. Avanindra Singh, IAS, Secretary, Department of Fisheries, Govt. of West Bengal. The programme was attended by 200 tribal fishers of the district.

The project was undertaken in co-management mode with fishermen group. A battery of 32 cages were installed at the reservoir and stocked with pangasius seed with a target to produce 80 tons of fish in 8-9 months of duration.

A training programme on fish production enhancement through cage culture in inland open waters of



The MoU was signed in presence of Shri Biplab Roy Chaoudhury, Honourable Minister in Charge, Fisheries, Government of West Bengal



Seed stocking in cages of Kangsabati reservoir

West Bengal was also organised at ICAR-CIFRI from 07-11 November, 2023 for the farmers of Bankura and Purulia districts aimed at imparting knowledge and skills to fish farmers and entrepreneurs on the latest technologies and practices in cage culture. The training covered a wide range of topics, including cage design and construction, site selection, stocking density, feed management, and disease control practical classes on feed preparation, disease diagnosis and treatment, and water quality parameter analyses.



Participants of the training programme on cage culture in reservoir of West Bengal

A fish harvest cum auction program was organized by ICAR-CIFRI at cage site, Kangsabati Reservoir, Mukutmanipur on December 2, 2023, in collaboration with Department of Fisheries West Bengal. The program was graced by Honorable Minister of State Sri Biplab Roychowdhury. In less than 6 months 48-ton fish yield (60% of the target) was achieved with around 15% stock reaching market size of more than 500g.The program also marked commencement of the first fish auction for sale of the produce.



Fish harvest cum auction programme at Kangsabati reservoir

The cage culture initiative in Kangsabati Reservoir has demonstrated remarkable progress in a short span, showcasing the potential for sustainable aquaculture practices and socio-economic development in

the region. The collaborative efforts between ICAR-CIFRI, the Directorate of Fisheries, and local fishing communities have laid a strong foundation for future endeavors in enhancing fish production and livelihoods.



Growth monitoring of cage reared fish

Project Title: (A) Assessment of production of fish, fish disease and feasibility study of certification for fish produced in East Kolkata Wetland

Duration: 2023 to 2026

Sub-project 1: Multiple value assessment

(B) Assessment of agriculture (Paddy), horticulture, medicinal plants, floriculture and uses

Sub-project 2: Culture of indigenous fish species

Sub-project 3: Assessment of invasive fish species with special emphasis on *Pterygoplichthys* spp. for control/eradication in East Kolkata Wetland

Funding Agency: Department of Environment, Government of West Bengal

Scientific Personnel: B. K. Das (P.I.), A. K. Das, S. Samanta, P. Mishal, L. Lianthuamluaia, G. Karnatak, V. Kumar

Summary

- The EKW hosts the largest sewage-fed aquaculture in the world. A project on East Kolkata Wetland management, funded by the Department of Environment, Government of West Bengal, is ongoing for multiple value assessment of the fish, agriculture, horticulture and floriculture production, fish disease status, indigenous fish culture potential and impact of invasive fish species with emphasis on possible management.
- ICAR-CIFRI team conducted an exploratory survey of East Kolkata Wetland (EKW) to interact with the farmers and collect samples and necessary baseline information. Sardar bherry was selected for the investigation as this is one the largest and most productive farms in EKW ecosystems.
- The most common cultured fish species are *Cirrhinus mrigala* (Mrigal), *Labeo bata* (Bata), *L. rohita* (Rohu), *L. catla* (Catla), *Cyprinus carpio* (Common carp), *Ctenopharyngodon idella* (Grass carp), *Hypophthalmichthys molitrix* (Silver carp) and *Oreochromis niloticus* (Nile Tilapia). Some farmers were also involved in horticultural crop production such as spinach, cauliflower cucumber, onion, potato, radish and ridge gourd.
- A few diseased fish samples of Bata and Tilapia (showing red spots and haemorrhage on the body) were identified and brought to the laboratory for diagnostic study. A preliminary analysis indicated the association of bacterial and viral pathogens with pathological conditions.

A project on East Kolkata Wetland management, funded by the Department of Environment, Government of West Bengal, is ongoing for multiple value assessment of the fish, agriculture, horticulture and floriculture production, fish disease status, indigenous fish culture potential and impact of invasive fish species with emphasis on possible management. The East Kolkata Wetland (EKW) is a complex of natural and manmade wetlands situated in the lower Bhagirathi basin bounded by latitude 22˚25′ N to 22˚40′ N and longitude 88˚20′ E to 88˚35′ E and lying between two rivers, Hooghly River in the northwest and Bidyadhari in the east of the city of Kolkata of West Bengal, India. The 12500 ha area of the wetland acts as a natural wastewater treatment plant and reuses/treats about 800 million liters of wastewater flowing out daily from Kolkata. The nutrients contained in the wastewater sustain fish farms and agriculture. The EKW hosts the largest sewage-fed aquaculture in the world.



Project team members with farmers and trainees at Sardar bherry of EKW



Diseased fish samples with red spots on the body (A: *L. Bata* and B: *O. niloticus*)

Under the project, the ICAR-CIFRI team conducted an exploratory survey in East Kolkata Wetland (EKW) to meet with the farmers and collect samples and necessary baseline information. Based on the previous works on EKW, Sardar bherry (Latitude: 22˚56′ N and Longitude 88˚44′ E) is selected for the investigation as this is one the largest and most productive farms in EKW ecosystems, covering approximately 500 bigha. Around 150 farmers are involved in this bherry for their livelihood. The most common cultured fish species are *Cirrhinus mrigala* (Mrigal), *Labeo bata* (Bata), *L. rohita* (Rohu), *L. catla* (Catla), *Cyprinus carpio* (Common carp), *Ctenopharyngodon idella* (Grass carp), *Hypophthalmichthys molitrix* (Silver carp) and *Oreochromis niloticus* (Nile Tilapia). Some farmers are also involved in horticultural crop production such as spinach, cauliflower cucumber, onion, potato, radish and ridge gourd. Later, the soil and water samples are collected from the inlet, mid-pond and outlet source of the bherry. Several water quality parameters like temperature, dissolved oxygen, pH, conductivity, total dissolved solids (TDS), salinity and chlorinity are measured at the spot. The water and soil samples were also brought to the laboratory for further analysis. A few disease fish samples like Bata and Tilapia (showing red spots and hemorrhage on the body) were identified and brought to the laboratory for disease diagnostic study. A preliminary analysis indicated the association of bacterial and viral pathogens with pathological conditions.

Project Title: Improving livelihood of tribal communities through Scampi fisheries enhancement technologies in under-utilized reservoir resources of Jharkhand

Funding Agency: Govt. of Jharkhand

Duration: 2023 to 2026

Scientific Personnel: B. K. Das (Co-ordinator), A. K. Das (PI), Mishal P., Raju Baitha

Summary

- A MoU was duly signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Jharkhand at Doranda, Jharkhand on 23 May 2023 for improving livelihood of tribal communities through Scampi (*Macrobrachium rosenbergii*) fisheries enhancement technologies in under-utilized reservoir resources of Jharkhand.
- Three reservoirs, *viz*., Ghagra (Hazaribag district), Kelaghagh (Simdega district) and Masaria (Gumla district) were selected for scampi culture. A total of 8 lakh seeds of *Macrobrachium rosenbergii* were stocked in the 3 reservoirs from 16-18 September 2023.
- Periodical sampling from 3 reservoirs has showed the improved growth and development of the scampi. Based on average growth performance of scampi, survival and recapture, an estimated yield of 12-15 kg/ha is expected from the reservoir after the scampi stocking.
- The pilot project has proven to be a success, and the positive outcomes suggest a promising future for scampi culture in reservoirs, benefitting the environment as well the fishermen communities involved.

The giant freshwater prawn (GFP), *Macrobrachium rosenbergii*, commonly called 'scampi', is the most important culturable freshwater species of prawn with a fairly high growth rate, high market value, wide range of temperature (15-35°C) and salinity tolerance. The scampi fisheries could contribute considerably for food security, nutrition and health, livelihood security to rural population and welfare of the fishers. Culture of GFP in reservoirs is a global practice which offers an immense scope to tap the naturally available food niches in reservoir environment. ICAR-CIFRI had also successfully demonstrated the culture of freshwater fishes along with scampi in enclosures in the reservoir of Telangana state. The state of Jharkhand is blessed with rich inland fishery resources especially medium and small reservoirs to the tune of 1.33 lakh ha.

The Govt. of Jharkhand has shown interest in popularizing GFP fisheries in underutilized reservoir areas in order to ensure species diversification and livelihood security of tribal communities. A MoU was duly signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Jharkhand at Doranda, Jharkhand on 23 May 2023. A tentative budget of Rs. 102.30 lakhs has been furnished for unimpeded and effective functioning of the project, out of which Rs. 32.50 lakh was sanctioned for the first year. In the meantime, Rs. 13.50 lakh has been already allocated for procuring scampi seed, feed and other minor items & consumables like net, digital balance, probes, etc. A total number of 3 reservoirs, *i.e.*, Ghagra (100 ha) in Hazaribag district, Kelaghagh (162 ha) in Simdega district and Masaria (110 ha) in Gumla district were selected to culture the scampi. A total of 8 lakh seeds of *Macrobrachium rosenbergii* were stocked in the 3 reservoirs from 16-18 September 2023. The size of the scampi at the time of stocking was 20 mm. Farmers were made aware of periodic sampling process with the project team for receiving the time to time growth data. A meeting was also conducted in the presence of tribal communities under the project, local representatives, fisheries experts and the project team to discuss over the objectives and overview of the project, potential economic and social sustainability through the farmers' active participation and indulgence in farming activities. The tribal communities were empowered through the several training programmes on scampi farming techniques and management conducted by the project team. They were sensitized regarding the process of reservoir management with the eradication of predatory species, provision of suitable hide-outs for the scampi, application of lime, minerals, water quality and disease management, feeding techniques and distribution of other inputs in the reservoirs. The farmers were supported with adequate inputs like required for scampi farming. A robust monitoring and evaluation system was established in order to assess the progress of the work and impact on livelihood of the fishers. Farmers were communicated pertaining to the monitoring of lift nets for the assessment of feed requirement. They were made aware of demand feeding technique. Feeding of scampi was not only fulfilling their gastronomic need but also acting as

fertilizer to increase the availability of the benthic fauna.

Periodical sampling data from 3 reservoirs has showed the improved growth and development of the scampi. Average weight gain of the species was 18 g, 17 g and 18 g in Kelaghagh, Masaria and Ghagra reservoir, respectively, within 3.5 months including the winter spell. Based on average growth performance of scampi, survival and recapture, an estimated yield of 12-15 kg/ha is expected from the reservoir after the scampi stocking. The actual yield can be ascertained only after the completion of this pilot project which is intended for feasibility of raising prawns in reservoirs. The pilot project, being a new practice, is not devoid of various challenges like susceptibility to diseases of the scampi, strict water quality management process, lack of knowledge of the fishers, building community support in remote area etc. But, these challenges can be surpassed through an expert team who can train the farmers and sensitise them regarding the benefits of the farming, involve the community members in decision-making processes to trigger the sense of empowerment among them and implement and monitor the biosecurity measures regularly to maintain a healthy stock. In summary, the scampi culture pilot project has proven to be a commendable success, characterized by robust sample sizes, community engagement and overall seamless execution. The positive outcomes suggest a promising future for scampi culture in reservoirs, with potential benefits for both the environment and the communities involved.

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)

Duration: 2022 to 2024

Scientific Personnel: Biswaup Saha (PI), WBUAFS; Arun Pandit

Summary

- Analysis of the performances of 4 FPOs in South Dinajpur district of West Bengal revealed that out of twenty (20) production and associated activities, the member farmers require trainings in fourteen (14) areas as revealed by skill gaps.
- The 3 topmost areas of training needs were in fish seed production & hatchery management skills, live fish handling and quality assessment skills and pond hazard management skills
- 'Inadequate understanding of modern technologies' was perceived to be the most pressing constraint, followed by a 'lack of technical direction and coordination' and company's lack of dividend.
- Proper training, mentoring and guidance is needed through FPOs to train them on the scientific fish production practices to marketing of the produce

FPO movement has gained momentum in the recent years and its number is steadily increasing attracting millions of small and marginal farmers. There are over 8000 Farmer Producer Organizations (FPOs) in India which covers around 4.5 million shareholder farmers. FPOs can play an important role by mobilizing and organizing the farmers for better market access, higher bargaining power, and higher price to their produce, better information dissemination in a developing countries like India, where agriculture is dominated by small and marginal farmers with limitedresource base. This group approach is proved to be effective to transform the way farmers upgrade their technologies to scaling up the production process, manage various resources for production purposes, securing livelihood through overcoming the risk and vulnerability, tap into supply chain efficiencies and negotiate with market players. Despite their rapid and continuing spread, there are challenges in ensuring sustainability of FPOs through capacity development of shareholders farmers. Perhaps most critical, and yet less discussed, are the challenges and skill gap that FPOs face in building both capacities and confidence to own, operate and expand these institutions to enable goals like doubling farmers' incomes.

A study was conducted in South Dinajpur district of West Bengal to ascertain the skill gaps of member farmers of the selected FPOs and different issues and constraints faced by them.

Four different FPOs viz. PurnobhavaAgro Farmers Producer Company Limited, Trimohini Farmers Producer Company Limited, Bhuihara Farmers Producer Company Limited and Krishi Jagoron Kendra Producer Company Limitedwere selected which were involved in cereal crops, horticulture, fishery, poultry, vegetable, seed, etc. Twenty memberfarmer from each FPO were chosen at random. The skill-gap analysis as described by Wentling (1992) was used to ascertain farmer's skill gap in fish production in addition to management of their farms. Competence was assessed on a scale of very high competent = 5, high competent =4, average competent= 3, little competent = 2, not competent at all = 1. Similarly, to identify the importance attached to these activities, another 5 point Likert-type scale was used to compute the perceived levels of importance placed on each of the listed activities. From the results, the skill gap of respondents was identified using the Borich Model (Borich, 1980). The competencies are then ranked on the basis of the weighted scores. For analysis of the constraints scoring was done and afterwards, the ranking of constraints was done according to mean score of each statement.

Brief socio-economic profile

The study showed that the majority of respondents (55.00%) were in the middle age group (30-55 years) and 7.5 percent of farmers had no formal education. More than half of the respondents (43.75%) belonged to medium size families (5-7 members). According to an analysis of the respondents' income distribution from the FPO, half of respondents (50.00%) fell into the medium category (Rs.1.5 lakh to 3 lakh), followed by 36.25 per cent who fell into the lower income category (Rs.1.5 lakh or below), 13.75 per cent farmers fall in the higher side of income category. Thirty per cent each of the respondents were involved in 'farming' and 'farming and labour' which indicates that some of them do their own farming and others work as labourers in addition to working in their own field. The majority of farmers joined FPOs in order to obtain a fair price for their products. 'To get rid of difficulties in marketing of the produce' and 'to avail common market facility for products' found to be the second and third important reasons for joining the FPOs.

Analysis of skill gaps in fish farmers

The results of the skill gap analysis of fish farmers using mean weighted discrepancy score (MWDS) and their ranking revealed that out of twenty (20) production and associated activities, respondents require trainings in fourteen (14) areas revealed by skill gaps. The topmost areas of training needs were in fish seed production & hatchery management skills (MWDS = 11.25), live fish handling and quality assessment skills (MWDS = 10.12), pond hazard management skills (MWDS = 9.92), farm business and record keeping (MWDS = 9.2), pest and disease management skill (MWDS = 9.16), water quality management (MWDS = 6.96), post harvesting skills(MWDS = 6.93), feed formulation and feeding management skills (MWDS = 6.9), fertilisers, manuring and liming management skill (MWDS = 6.63) and harvesting skills (MWDS = 6.37). Fish production in the district is expanding rapidly but there is a huge gap in fish seed production and demand. Low production even sometimes failure in seed production business occurred due to lack of proper risk assessment. Therefore, proper training, mentoring and guidance is needed through FPOs to train them on the scientific seed

Table: Major areas of skill gap of fish farmers

Area of skill	MWDS	MeanImportance	S.D.	Mean Competence	S.D.	Rank
Fish seed production and hatchery management skills	11.25	4.83	1.32	2.5	1.21	1
Live fish handling and quality assessment skills	10.12	4.76	0.93	2.63	1.09	2
Pond hazard management skills	9.92	4.8	0.82	2.73	0.79	3
Farm business and record keeping	9.2	4.6	1.08	2.6	1.08	4
Pest and disease management skill	9.16	4.83	0.93	2.93	1.58	5
Water quality management	6.96	4.66	0.82	3.17	1.24	6
Post harvesting and processing skills	6.93	4.43	1.2	2.87	1.04	7
Feed formulation and feeding management skills	6.9	4.6	0.74	3.1	0.97	8
Fertilisers, manuring and liming management	6.63	4.53	1.2	3.06	1.46	9
Harvesting skills	6.37	4.46	1.42	3.03	1.32	10



Project staff with the office bearers of the Bhuihara FPO



Harvesting of fishes by the FPO member farmer

production practices to marketing of the produce.

Fish spoilage and quality assessment skills was also perceived as very important as fish being a perishable commodity need careful handling to minimise loss from spoilage. Managing profitable farm enterprise will require that farmers are able to manage the infestations of pest anddiseases that attack their fishes and also have thorough knowledge on the specific and required control measures. Business and record keeping were also identified as major skill development area which were perceived as important. Post-harvest management and processing were also identified as one of the major areas of training need. However, post-harvest management could be a major limitation if not properly done, hence the high need for training.

Constraints faced by the member farmers and office bearers of FPOs

'Inadequate understanding of modern technologies' was perceived to be the most pressing constraint, with a mean score of 3.21, followed by a 'lack of technical direction and coordination' (mean score = 3.12). The company's lack of dividend came in the third place with a weighted mean score of 3.09. The lack of technical direction and coordination has been found to be moderately severe by 42.50 per cent of the respondents, and about the 35 per cent of the respondents thought it to be a severe problem. Poor credit facilities and the non-availability of custom hiring centreswere some of the other constraints faced by the farmers. Regarding payment, some farmers were satisfied with the payment method of the company, but some of them were not as 56.25 per cent of them perceived it as a moderately severe problem. 'Poor credit facility' with a mean score of 3.05, possessed fourth place among the constraints that indicate members' dissatisfaction with the credit availability.

Project Title: Study on impact of water intake due to Gadarwara STPP on Ecology of Narmada River

Funded Agency: National Thermal Power Corporation

Duration: 2022 to 2023

Scientific Personnel: B. K. Das, S. Samanta, S. K. Das, A. K. Sahoo, Vaisakh G.

Summary

- A project was conceived to assess the impact of water intake due to NTPC Gadarwara STPP on ecology of Narmada River.
- Rivers Narmada and Sitareva was recorded to sustain as many as 34 fin fish species and 1 shell fish species belonging to 13 families. The exotic fish *Cyprinus carpio* was recorded from the sampling stations. The plankton content and diversity were moderate.
- The water intake system, its distribution and utilization were visualized during survey. NTPC Gadarwara Super Thermal Power Project, during normal course of project operation is a Zero Liquid Discharge (ZLD) system was recorded ecologically safe for the river Narmada.

NTPC Gadarwara Super Thermal Power Project (STPP) is a coal-fired power plant near Gadarwara in Narsinghpur, Madhya Pradesh for meeting the power demand of Western Region. It is one of the modern and environment friendly thermal power projects set up by NTPC Ltd. The project has been commissioned and is operating with two 800 MW units with a total capacity of 1,600 MW. The final capacity of the project was initially estimated at 3200 MW (2x800 2x800 MW) and the water consumption commitment for the final phase was 125 months (12742.58 m^3/h). However, the capacity of the thermal energy project is currently limited to only 1600 MW (2 x 800 MW) and the water consumption has been revised to 62.7 Cusec (equivalent to 6391.67 m^3/h). Present project was conceived to assess the impact of water intake due to Gadarwara STPP on ecology of Narmada River.

Performed the premonsoon sampling during June 2023 and the monsoon sampling during September 2023. The water availability in the river Narmada was low during premonsoon season however, it was recorded sufficient for the intake by NTPC Gadarwara pumping station at Kakraghat and also to maintain a flow in the river. Water and sediment qualities were normal. During monsoon sampling the river was almost at its full capacity. Rivers Narmada and Sitareva was recorded to sustain as many as 34 fin fish species and 1 shell fish belonging to 13 families. The exotic fish *Cyprinus carpio* was recorded from the sampling stations. The plankton content and diversity was recorded moderate. Studied benthic community and their diversity indices.

The water intake system, its distribution and utilization was visualized during survey. NTPC Gadarwara Super Thermal Power Project, during normal course of project operation is a Zero Liquid Discharge (ZLD) system. It was very interesting to note that even in the peak monsoon when the 3rd sampling was performed, there was no significant discharge from the final effluent release point. A sizable portion of waste water is utilized for ash pond management. Thus, the NTPC Gadarwara STPP was recorded ecologically safe for the river Narmada.

Project Title : Production Systems, Agribusiness and Institutions - Component I : Impact of Agricultural Technology'

Funding Agency : ICAR-NIAP

Duration : 2023 to 2026

Scientific Personnel : Arun Pandit, Anjana Ekka

Summary

- Cage culture in Chhattisgarh has led to a 136% increase in reservoir productivity, adding 5092 tonnes of fish annually from *Pangasius* and *Tilapia* species.
- Cage culture generates 53 man-days of work per cage unit yearly, amounting to 2.5 lakh man-days across 4936 cages, enhancing local livelihoods.
- Each cage unit nets ₹75,420 per year, with cage culture contributing 0.05% to the state's GDP.
- Women own 20% of cage culture sites, fostering financial independence and socio-economic improvement through self-help groups.
- Chhattisgarh's effective use of water resources and river systems in cage culture sets a sustainable model for other regions.

Under the Network Project on Impact Assessment, the impact of cage culture in Chhattisgarh is being studied. Over the past decade, the state has experienced a remarkable surge in fish production, due to the highly effective implementation of cage culture techniques. The primary objective is to provide a comprehensive assessment of the impact of cage culture in reservoirs of Chhattisgarh focusing on key parameters which include increased fish production, contributions to employment generation, economic impact, and women empowerment.

Increase in fish production

Cage culture in reservoirs has the potential to greatly enhance fish production, addressing food security and promoting economic development. By confining fish to cages, farmers can control growth

factors, leading to faster and more efficient growth. Higher stocking densities within cages allow for optimal resource utilization, maximizing production potential. This increased yield, combined with year-round production and stable supply, ensures a consistent source of fish for consumption and markets. Pangasius and Tilapia species are cultivated in the sampled cages, the average production from one cage unit is estimated to be 2.5 -3.0 tons per year. The study reveals a remarkable 136 percent increase in average reservoir productivity. The cage culture is adding 5092 tonnes of fish to the overall state fish production.

Livelihood support through employment generation

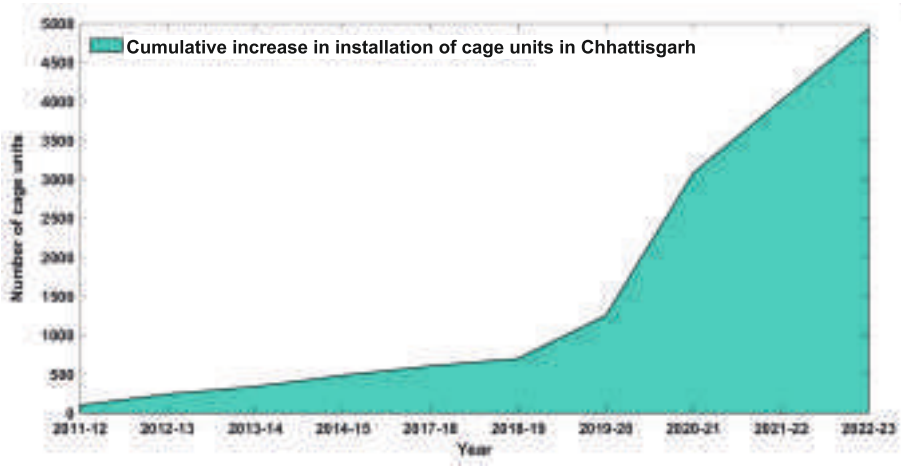
Cage culture stimulates economic development by generating employment, improving livelihoods, and fostering related industries. It generates year-round employment opportunities, both directly within cage culture operations and indirectly along the marketing chain. Each cage unit contributes approximately 53 man-days of work annually, and with all 4936 cages operational, the potential for generating 2.5 lakh man-days per year becomes evident. The net return from each cage unit, estimated at ₹ 75,420 per year, significantly improves the livelihoods of the communities involved and contributes to overall economic prosperity.

Contribution to State's GDP

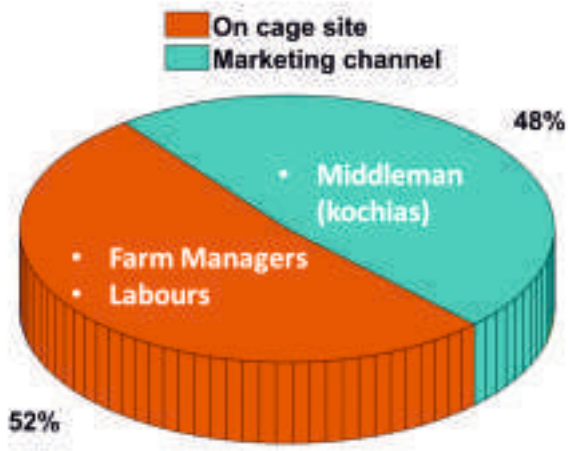
This measure encompasses the monetary worth of activities related to both capture fisheries (including commercial and artisanal fishing) and aquaculture (fish farming and related activities were worked out).The contribution of cage culture to the state's GDP is estimated to be 0.05%.

Women empowerment

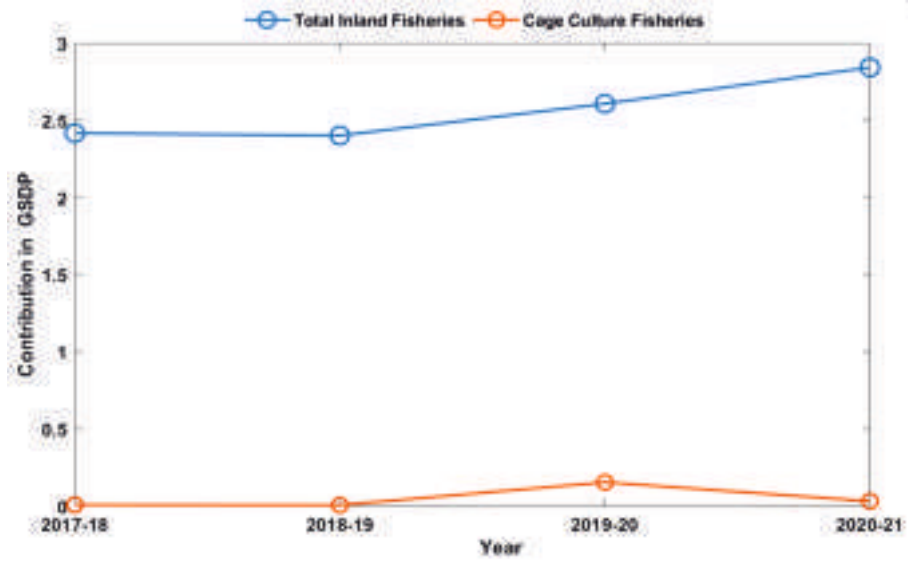
Cage culture in reservoirs can be a



Growth of cage units in Chhattisgarh



Employment generation through cage culture technology in reservoirs of Chhattisgarh



The contribution of fisheries to a state's Gross Domestic Product (GDP) of Chhattisgarh

powerful tool for women empowerment, offering numerous opportunities for economic, social, and personal development. In Chhattisgarh, out of sampled cage culture sites, 20% are owned and operated by women fish farmers. A self-help group in cage culture were also formed and run exclusively by females. Such activities have allowed women to generate income and become economically independent. By earning their own income, women gain financial autonomy, enabling them to support themselves and their families, make financial decisions, and improve their overall socio-economic status. To ensure effective women empowerment through cage culture, it is crucial to address gender-specific barriers, provide equal access to resources and training, and promote gender equality in the fisheries sector. Encouraging supportive policies, fostering inclusive environments, and creating opportunities for women's capacity building and leadership development are essential for realizing the full potential of women empowerment in cage culture in reservoirs.



Women enterprenures

In conclusion, the strategic investment in cage culture in Chhattisgarh, leveraging abundant water resources and a river network, has been a remarkable success. The study not only highlights the remarkable achievements of the state's fisheries sector but also presents a compelling case for the adoption of sustainable and environmentally responsible practices in cage culture. The combination of abundant water resources, a robust riverine system, and the successful implementation of cage culture techniques has positioned Chhattisgarh as a frontrunner in the fisheries sector, setting an example for other regions to emulate.



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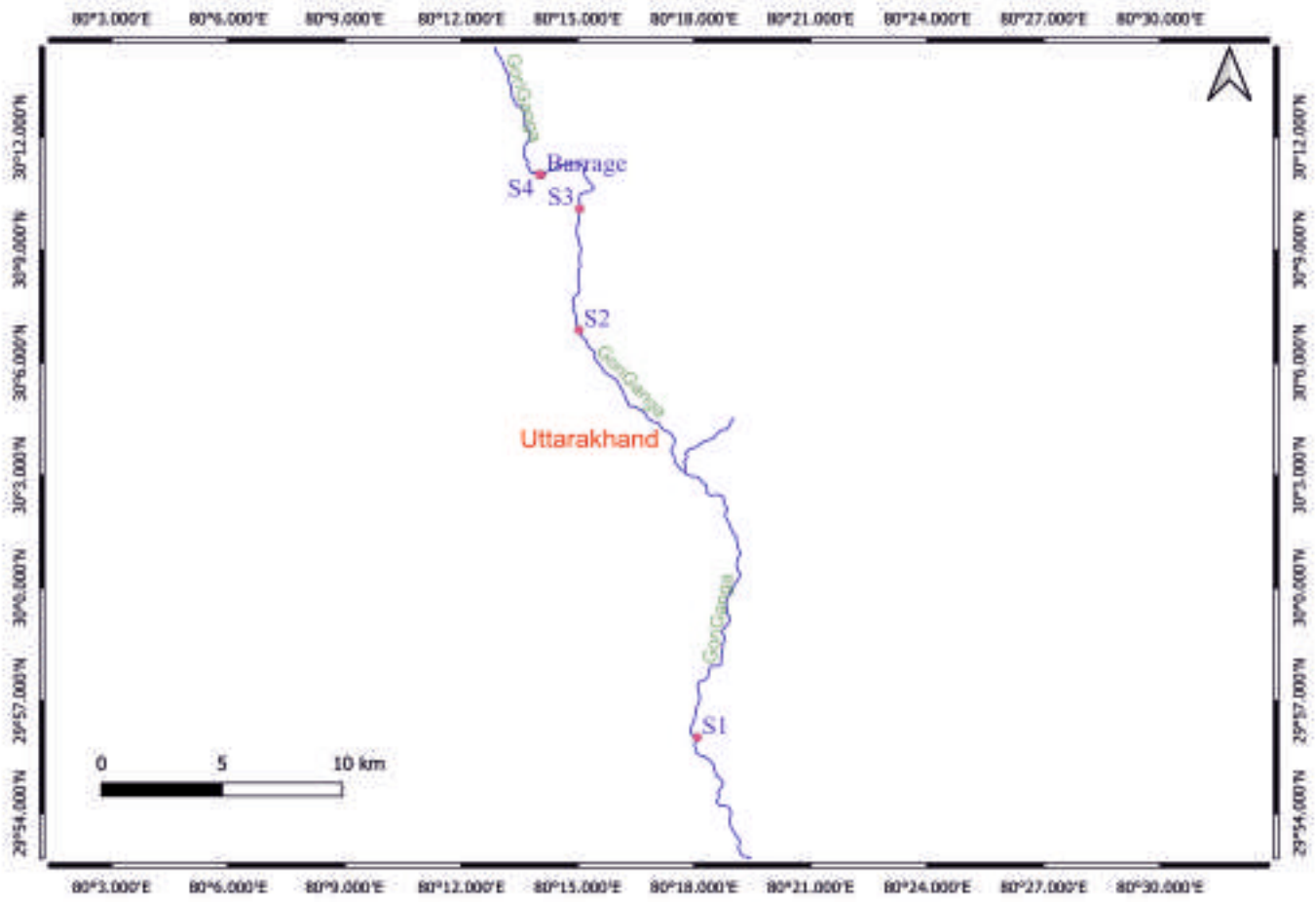
Project Title : Fish Survey of Goriganga for Sirkari Bhyol Rupsiabagar HE Power Project in Munsiyari, Pithoragarh, Uttarakhand

Funding Agency : Uttarakhand Jal Vidyut Nigam (UJVN) Ltd. Dehradun

Duration: 2023 to 2024

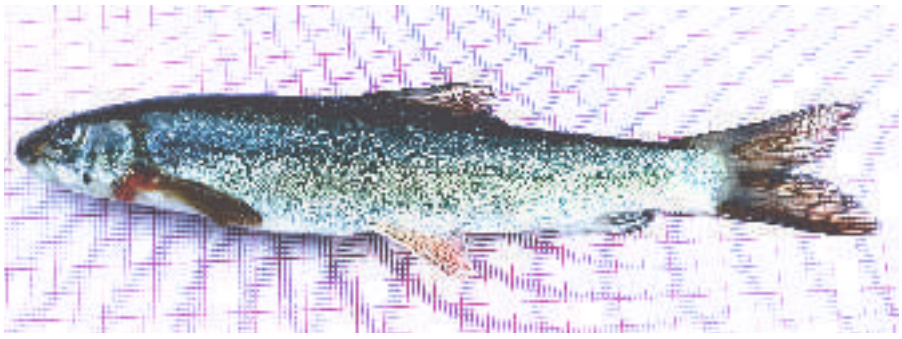
Scientific Personnel : B. K. Das (PI), A. K. Sahoo, A. Alam, Roshith C. M., Jeetendra Kumar

The principle source of Goriganga is the Milam Glacier, northeast of Nanda Devi peak in the Pithoragarh district of Uttarakhand, India. The river is also known asthe Ghori Ganga and Gori Gad. It flows through the Munsiyari tehsil of Pithoragadh district of Uttrakhand and the river confluences with River Kali after flowing in the zig-zag course through the entire gradient of Himalayan habitats varying from subtropical sal to alpine meadows of about 100 km at Jauljibi in Pithoragadh district of Uttrakhand. The catchment area of Goriganga is 1385 sq. km out of which about 640 sq. km is under snow. The Goriganga has been identified as a potential resource for power generation through the development of 7 large hydroelectric projects and one among them is the Sirkari Bhyol Rupsiabagar Hydroelectric Power Project. The Sirkari Bhyol Rupsiabagar Hydroelectric Power Project, is a run-of-river project proposed upstream of the Rupsiabagar-Khasiyabara H. E. Project on the Goriganga river in the Munsiyari Tehsil of Pithoragarh District of Uttarakhand. It is a 120 MW power plant which is planned for the right bank of the Goriganga river near the village of Rupsiabagar, as well as a 12 m high by 80 m long construction barrage on the river near the village of Radgadi which is located upstream of the confluence of Ralm Gad and Goriganga between the latitude 30° 11' 06″ N and longitude 80° 14' 16″ E at an altitude of 2048 m MSL. The fishery survey was carried out during pre-monsoon (May, 2023) in the river Goriganga covering a stretch of 35 Km downstream (S1, S2, S3) and about 0.1 km upstream (S4) of the barrage site through experimental fishing that employed cast nets, hook and line, gill net locally called Surka and pot and pan method along with



Map of River Goriganga depicting sampling sites and fish species documented

interactions with local people. The sites S1 (Banga Pani), S2 (Suringad), S3 (Milam), and S4 (Radgadi) were situated at an altitude of 952 m, 1345 m, 1710 m, and 2048 m MSL respectively. The habitat at sites S1 and S2 had bedrocks, boulders, cobbles and pebbles while sites S3 and S4 was characterized bedrocks and boulders only. The water temperature recorded at sites S1, S2, S3 and S4 were 16.5, 10.1, 9.3 and 9.3ºC, while the pH were 7.3, 6.2, 7.8 and 7.7, respectively, The experimental fishing conducted using different fishing gears during pre-monsoon season resulted in the collection of only two species of fish namely *Schizothorax richardsonii* (snow trout), and *Naziritor chelynoides* (dark mahseer). These two fish species were collected only from the site S1 (Banga Pani), situated at a distance of about 35 km downstream from the proposed barrage site. No fish species were recorded between Suringarh, near village Tallu Dumar, S2 (1345 m MSL) and Milam (S3) near village Patoi, Boi (1710 m MSL) a stretch of about 15 km downstream, and also at site S4 100 m upstream (2048 m MSL) of the proposed barrage site. The fish species *S. richardsonii* and *N. chelynoides* are presently categorised as vulnerable (VU) under the IUCN Red List of threatened species.



Schizothorax richardsonii



Naziritor chelynoides

Consultancy Projects

Project Title: Assessment of fisheries and ecology in Kameng basin of Arunachal Pradesh in relation to proposed hydropower projects at Gongri and Dinchang (Phase I & II)

Funding Agency: Scatec ASA, Norway

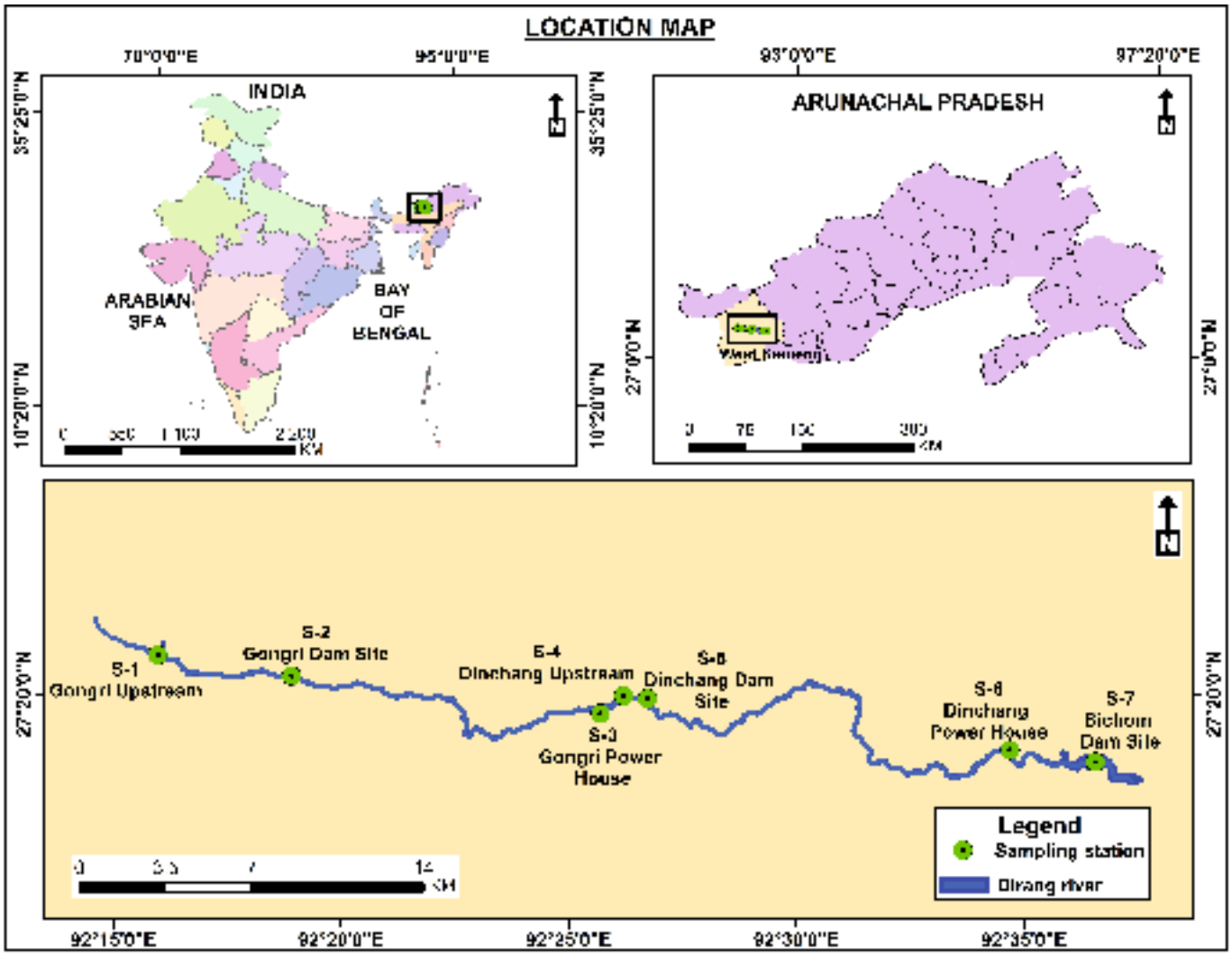
Duration: 2023 to 2024

Scientific Personnel: B. K. Das (PI), Mishal P., Simanku Borah

A scientific study was conducted in river Dirang (locally known as Gongri/Digo/Digean), a right bank tributary of Bichom river, which forms a part of Kameng basin in Arunachal Pradesh in relation to proposed hydropower projects at Gongri and Dinchang. The objective was to generate a database on aquatic environment, fish biodiversity, abundance, species composition, existing fisheries at upstream and downstream to assess the likely impacts of the dams, and possible mitigation measures. Seasonal sampling covering winter, pre-monsoon (Phase I), monsoon and post-monsoon (Phase II) was conducted under the project.



Dirang river at Gongri



Map showing the sampling sites



Flow velocity measurement during study

Ecology and fisheries of Dirang river

Dirang river is relatively unimpaired and bear good ecosystem health as evident from high water transparency, high DO values, slightly alkaline pH, high flow velocity, composition of biotic community, trophic status and low nutrient content at most sampling sites and the water quality parameters were in favorable range for supporting aquatic life/fisheries. The Carlson's trophic state index based on chlorophyll a showed oligotrophic state of the river. Water flow and depth was found to be significantly higher during the monsoon sampling compared to winter, pre-monsoon and post-monsoon. Heavy metal

content of water and sediment (Cr, Cu, Zn, Fe, Mn, Pb and Cd) analyzed using ICP-MS showed no pollution of the river with respect to these potentially toxic elements. The hydrological regime and ecological parameters showed typical hill stream environment congenial for sustaining endemic coldwater fishes and supports a number of restricted range species, breeding and nursery grounds highlighting the conservation significance of this critical habitat.and post-monsoon. Heavy metal content of water and sediment (Cr, Cu, Zn, Fe, Mn, Pb and Cd) analyzed using ICP-MS showed no pollution of the river with respect to these potentially toxic elements. The hydrological regime and ecological parameters showed typical hill stream environment congenial for sustaining endemic coldwater fishes and supports a number of restricted range species, breeding and nursery grounds highlighting the conservation significance of this critical habitat.

A total of 22 fish species belonging to 5 families *viz*., Cyprinidae, Nemacheilidae, Psilorhynchidae, Sisoridae, Anguillidae including five migratory species were recorded from Dirang river during seasonal surveys. Among the 22 indigenous fish species recorded, *Schizothoraxc richardsonii* is categorized as Vulnerable (VU) as per IUCN, while *Neolissochilus hexagonolepis*, *Bagarius bagarius* and *Anguilla bengalensis* are categorized as Near Threatened (NT). Cyprinids were the most dominant group, followed by Sisorid catfishes and loaches. Snow trouts (*Schizothorax* spp.) and chocolate mahseer (*N. hexagonolepis*) are the most important/ keystone fish species in the river as per the assessment. Common Snow trout, *S. richardsonii* is the most dominant fish species in terms of abundance and biomass even though its catch has gradually declined over the years as per stakeholder's perception.
Common fishing gears operated in the river include cast nets, gill nets, hook and line, noose and line and traps. In the Bichom reservoir site,



Experimental fishing



Haul of snowtrout



Hook and line fishing

gill nets were the only gear operated. Fishing is not considered as a primary occupation in the study area for livelihood, however, the riparian communities carry out fishing activities for household consumption or as a recreational activity. The fish caught from the river is disposed locally and play important role in meeting household nutritional requirements.



Interaction with the stakeholders

Project Title: Watershed development plan for micro-watershed within 10 km radius of the 1440 MW Malshejghat Bhorande Pumped storage project in Thane District (Maharashtra)

Funding Agency: Adani Green Energy Limited, Ahmedabad

Duration: 2023 to 2024

Scientific Personnel: D. K Meena (PI), Arun Pandit, S. P. Kamble

The groundwork for this project began in November-December 2023 with a comprehensive survey of the proposed site. Conducted in collaboration with ADANI officials, the survey aimed to understand the existing landscape and plan for micro-watershed development within a 10 km radius.

At the heart of the project lies a 1500 MW power plant, envisioned to harness clean energy. The key element lies in the strategic placement of its reservoirs:

Upper Reservoir: Nestled near Adoshi village in Junnar taluka, Pune District, this reservoir will rest on a plateau, capturing the vital flow of a minor nallah. Its catchment area spans a neat 0.8 sq. km.

Lower Reservoir: Located close to Bhorande village in Murbad taluka, Thane district, this reservoir will also be formed by a minor nallah. With a slightly larger catchment area of 3.0 sq. km, it will play a crucial role in the overall water management system.

The project area falls within Zone 9 of India's agroclimatic zones, known as the Western Plateau and Hills region. This region receives an average annual rainfall of 842.4 millimeters.To understand the land and water conditions, the samples were collected from projects sites across the catchment. The soil samples were analyzed for essential nutrients like nitrogen (N), crucial for plant growth, phosphorus (P), which fuels energy transfer in plants, and organic carbon (OC), a vital indicator of soil structure and fertility. The pH level, measuring acidity or alkalinity,



Scientific team of ICAR-CIFRI with ADANI officials at Malshejghat PSP Project site

was also assessed, as it impacts nutrient availability. The soil composition Sand (%), Silt (%), Clay (%) varied from 84-85, 12-13, and clay3-4, respectively.

Assessment of fish diversity in catchment of Malshejghat PSP Project site

A total of 12 species including *Systomus sarana, Puntius sophore, Rasbora daniconius, Pethia ticto, Tor tor, Garra gotyla, Garra mullya, Parambassis ranga, Clupisoma garua, Glossogobius giuris, Mastacembelus armatus, Sperata seenghala, Mystus cavasius, Channa striatus, Channna marulius* were recorded in the catchment area and as per the information received from the local resiudents.



Soil sample collection from Malshejghat PSP Project site

Title of the project: Watershed development plan for micro- watershed within 10 km radius of the 1200 MW Warsgaon Warangi Pumped storage project village Teckpole and Warangi, Tehsil Velhe and Mahad, District Pune & Raigad (Maharashtra)

Funding Agency: Adani Green Energy Limited, Ahmedabad

Duration: 2023 to 2024

Scientific Personnel: D. K. Meena (PI), Arun Pandit, S. P. Kamble

A preliminary site survey was conducted by scientific team of ICAR-CIFRI in November-December 2023, in collaboration with Adani officials, to assess the existing conditions within a 10-kilometer radius of the proposed 1200 MW off-river PSP scheme. This project involves constructing both upper and lower reservoirs across minor tributaries ("nallahs") in their initial stages near Teckpole (Velhe Taluka, Pune District) and Warangi (Mahad Taluka, Raigad District). The survey aimed to inform the development of micro-watersheds within this area.

Nestled amidst the lush greenery of the Sahyadri ranges, the project site sits proudly within the Western Ghats



Scientific team of ICAR-CIFRI at Teckpole project site

of Maharashtra. This region, classified as Zone-9 in India's Agroclimatic zoning system (Western Plateau and Hills), experiences an average annual rainfall of 3231 mm and a pleasant temperature of 39.4 °C. The abundant rainfall, characteristic of the Western Ghats, plays a crucial role in shaping the region's ecosystem. It nourishes the dense vegetation, feeds numerous rivers and streams, and creates a microclimate that supports a unique biodiversity. During the field survey, soil and water samples were collected from the project site. These samples were then analysed for various parameters, including soil nutrients like nitrogen (N), phosphorus (P), organic carbon (OC), and pH, as well as water quality. The most noticebaly Nitrate-N (ppm), Silicate-Si (ppm), Phosphate-P (ppm) varied from 0.13-0.16,0.039-0.043, and 0.054-0.057, respectively. The soil composition Sand (%), Silt (%),Clay (%) varied from 88-91, 5-10, and 2-5, respectively.

Assessment of Fish diversity of catchment area

This assessment provides valuable insights into the health and biodiversity of the water body at the project site. Understanding the existing fish communities is crucial for planning any development activities in a way that minimizes impact and potentially even enhances the aquatic habitat. A total of 20 species belonging to seven family were recorded with dominance of cyprinidae family. Interestingly, the *Garra mullya* species emerged as the most dominant fish within the identified community.



Soil collection from Teckpole



Collection of Socio-economic data from project site

Collections of data for developing suitable watershed developmental plan

We're currently gathering information about the social and economic situation of the farmers in the project area. This information, along with their feedback, will help us develop appropriate agricultural and engineering solutions to improve their lives. To develop a sustainable water conservation and utilization plan for the project site, we're comprehensively studying various factors. This includes collecting meteorological data, measuring groundwater levels, mapping land use and vegetation, analysing the topography, and understanding the socio-economic scenario of the local community. Based on this data, we will identify the most suitable location and practices for effective water management.

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Project Title: Refinement of management strategies for openwater fisheries of Northeastern India through location and ecosystem-based approaches

Project Code: NEH/20-23/03

Sub Project 1: Sustainable utilization of openwater fisheries in Assam and Nagaland through community participation

Sub Project 2: Enclosure culture in openwaters of Manipur incorporating locally important fish species

Sub Project 3: Refinement of cage culture and species enhancement in Dumbur reservoir of Tripura

Sub Project 4: Refinement of cage aquaculture technology in reservoirs of Mizoram

Sub Project 5: Sustainable utilization of reservoir fisheries of Meghalaya through community participation

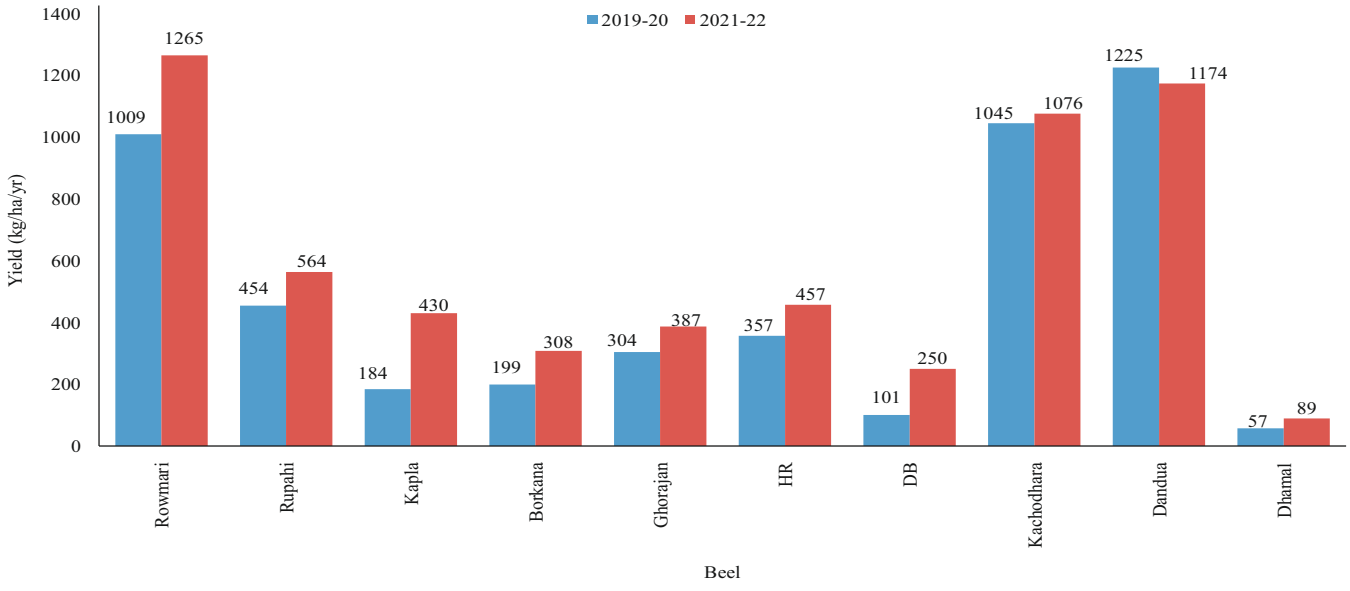
Sub Project 6: Refinement of enclosure culture technologies for stock enhancement and table fish production in openwaters of Arunachal Pradesh

Sub Project 1: Sustainable utilization of openwater fisheries in Assam and Nagaland through community participation

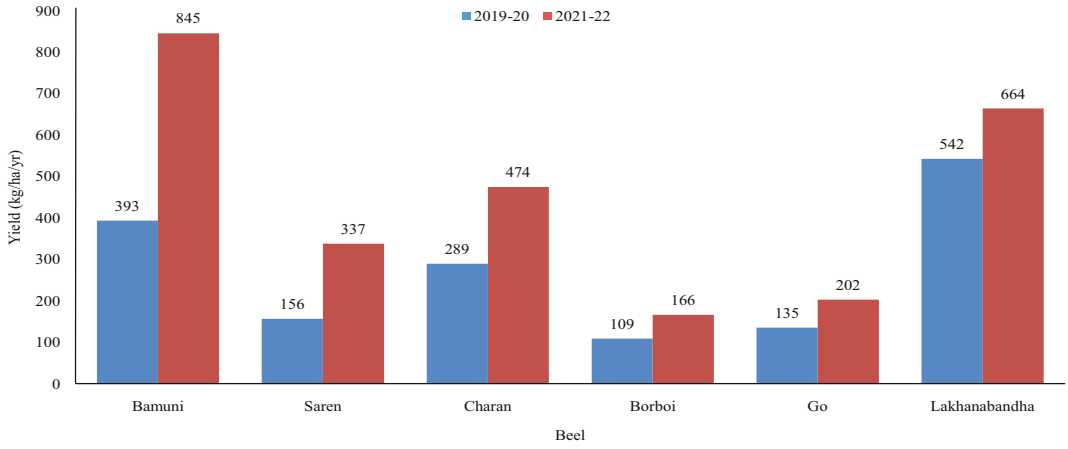
Scientific Personnel: B. K. Bhattacharjya (PI), Simanku Borah (Sub-project leader), A. K. Yadav, Pronob Das, Shyamal Chandra Sukla Das, Raju Baitha, Aparna Roy (w.e.f. 01.04.22)

Impact of fish stock enhancement on fish production in beels of Assam

Impact of fish stock enhancement on fish yield after direct intervention by ICAR-CIFRI was carried out in 10 floodplain wetlands of central and lower Brahmaputra valley. A total of 4.09 lakh advanced fingerlings of IMCs and minor carps were stocked in Rowmari beel of Darrang district, Rupahi beel of Nagaon district, Kapla and Borkona beels of Barpeta district, Ghorajanand Hiragota-Roumari (HR) beels of Kamrup (Rural) district, Duamara-Batamara (DB) beel of Nalbari district, Danduaand Kachodhara beels of Morigaon district and Dhamal beel of Goalpara district, Assam. All beels (except Dhamal beel) are under the administrative control of Assam Fisheries Development Corporation Ltd., Guwahati. Average fish yield of the beels increased from 493.57 kg/ha during 2019-20 to 599.96 kg/ha during 2021-22. Maximum increase in fish yield was observed in Duamara-Batamara beel (148%). Thus, fish stock enhancement led to 21.6% increase in average fish yield in 10 beels of Assam following



Impact of fish stock enhancement on fish production in beels of Assam



Impact of culture-based fisheries on fish production in beels of Assam

CIFRI's intervention. The gross revenue was shared in 60 (Lessee): 40 (Fishers) ratio in all beels except Dhamal beel (equally shared by fishers). A total of 296 fishers got benefited in terms of per capita fish production and revenue per fisher per year from the enhanced fish production in the ten beels.

Impact of culture-based fisheries on fish production in beels of Assam

Culture-based fisheries protocols were demonstrated in closed beels to create awareness among fishers through supplementary stocking of advance fingerlings of IMCs and minor carps in six beels (Bamun, Saren, Charan, Borboi, Go, and Lakhanabandha beel) located in five districts of Central and Lower Brahmaputra Valley, Assam during 2020-21 under NEH component of the Institute. A total of 2.36 lakh advanced fingerlings of IMCs and minor carps were stocked in the beels. Average fish yield of the beels increased from 270.61 kg/ha during 2019-20 to 448.12 kg/ha during 2021-22. Maximum increase in fish yield was observed in Bamuni and Saren beels (115%). Thus, average fish yield in 6 beels increased by 65.6% after intervention by ICAR-CIFRI. The gross revenue was shared equally among the fishers. The program benefited 288 fishers of the six beels in terms of per capita fish production and revenue per fisher per year.

Sub Project 2: Enclosure culture in openwaters of Manipur incorporating locally important fish species

Scientific Personnel: Sona Yengkokpam (Sub-project leader), Dipesh Debnath, T. Nirupada Chanu, Niti Sharma

Demonstration of cage culture technology in Takmu lake of Manipur

ICAR-CIFRI carried out cage culture demonstrations in Takmu pat/ lake (a part of Loktak lake) of Manipur for stock enhancement in Loktak lake in collaboration with the Department of Fisheries, Govt. of Manipur. In the present demonstration, monoculture of *Osteobrama belangeri*, *Ctenopharyngodon idella* 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% crude protein at 3-5% body weight. The initial average length and weight of the stocked fish were 9.25±0.24 cm and 8.68±0.66 g for *O. belangeri*, 12.62±0.31 cm and 20.32±1.22 g for *C. idella* and 9.89±0.16 cm and 7.68±0.25 g for *L. bata*. After 4 months rearing period, *C. idella* gained the highest growth followed by *O. belangeri* and *L. bata* with specific growth rates of 1.76,



Cages at Takmu lake, Bishnupur district, Manipur

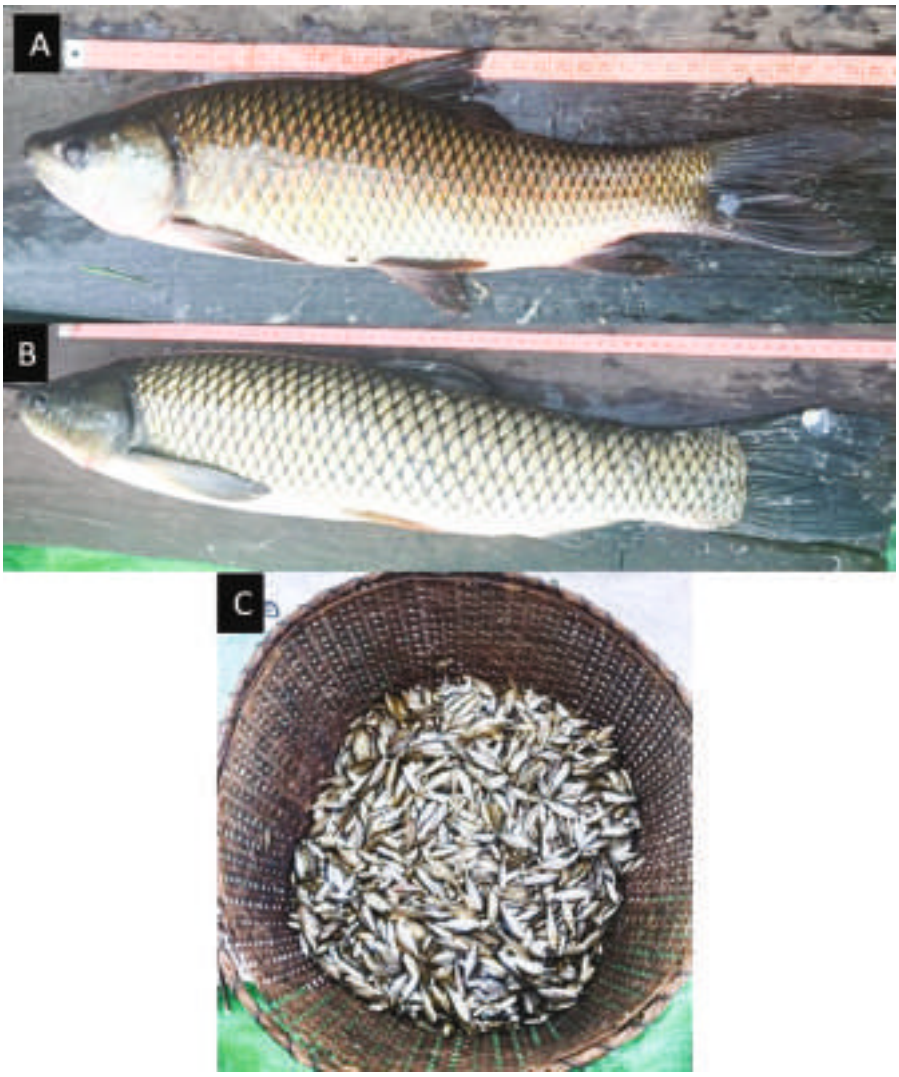


Pens constructed with macrophyte mass as floating structure in Takmu lake, Manipur

1.43 and 1.05, respectively. The reared fish were released in the lake proper for stock enhancement.

Polyculture of *Amblypharyngodon mola, Ctenopharyngodon idella* and *Labeo rohita* in pens at Takmu lake of Manipur

ICAR-CIFRI carried out an innovative pen culture demonstration in Takmu pat of Manipur in collaboration with Department of Fisheries, Govt. of Manipur. A highly demanded small indigenous fish (SIF) *Amblypharyngodon mola* (mola) was cultured in pens along with major carps *viz.*, grass carp (*Ctenopharyngodon idella*) and rohu (*Labeo rohita*) in pen enclosures for one year. 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 were installed and managed by the Thanga Tongbram Leikai Fishery and Duckery Co-operative Society consisting of 32 members, including 14 women. The 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. Majority of the grass carp reached



A. *Labeo rohita,* B. *Ctenopharyngodon idella* and C. *Amblypharyngodon mola* harvested from pens installed in Takmu lake, Manipur

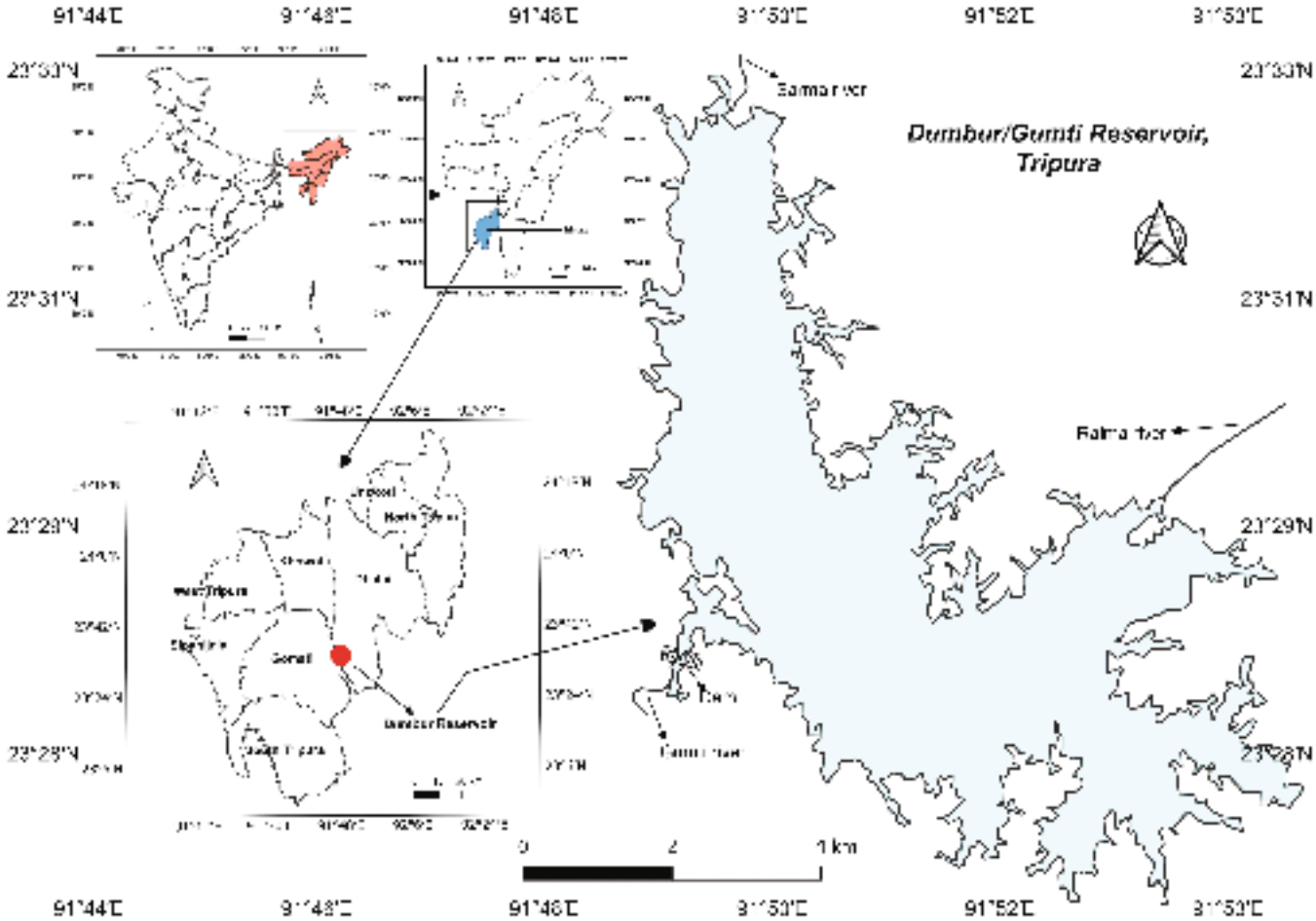
over 2 kg individual size within 6 months, which were partially harvested and marketed. A total of 341 kg grass carp was harvested and sold at Rs. 300 per kg generating an income of Rs. 1,02,300/- in the first harvest. Final harvest after one year of stocking yielded 548 kg grass carp (average weight 2.6 kg), 170 kg rohu (785 g) and 45 kg mola (2.8 g) generating a total income of Rs. 2,24,900/-. Therefore, the total revenue generated at the end of one year was Rs. 3,27,200/-. The fish yield from the pens is estimated at 3680 kg/ ha/ yr.

Sub Project 3: Refinement of cage culture and species enhancement in Dumbur reservoir of Tripura

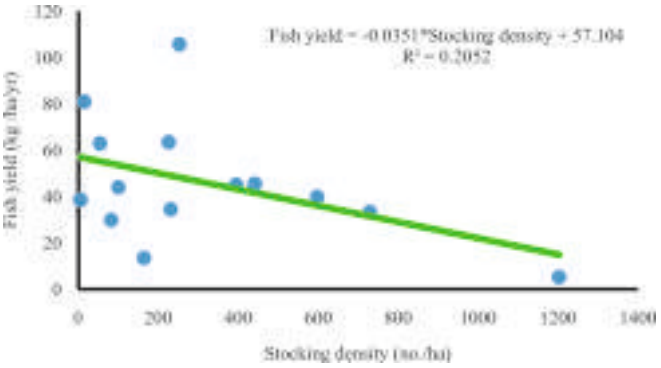
Scientific Personnel: S. C. S. Das (Sub-project leader), D. Debnath, A. K. Yadav, M. Shaya Devi

Impact of fingerling stocking in Dumbur reservoir, Tripura

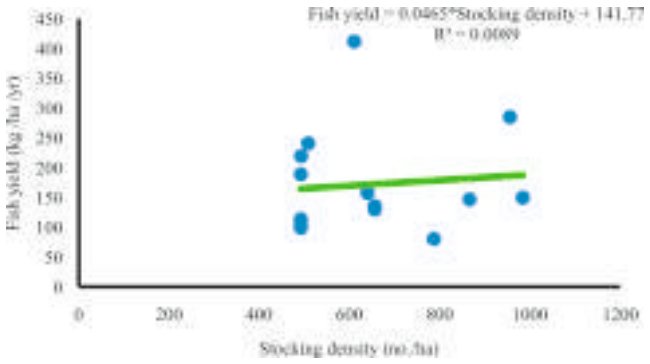
The Dumbur (also called Dumboor and Gumti) reservoir is the only reservoir in Tripura constructed on river Gumti. The river Gumti is one of the largest rivers of Tripura formed by the confluence of two rivulets namely Raima (originating in the Longtarai Range) and Sarma (originating in the Atharamura range). The reservoir is located around Gomti and Dhalai districts between 23°25'45" N and 91°49' 20"E. The water-spread area of the reservoir was earlier estimated at 4500 ha, but have shrink to its present area of 3049.34 ha due to reduced rainfall and continued siltation. The annual data on stocking and fish production (metric tonnes) of Dumbur reservoir for the period from 1978-79 to 2021-22 was collected from secondary source. Based on data availability, available data were divided into two periods, viz., period I (1978-79 to 1992-93) and period II (2006-07 to 2021-22). During period-I, average stocking of fingerlings was 361 no./ha/yr. Fish production from the reservoir ranged between 15.73 and 322.04 tonnes with a mean of 141.74 ±76.55 tonnes during this period. Regression analysis revealed an inverse relationship between fish yield rate (kg/ha/yr) and stocking density (no./ha), though it was statistically insignificant (R^2=0.2052,



Dumbur Reservoir, Tripura



Relationship between stocking density (in the previous year) and fish yield (in the succeeding year) during period I (1978-79 to 1992-93) in Dumbur reservoir



Relationship between the stocking density (in the previous year) and fish yield (in the succeeding year) during period II (2006-07 to 2021-22) in Dumbur reservoir

p=0.104). During period-II, average stocking of fingerlings was 660 no./ha/yr. Fish production from the reservoir ranged between 245.96 and 1254.71 tonnes during this period with a mean of 506.66 ± 257.56 tonnes. Regression analysis revealed a positive relationship between fish yield rate and stocking density, but was statistically insignificant (R^2=0.0089, p=0.738).

Demonstration of cage culture of grass carp in Dumbur reservoir

The Dumbur (Gumti) reservoir (3049 ha) is constructed across the river Gumti in the year 1977 for generation of hydroelectricity. The reservoir draws water from Barak, Raima and Sarma river basins. The Department of Fisheries, Government of Tripura is the apex body for the overall development of fishers and fisheries of this only reservoir in the state. Presently, there are six fishermen cooperative societies operating in the reservoir with approximately 23573 licensed fishers (2010-2022). The Department of Fisheries, Govt. of Tripura hassanctioned more than 1500 cages to be installed in Dumbur reservoir and reportedly there are 888 numbers of cages in the reservoir. It is expected that the fishers will take up the cage culture technology as a profitable venture in the reservoir.

ICAR-CIFRI has demonstrated *cage culture technology with grass carp (Ctenopharyngodon idella) in Dumbur reservoir. A* total of 7,000 fingerlings of *grass carp* were stocked @ 8 no./m^3 in ten cages (6 x 4 x 4 m^3 each; effective water volume 84 m^3) installed in the reservoir. The initial length and weight of the fingerlings were 9.36 ± 0.14 cm and 8.19 ± 0.44 g, respectively. The stocked fishes were fed twice-a-day with CIFRI Cage Grow floating pellets @ 5% body weight for initial 3 months; afterwards it was reduced to 3% of body weight. The health and growth of stocked fishes were monitored monthly. After a culture period of 10 months, grass carp attained an average weight of 790.73±34.22 g with specific growth rate of 1.52 and survival of 92%. The gross fish production achieved from each cage was 509.23 kg (6.06 kg/m^3) and net fish production was 503.5 kg/cage (6.0 kg/m^3).





Cage culture in Dumbur reservoir of Tripura

Sub Project 4: Refinement of cage aquaculture technology in reservoirs of Mizoram

Scientific Personnel: Dipesh Debnath (Sub-project leader), S. C. S. Das, A. K. Yadav, Lianthuamluaia L.

Reservoir fisheries resources of Mizoram

Mizoram has three reservoirs with a total water-spread area of 8,900 ha, namely Tuirial (4,500 ha), Serlui-B (4,000 ha) and Teirei (400). Among them, ICAR-CIFRI studied Tuirial and Serlui-B reservoirs and generated data on fisheries ecology. Tuirial reservoir was created during Tuirial HEP (1998-2004) on River Tuirial, a 60 MW plant built by NEEPCO that was commissioned in 2019. It is relatively new and there is immense scope for developing reservoir fisheries through stock enhancement protocols and cage culture in Tuirial reservoir that will improve livelihoods of fishers. Serlui-B is a small hydroelectric project of 12 MW built across River Serlui and commissioned by BHEL in 2009. This reservoir supports capture fisheries and has potential for cage culture.

Cage culture status in Serlui-B reservoir

Mizoram was the first Northeast state to successfully implement cage culture in Serlui-B reservoir in 2012 under RKVY. Seven batteries of cages each with 16 cages (total cage units = 112) each measuring 6 x 4 x 4 m^3 were installed in the reservoir. Initially, *Pangasianodon hypophthalmus* (pangas) was cultured in the cages. The survival and growth of pangas were not so encouraging mostly due to sub-optimal management of the reared fish. In addition, the local demand of the species was low. Later, grass carp (*Ctenopharyngodon idella*) was cultured in cages, reportedly without remunerative returns. Therefore, the cages were left unutilized at present. However, ICAR-CIFRI has been assisting the Mizoram State Fisheries Department in developing human resource in cage culture through on- and off-campus training programmes.

Governance and Management guidelines

Serlui-B reservoir is under the administrative control of the Department of Fisheries, Govt. of Mizoram. The reservoir is normally leased out to individuals or groups for fishing on annual lease system. The lessee engages about 20 number of fishers' groups who catch fish by gill net, 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. Based on field studies and information collected through focused group discussion, the following recommendations could be made for utilizing the cage culture infrastructure available in Serlui-B reservoir: (i) the Dept. of Fisheries can invite expression of interest from private parties for leasing the cage infrastructure, (ii) ICAR-CIFRI would conduct training programmes on cage culture for the selected private parties, and also (iii) monitor fish growth and survival as and when required.



Sampling and cage culture setup in Serlui-B reservoir, Kolasib, Mizoram

Sub Project 5: Sustainable utilization of reservoir fisheries of Meghalaya through community participation

Scientific Personnel: Pronob Das (Sub-project leader), Sona Yengkokpam, Dharmendra Kumar Meena, Simanku Borah

Ecology and fisheries of Umiam reservoir, Meghalaya

Umiam reservoir is located in Ri-Bhoi District of Meghalaya. The reservoir was commissioned in 1965 and it falls under jurisdiction of Khasi Autonomous District Council. It was formed due to commissioning of the Umtru-Umiam Hydro-electric project in 1965.The morphometric features of Umiam reservoir is given in Table.

The reservoir water level increased from June-July and decreased from November- December and reached lowest level during April-May.



A view of Umiam reservoir, Meghalaya

Table: Morphometric features of Umiam reservoir, Meghalaya

Category	Characteristics
Area (ha)	500
Category (small/ medium/ large)	Small
Latitude and Longitude	25º39'30" N and 91º43'51" E
Altitude	900 m above mean sea level (MSL)
Maximum reservoir level	3220 ft
Minimum reservoir level	3150 ft
Gross storage level	3220 ft
Dead storage level	3150 ft
Total length of the dam	640 ft
Maximum height of the dam	238 ft

Environmental variables

Physio-chemical parameters of Umiam reservoir were recorded during monsoon, post-monsoon, winter and pre-monsoon season. Sediments are acidic (pH 5.54 -6.37) and sandy loam in nature with highest composition of sand (62-74%) followed by silt (16-27%) and clay (11-20%). The water quality parameters were favourable for fish production and important parameters estimated were temperature (16.70-29.12ºC), pH (5.78-8.84), dissolved oxygen (5.67-9.13 mg/l), free carbondioxide (1.02- 5.47 mg/l), total alkalinity (24-58 mg/l), transparency (1.75-2.37 m), total phosphorous (44-126 µg/l) cholorophyll-a (23-47 µg/l), specific conductivity (39-92 µS/cm) and total dissolved solids (16-45 mg/l).

Biotic variables

Biotic variables in Umiam reservoir were recorded during the four seasons, *viz*., monsoon, post-monsoon, winter and pre-monsoon. The reservoir had moderately high density of plankton (617-873 no./l) and periphyton (556-982 no./cm^2) and they varied between different stations as well as in different seasons.The phytoplankton population was dominated by Bacillariophyceae (46.67-75.28%), followed by Chlorophyceae (12.45-30.23%), Desimidaceae (5.09-15.25%), Myxophyceae (4.18-9.34%) and Gonatozygaceae (1-2.97%). Periphyton population was dominated by Bacillariophyceae (48.27-63.14 %), followed by Chlorophyceae (15.56-23.72%), Myxophyceae (12.07-17.86%), Gonatozygaceae (4.92-8.61%) and Desimidaceae (1.32-5.78%).

Fish community structure

The fish catch from Umiam reservoir was dominated by common carp (*Cyrprinus carpio*), which contributed 70-80% of the catch. This species has established in the

reservoir whereas the catch of indigenous chocolate mahseer (*Neolissocheilus hexagonolepis*) has declined over the years. Five varieties/ strain 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 from the reservoir. Among these, scale carp was recorded most frequently. Leather and Amur carp was recorded for the first time in the reservoir.

A total of 38 fish species has been documented from primary and secondary source. Order Cypriniformes and Cyprinidae family contributed to the maximum number of species in the reservoir. Exotic fish species *Clarias gariepinus* (highly carnivorous) is also recorded from the reservoir, which is a major threat to ichthyofaunal diversity of the reservoir.

Fish stock enhancement through stocking of cage reared fish

The technological backstopping provided for reservoir fisheries management of India by ICAR-CIFRI resulted in substantial increase in average fish production. We proposed to practice stock enhancement regime of reservoirs and lakes of Meghalaya for enhancing fish production in a sustainable manner by stocking fingerlings of carps @ 2,000 fingerlings ha^{-1} for small reservoirs.

ICAR-CIFRI successfully carried out cage culture in Umiam Reservoir, Meghalaya in collaboration with ICAR Research Complex for NEH Region, Umiam through participation of tribal fisherwomen under the Ri-Bhoi Farmers' Union (RFU). Cage culture trial was carried out in CIFRI-GI cage (6 nos.; 100 m^3/cage; effective water area: 90m^3/cage) using CIFRI-CageGrow floating feed in the reservoir. Six CIFRI-GI cages (5x5x4m) were stocked with fingerlings of *Cyprinus carpio* (60%), *Barbonymous gonionotus* (20%) and *Labeo rohita* (20%) with a stocking density of 10-20 no./m^3. After six months of rearing, an average fish production of 5-6 kg/m^3 was achieved. A part of the harvest was sold at the cage site benefiting the 25 fisher women families of the Ri-Bhoi Farmers'



Cyprinus carpio harvested from cages



Involvement of women in cage aquaculture

Union. A major portion of the cage reared fishes consisting mainly of rohu were released in the reservoir as a fish stock enhancement measure for sustainability.

Management guidelines

Based on our study, following management guidelines can be suggested for sustainable utilization of the reservoir fisheries: (a) Protection from habitat degradation; (b) Conservation of biodiversity; (c) Control of introduction of harmful exotic fishes (like *Clarias garipeneus*); (d) Fish stock enhancement in the reservoir for production enhancement; (e) Cage culture through participatory approach involving local community; (f) Promotion of recreational fishery; (g) Promotion of sustainable fishing; (h) Proper institutional mechanism for maintenance of fisheries (including production) database.



Fish stock enhancement in Umiam reservoir

Sub Project 6: Refinement of enclosure culture technologies for stock enhancement and table fish production in openwaters of Arunachal Pradesh

Scientific Personnel: Anil Kumar Yadav (Sub-project leader), Sona Yengkokpam, Simanku Borah

Study of fisheries and ecology of Borbeel, Arunachal Pradesh

Borbeel located (N 27° 44' 37"; E 95° 49' 81") at Namsai district, Arunachal Pradesh is an open beel having connection with the river Dihing. The beel has a water-spread area of 234 ha and is under the administrative control of the Department of Fisheries, Govt. of Arunachal Pradesh. It is an open access water body and is being managed as capture fisheries. The ecology and fisheries of Borbeel has been documented.

Water quality parameters

Physico-chemical parameters assessed in Borbeel indicated suitable environment for fish



A view of Borbeel, Arunachal Pradesh

production. The range of water quality parameters estimated were: temperature 21.57–32.10°C, pH 7.01–7.37, dissolved oxygen 4.5–6.7 mg/l, free carbondioxide 1.09–5.57 mg/l, transparency 1.57–2.00 m, total phosphorus 17.12–42.13 µg/l, chlorophyll a 31.25 – 56.08 µg/l, total alkalinity 103.76–147.37 mg/l, specific conductivity 228.50–336.52 µS/cm and total dissolved solids 110.26 – 285.45 mg/l.

Trophic status

Trophic State Index (TSI) of Borbeel in Namsai district, Arunachal Pradesh was estimated based on Carlson's Trophic State Index (Carlson, 1977). TSI was calculated based on transparency, total phosphorus and chlorophyll-a content of water. A TSI value of 56.71 was estimated for Borbeel indicating that the beel is moderately eutrophic.

Biotic communities

Borbeel is heavily infested with macrophytes with 70-80% of its surface area covered with macrophytes dominated by *Eicchornia crassipes.* The other free floating macrophytes were *Pistia stratoites, Salvinia* sp. and *Azolla* sp. The macrophyte biomass based on wet weight was estimated at 12.5 kg/m^2. Submerged macrophyte consisting of *Ceratophyllum demersum* and *Hydrilla* sp.covered most part of the bottom of the beel.

The beel had low phytoplankton population ranging from 68-180 units/l. Cyanophyceae (47.5%) dominated the phytoplankton population followed by Bacillariophyceae (37.5%) and Cyanophyceae (15%). A total of 13 genera of phytoplankton were recorded from Borbeel during the seasons. In case of periphyton, Bacillariophyceae (52.18-55.0 %) was dominant in Borbeel followed by Chlorophyceae (20-35%) and Cyanophyceae (10-21.7%). Total periphyton population ranges from (750-937.50 no. /cm^2). A total of 15 genera of periphyton were recorded from Borbeel.

The abundance of macrophytes-associated fauna was low (28 nos./ m^2) and consisted of small indigenous fishes (6 species), insects (7 species), molluscs (2 species) and crab (1 species). The number of macro-benthic fauna observed in the beel was low with average density of 15 no. /m^2. It was represented by *Pila globosa*, *Ranatra elongata*, *Dysticus* sp., dragonfly larvae and may fly larvae.

Ichthyofaunal Diversity and fish yield

A total of 52 fish species were recorded from Borbeel belonging to 22 families and 8 orders. The order Cypriniformes (19 species) contributed highest number of species followed by Perciformes (12 species), Siluriformes (10 species) and others. Among the families Cyprinidae (17 species) contributed highest number of species followed by Channidae (5 species), Bagridae (4 species), and Mastacembelidae (3 species). Besides indigenous species, four exotic fishes (*Cyrpinus carpio, Ctenopharyngodon idella, Hypothalmicthys molitrix* and *Piaractus brachypomus*) were also recorded from the beel.

The fish yield of the beel estimated in different season varied between 35-155 kg/ha/yr. *Puntius* spp. dominanted the fish catch of Borbeel. High macrophyte infestation, over-exploitation of major fishes and lack of scientific management like stock enhancement practices, macrophyte management, etc. led to poor fish yield of the beel.

Feasibility of cage culture in Borbeel

A battery of 16 cages (Cage dimension: 6 x 4 x 3 m^3 each) was installed in the Borbeel by Department of Fisheries, Govt. of Arunachal Pradesh. The beel is highly infested with floating and sub-merged aquatic macrophytes, rendering it unusable for cage culture and fisheries activities. The guidelines for selection of waterbody/ site for installation of cage culture was not followed by the Department. However, the cage culture activities in the beel may become favorable only after macrophyte clearance in and around the cages. The fishers inhabiting the Borbeel may be motivated for cage culture activities in the beel and dense macrophyte mass in the beel may be removed through community participation.



A view of cages installed in Borbeel by Dept. of Fisheries, Arunachal Pradesh

Scheduled Tribe Component (STC) Programme



वार्षिक प्रतिवेदन

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Scheduled Tribe Component (STC) Programme

Stakeholder consultation and ornamental fish farming demonstration programme at hilly region

ICAR - CIFRI in collaboration with Hemnagar Sundarbans Dreams and Rotary Royal Bhubaneswar organized a stakeholder consultation cum mass awareness and ornamental fish farming live demonstration programme for the tribal beneficiaries at Hilly region of Darjeeling district of West Bengal on 6th February, 2023 under TSP programme.

Demonstration was organized for the tribal beneficiaries comprising 20 male and 10 female from 6 villages of Shittong, Khasmahal. During the awareness programme Dr. B. K. Das, Director, ICAR-CIFRI outlined the objectives of the programme and expressed his views that how it will help the beneficiaries to get economic empowerment and 'Atmanirvar', a flagship programme of Honourable Prime Minister. The beneficiaries were sensitized on different aspects of technical know how on ornamental farming and also addressed the issues of growth, maturation and prospects of marketing of ornamental fishes.

Enabling tribal fishers through distribution of fishing implements

The Institute extended its support to the fishermen cooperative societies belonging to Scheduled Tribe (ST) communities. The outboard engines (5 nos.) were supplied to the societies with the aim of making motorization of traditional boats primarily used in the reservoir. The societies of ST fishers of 5 reservoirs located in two districts, namely Ranchi and Simdega, each society received one outboard engine. The recipient societies are Meheshpur Matsyjivi Sahayog Samiti Ltd. (Getalsud reservoir, Ranchi), Keundih Jalashay Matsyjivi Sahayog Samiti Ltd. (Kansjor reservoir, Simdega), Uttiyel Matsyjivi Sahayog Samiti Ltd. (Ramrakha reservoir, Simdega), Chinda/Kelaghag Jalashay Matsyjivi Sahayog Samiti Ltd. (Chinda/Kelaghag reservoir, Simdega) and Larba Jalashay Matsyjivi Sahayog Samiti Ltd. (Larba reservoir, Simdega) of Jharkhand.



Distribution of FRP tanks among fishers of Shittong

Demonstration of outboard engines at Getalsud reservoir

The demonstration of the motorised FRP boats was organised at Getalsud and Kelaghag reservoir of Simdega, respectively. Purpose of the distribution of motorised boats will help in monitoring fishing and fish culture activities in enclosure systems of the reservoirs.

Tribal Women of Sundarbans trained on ornamental fish farming

Ornamental fish farming training was organized at ICAR-CIFRI, Barrackpore for 19 rural women of Kultali, Sundarbans during 14 to 16 February, 2023 with a mission to develop the livelihood of the rural community through ornamental fish culture. The training programme was designed based on hands-on sessions, class room teaching and exposure visit. Knowledge and skill on fabrication of an aquarium, natural and artificial feed preparation, feeding technique, breeding technique of livebearers and egg layers ornamental fish, maintenance and monitoring of aquarium such as



Distribution of outboard engines among fishers of Getalsud reservoir



Capacity building programme on ornamental fish farming

water quality management, use of aerator and thermostats, selection of compatible aquarium fish species etc were imparted through the training. Exposure visit was conducted to an ornamental fish market and farming units. At the valedictory session, manual on ornamental fish farming written in Bengali were distributed among the trainees.

Training to strengthen the livelihood of people of hilly region through Ornamental fish farming

CIFRI conducted a training programme on "Inland ornamental fisheries management for income generation & livelihood enhancement in Hilly region" during 28th April to 1st May 2023. In this training programme 26 candidates including 8 females from Sittong, Manju Gaon and Mongu of Darjeeling district have participated. During this session, Dr. B. K. Das, Director, ICAR-CIFRI addressed and advised people to continue ornamental fish farming on a mission mode approach in clusters so that, people can get better price during marketing.

ICAR-CIFRI initiated 'Mission 3000' programme at Kultali

ICAR-Central inland fisheries Research Institute Organised Mahila Matasyajibi Sammelan (Women Fishers Meet) at Kultali, Sundarbans, West Bengal in collaboration with Kultali Milantirth Society on 19 May



Glimpses of training on ornamental fish farming



Distribution of fish seed & feed by the DG, ICAR

2023. Dr. Himanshu Pathak, Secretary, Department of Agricultural Research and Education, Govt. of India and Director General, Indian Council of Agricultural Research inaugurated the meet as the Chief Guest. Other distinguished guests were Dr. B. K. Das, Director, ICAR-CIFRI, Dr. Gouranga Kar, Director, ICAR-CRIJAF and Dr. D. B. Shakyawar, Director, ICAR-NINFET. Honourable Secretary, DARE & DG, ICAR distributed fisheries inputs like fingerlings, ICAR-CIFRI Cagegrow feed etc. to 30 tribal women fish-farmers who have backyard ponds with an average area ranging from 0.02 ha to 0.04 ha in their household. These women beneficiaries have been selected from a vast area covering 38 hamlets under 17 GPs of two Community Development Blocks namely, Gosaba and Basanti of Sundarbans. More than five thousand fishers including 3000 women fishers participated in the meet.

Pen culture demonstration cum awareness programme at Chhattisgarh

Pen culture intervention is a tool to raise in situ fish seed in the reservoir which will not only improve the production of the reservoir, but also reduce the cost of production, subsequently the livelihood of the fishers will be improved. ICAR-CIFRI organized Penculture demonstration programme in collaboration with DOF, Chhattisgarh in five small reservoirs *viz*. Baherakhar, Sutiyapath, Rabo, Paralkot and Ghunghutta of the state during 24th May to 4th June, 2023 aiming to raise in situ fingerling in the pen for enhancing the production of the reservoir cost-effectively. Two scientific team demonstrated CIFRI HDPE installation and stocking in the selected reservoirs. After the demonstration, sensitization programme was organized at the reservoir site to aware the beneficiaries about the importance of Pen culture for fish production enhancement in the reservoirs. A total of 340 tribal beneficiaries attended the demonstration cum awareness programme.

Alternative livelihood options for tribal women of Birbhum, West Bengal

ICAR-CIFRI took the initiative to stand by the rural populace belonging to the ST community by extending its support in terms of fisheries inputs as



Distribution of FRP tanks



Distribution of fish seed in Kultali, Sundarbans

well as technical know-how for generating an alternative livelihood option. CIFRI has taken a new initiative to support the rural ST women in developing their knowledge and skill in ornamental fish farming practices for generating alternative livelihood. This initiative is a part of CIFRI's 'Mission 3000', target to cover 3000 women across the country with active support for their economic empowerment. For this purpose, CIFRI organized one 'Input Distribution and Demonstration programme' on Ornamental Fish Farming under STC on 4th July 2023 at the campus of Rathindra KVK, Shrniketan, Birbhum. Thirty tanks along with kits were distributed to the women of tribal community.

Initiative to address SDG 5

ICAR-CIFRI has been supporting the tribal community, one of the most vulnerable sections of the population of Sagar Island by providing technological inputs for rejuvenating their livelihood through fish farming under the STC programme. In this programme, CIFRI distributed fisheries inputs to 252 ST woman-fishers who have backyard ponds with an average area ranging from 0.02 ha to 0.04 ha in their household. All the households belonging to Scheduled Tribe community residing in Sagar Island have been covered in this programme. CIFRI has distributed 6 kg of IMC seeds, 20 kg of lime and 90 kg of fish feed to each beneficiary in this programme under the Scheduled Tribe Component.

Distributed fish feed to the tribal farmers of Ri-Bhoi district, Meghalaya

ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Regional Centre, Guwahati in collaboration with the Department of Fisheries (DoF), Govt. of Meghalaya organized an "Awareness-cum-fish feed distribution programme" at Nongpoh, Ri-Bhoi District, Meghalaya on 18th October,23 for the benefit of 50 tribal fish farmers of the state. Shri Andrew L. Myrthong, MCS, Assistant Commissioner, Ri-Bhoi District, Government of Meghalaya; graced the programme. It was attended by 60 participants (fish farmers and fisheries officials) of Ri-Bhoi District.

Mass awareness programme on responsible fishing and distribution of coracles at Hogenakkal, Tamilnadu

A mass awareness programme on responsible fishing was organized by the Bengaluru Regional Centre of ICAR - Central Inland Fisheries Research Institute (CIFRI) at Hogenakkal in Dharmapuri District, Tamil Nadu on 02 November 2023 and was attended by 50 fishermen. Coracles were distributed to 10 tribal fishers.

Pumpset distribution at Paloterghat, Kakdwip

Two nos. of pumpset were distributed to the fisherwomen belonging to Scheduled Tribe community at



Distribution of pumpsets among women fishers of Kakdwip, Sundarbans



Training of tribal fishers of Odisha

Palotghat, Kakdwip, South 24 parganas, Sundarbans of West Bengal on 20th November, 2023.

Capacity building of the tribal women of Odisha

ICAR-Central Inland Fisheries Research Institute, Barrackpore organized a three-day training program on "Opportunities in ornamental fish rearing and management for income generation" for the tribal women beneficiaries from Salia-sahi, Odisha during 21-23, December 2023 under Tribal Sub Plan at ICAR-CIFRI, Barrackpore. The training program was organized to strengthen the skills and knowledge of the tribal women in different aspects of ornamental fish rearing. A total of 12 tribal women beneficiaries from Salia-Sahi area of Bhubaneswar, Odisha have participated in this training program.

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Scheduled Caste Sub Plan (SCSP) Programme



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Scheduled Caste Sub-Plan (SCSP) Programme

ICAR-CIFRI has implemented the Scheduled Caste Sub Plan (SCSP) for livelihood development of Scheduled Caste community through inland fisheries development. Various fisheries technologies like ornamental fish culture, backyard pond fish culture, culture based fisheries (CBF) and pen culture has been demonstrated. The demonstration was carried out in a participatory mode with the involvement of the local SC community. The technology was demonstrated by providing the fisheries inputs and conducting training and awareness programs to enhance capacity. This enables beneficiaries to adopt the technology for the development of their livelihoods. The SCSP scheme carried out by ICAR-CIFRI has benefitted more than 3000 SC people in the form of fisheries inputs, capacity building, sensitization and technical assistance.



Fish seed distribution in Sundarbans



Distribution of fishery inputs among fishers of Sundarbans

Empowering women for sustainable livelihood development through backyard pond fish farming

Backyard pond fish culture is a simple intervention which is considered as one of the best options to improve livelihood of rural community. ICAR-CIFRI adopted SC women of Sunderbans for livelihood development through inland fisheries. Women Fishers Meet (Mahila Matasyajibi Sammelan) was organized to sensitize the women of Sunderban on the opportunities of inland fisheries for livelihood development. Dr. Himanshu Pathak, Secretary, DARE, Govt. of India and Director General, ICAR inaugurated and graced the occasion. Various fisheries inputs such as fish seed, fish feed and lime were provided to the 470 SC women from 38 hamlets under 17 GPs of Gosaba and Basanti block of Sundarbans for backyard pond fish farming.

An awareness programme on backyard pond fish culture was organized in collaboration with Kultali Milon Tirtha Society at Kultali, South 24 Parganas, West Bengal. Fisheries inputs in the form of fish seed and feed were distributed to the 100 SC women from six villages (Amjhara, Basanti, Ramchandrakhali, Uttar Mokamberia, Fulmalancha, Charavidya) of Basanti, Sunderban. Input distribution and awareness programme on Backyard ponds fish culture was also conducted in Hasnabad and Dakshin Dinajpur in West Bengal. Fish seed and feed were distributed to 102 women in Hasnabad and 104 women in Dakshin Dinajpur.

Income generation and livelihood support through Ornamental Fish Culture

ICAR-CIFRI is providing a platform on ornamental fish culture for uplifting the livelihood of the rural SC women. The institution is



Capacity building on ornamental fish farming



Distribution of inputs of ornamental fish farming

extending support towards establishing the ornamental fish culture units among the SC women in different places of West Bengal under SCSP. Awareness, demonstration and hands on training were given to the beneficiaries before establishing the ornamental fish culture clusters. The Institute demonstrated ornamental fish culture for 50 beneficiaries of the SC community of Kurseong and Mirik, Darjeeling district of West Bengal. Each beneficiary was provided with a startup ornamental fish culture kit. A live demonstration was organized for the ornamental fish rearing and its maintenance during the initiatives.

In collaboration with Hemnagar Sundarban Dreams and Rotary Royal Bhubaneswar, ICAR-CIFRI organized a mass awareness cum live demonstration on ornamental fish farming at at Sukhiya and Manju Tea Estates in the Hilly region of Darjeeling district, West Bengal. The demonstrations were attended by 90 beneficiaries of the SC community and received inputs for ornamental fish culture.

ICAR-CIFRI adopted 50 SC women of Sajnekhali, West Bengal and distributed ornamental fish culture unit consisting of FRP tank, aerator and other accessories, ornamental fish and ornamental fish feed to the individuals. In collaboration with Sasya Shyamala KVK, Sonarpur, West Bengal awareness cum input distribution programme on ornamental fish culture was organized. Ornamental fish culture units were received by 22 women beneficiaries who participated in the demonstration cum start up programme. The Ornamental fish culture inputs were distributed to 28 numbers SC women of Balagarh, West Bengal for sustainable livelihood development. An awareness programme on ornamental fish culture was carried out in Dakshin Dinajpur, West Bengal, where 50 SC women received ornamental fish culture units.

Culture based fisheries and enclosure culture for livelihood development

ICAR-CIFRI is promoting CBF and enclosure culture technology for



Dispatching of fishery inputs to the fishery Cooperatives of West Bengal

improving the livelihood of SC community by increasing fish production. The pen culture technology and CBF was carried out in a participatory mode in the adopted wetlands of West Bengal. Technology based assistance was provided to the adopted wetlands throughout the year. HDPE pens were provided to Chamta FCS, West Bengal for seed raising for stocking purposes of CBF in the floodplain wetland. ICAR-CIFRI had already demonstrated the in-situ fish seed raising through pen culture in wetlands of West Bengal which has motivated the local community to implement pen culture in a participatory mode. FRP boats along with engines were distributed to individual wetlands for efficient income generation. Fish feed and FRP pens were redistributed to extend the ICAR-CIFRI support to the SC Fishers community. Technical assistance for enhancement of fish production has been adopted in the reservoirs of Jharkhand, Odisha, Karnataka and Tamil Nadu were given.

Capacity Building of SC fishers

For enriching the capacity of the SC fishers several on and off campus trainings were organized with the goal of improving livelihood improvement, nutritional security and extra income generation through inland open water fisheries, ornamental fish culture and backyard pond fish production. ICAR-CIFRI trained more than 200 SC beneficiaries including females of the Sunderbans, Dakshin Dinajpur, and the hilly areas of West Bengal.

Interactive workshop

Interactive workshop on "Livelihood development addressing SDG through inland open water fisheries" was conducted at ICAR-CIFRI, Barrackpore under SCSP on 18 August 2023. The workshop was intended to draw out the way forwards for the sustainable enhancement of fish production in



Capacity building on ornamental fish farming at hilly region of West Bengal



The Director addressing the women fishes on livelihood improvement



Input distribution of ornamental fish farming

the adopted wetlands of the institute. Scientists, technical staff, research scholars, and 32 fishermen from the 16 adopted wetlands under the SCSP programme in Murshidabad, Nadia, and North-24 Parganas districts of West Bengal participated in the workshop.



Participants of the workshop on "Livelihood development addressing SDG through inland open water fisheries"

New Initiatives



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New Initiatives

Strengthening the livelihood of fishers and farmers in East Kolkata Wetland

A new project, consisting of 3 sub-projects and funded by the East Kolkata Wetland Management Authority, Department of Environment, Government of West Bengal was taken up in the East Kolkata Wetlands since December 2023 to strengthen the livelihood of fishers and farmers of the East Kolkata Wetland area. The aims of the project are to assess the aquaculture production system of the East Kolkata Wetlands, its present status, issues and challenges faced by the fishers, occurrence of fish diseases, feasibility of extending support to the fishers, understanding the pollutant accumulation status and feasibility of certification of fish products. The initiative will also deal with managing invasive fish species through adoption of suitable management practices. The project objectives also include agricultural production processes including field crops, horticultural, medicinal and floricultural crops and scope of improvement of such systems.

Cage culture in Kangsabati reservoir

The Institute initiated cage culture activities in the Kangsabati reservoir, Bankura, West Bengal for table fish production in 32 CIFRI GI Cages under a project funded by Govt. of West Bengal. The objectives of this development project are to disseminate and demonstrate the table fish production technology in cage culture; strengthening the capacity of Directorate of Fisheries, the resource user communities and cooperatives. A MoU was signed with the Directorate of Fisheries, Government of West Bengal on 1 March 2023.

IoT based DO management system

The Institute has taken up this project to harness potentials of IoT in inland fisheries. Water quality parameters, especially dissolved oxygen (DO) have significant influences on aquatic organisms. Therefore, an IoT based DO management system, connected to the cloud via internet, has been developed which continuously monitors and well as manages the DO level in the waterbody. The system has been tested in different water bodies and results have been validated to satisfactory levels.

Drone based vertical water sampler

Water sampling in open water resources is a challenge due to vastness, inaccessibility, rugged terrain, etc. To overcome the difficulty, a drone based vertical water sampler has been developed using a remotely controlled water sampler. The water sampler can collect one litre of water in a single attempt. It will be useful for inland aquatic ecosystem health monitoring programs of Government, Non-Governmental agencies and research organizations. For physical survey of vast water resources and estimation of macrophyte coverage etc. an RGB sensor mounted on aerial drone has also been developed.

Study of the changing dynamics of labour migration on employment, livelihoods and resource productivity patterns in the Indian marine fisheries sector

Complex linkages associated with labour migration and resulting socio-economic challenges need to be analyzed in a comprehensive manner, which is more significant when considering a marginalized group such as migrant. The project is an attempt to understand the labour migration pattern in the marine as well as inland fisheries sector and its subsequent consequences. The project started in the month of June 2023.

Improving livelihood of tribal communities through scampi fisheries enhancement technologies in under-utilized reservoir resources of Jharkhand

The giant freshwater prawn (GFP), *Macrobrachium rosenbergii*, commonly called 'scampi', is the most important culturable freshwater prawn with a fairly high growth rate, high market value, and tolerance to a wide range of temperature and salinity. The Govt. of Jharkhand had shown interest in popularizing scampi fisheries in reservoirs in order to ensure species diversification and livelihood security of tribal communities. The Institute has initiated the project in May 2023 at a tentative budget of Rs. 102.30 lakhs. So far, 8 lakh seeds of *Macrobrachium rosenbergii* have been stocked in three reservoirs of Jharkhand with an estimated potential yield of 12-15 kg/ha.

Fish stock enhancement including Hilsa and livelihood improvement for sustainable fisheries and conservation in River Ganga

National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India has funded the 3rd phase of the project with different work components, *viz*., (i) Captive breeding of commercially important indigenous fish and ranching programme through livelihood enhancement and conservation in Arth Ganga concept, (ii) Establishment of Hilsa stock in middle stretch of River Ganga through ranching of Hilsa seed bred through captive breeding, and (iii) Community sensitization on dolphin and fish biodiversity including Hilsa for improving livelihood for fishers.

Institute-industry interface on waste-to-wealth products

The Institute organised an Institute-

Industry Interface meeting on waste-to-wealth products on 15 March 2023. The meeting was centred around the technology of silkworm pupae-based fish feed developed recently. The meeting attended by Dr. B. K. Das, Director, and all staff of the ICAR-CIFRI; Dr. K. Satyanarayana, Director, CSB-Central Tasar Silk Research and Training Institute, Ranchi; and industry representatives.

Mahila Matsyajibi Sammelan

In collaboration with the Kultali Milan Tirtha Society the Institute organized *Mahila Matasyajibi Sammelan* (Women Fishers Meet) at Kultali, Sundarban, West Bengal on 19 May 2023. Dr. Himanshu Pathak, Secretary, DARE, Govt. of India, and DG, ICAR, inaugurated the event as the Chief Guest. Dr. Pathak, in his address, said that the rural population of Sundarban is suffering due to continuous natural disasters like cyclones. He acknowledged excellent and exceptional works carried out by ICAR-CIFRI for livelihood enhancement of women fishers in the Sundarban. More than five thousand fishers, including 3,000 women, participated in the meet.

Customized catch assessment survey software for the Government of Chhattisgarh

A customized catch assessment survey software was developed for the Department of Fisheries, Government of Chhattisgarh. The CAS ver. 2.0 software is suitable for fish catch estimation of waterbodies below 10 ha for fishes like IMC, pangas, tilapia, and prawn-specifically. Dr. B. K. Das, Director, ICAR-CIFRI, handed over the software to Mr. Y. P. Singh, Assistant Statistical Officer, Department of Fisheries, Government Chhattisgarh on 20 September 2023.



State-wise and Resource-wise Reach of ICAR-CIFRI in 2023



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State-wise and Resource-wise Reach of ICAR-CIFRI in 2023

State	Resource	Activity
Andhra Pradesh	Reservoir	• Development of ecosystem-based fisheries management strategies for upper Manair reservoir
Arunachal Pradesh	River	• Planning and design of fish hatchery at Bichom dam site • Ecology and fisheries of Dirang river
	Reservoir	• Assessment of ecology and fisheries of Bichom reservoir
	Wetland	• Ecology and fish diversity and vulnerability study in Borbeel, Namsai district
Assam	River	• Fish diversity and estimation of fish landing and catch structure in river Barak • Formaldehyde contamination in fish samples collected and analyzed from Uzanbazar and Betkuchi wholesale markets
	Wetland	• Assessment of fisheries and ecology of Dandua, 46-Morakolong, Lakhanabandha, Rupahi, Algapuranua, Sone, Tamranga, Deepor and Dhir beels • Fish diversity in Rowmari beel located in Orang National Park, Darrang district • Assessment of C-sequestration potential from Deepor beel • Study of effectiveness of stocking of Indian major and minor carps in 16 floodplain wetlands • Impact of high pre-monsoon flood in floodplain wetland fisheries in CBV Zone
	HRD	• Demonstration of *eMatsyaApp* for collection of fish catch data from inland open water at Directorate of Fisheries, Guwahati • Five training programmes on different aspects like, 'Concept Building in Basic Statistics for Inland Fisheries Data Analysis', 'Fisheries Enhancement in Open Waters of North-Eastern (NE) India', 'Enclosure culture in inland openwaters for production enhancement' 'Strategies for openwater fisheries management in Northeast India', 'Methods and practices for fisheries enhancement inopenwaters of Northeast India' • Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference at Guwahati • Brainstorming workshop on 'Cage culture in Northeast India: Status and future prospects' at Guwahati • Capacity building program under PIDPI through lectures and awareness programme • Awareness programme on 'pen culture in beels' cum feed distribution at Dhemaji district • Awareness programme cum feed distribution at Cachar district • Exhibition stall at the Directorate of Fisheries, Govt. of Assam, Guwahati on the occasion of World Fisheries Day 2023
Bihar	River	• Estimation of fish landing and catch structure in river Kosi and middle stretch of River Ganga • Assessment of fish and fisheries of the Ganga river system • Ranching of IMC and awareness among the fishers in depleted stretches of river Ganga
	Wetland	• Assessment of ecology and fisheries of Manika, Simra and Bhusra wetlands of Muzaffarpur district
Chhattisgarh	River	• Estimation of fish landing and catch structure in Mahanadi river • Developed fish catch assessment software based on participatory approach
	Reservoir	• Investigation on status of fisheries and development of ecosystem-based fisheries management strategies in Kodar reservoir • Demonstration of pen culture and feasibility of pen seed rearing in five reservoirs viz. Paralkot, Baherakhar, Sutiyapath, Rabo, and Ghunghutta • Demonstration of pen culture and distribution of fish seed in the five reservoirs viz. Sutiapath, Rabo, Ghunghutta, Koserteda dam Matiamotidam, Paralkot • Penculture demonstration cum awareness programme at Sutia Path and Rabo
	HRD	• Capacity building programme for tribal fishers • Capacity development of 21 DFO officials on production enhancement in small reservoirs through pen culture
Goa	HRD	• Exhibitions stall at Aqua Goa Mega Fish Festival 2023 during 10-12 February 2023 at Panaji

State	Resource	Activity
Gujarat	River	• Fish catch estimation of river Tapti • Study on impact of water intake due to Gadarwara STPP on Ecology of Narmada River
	Reservoir	• Assessment of ecology and fisheries and socio-economic status of fishers of Panam reservoir • Advisory on cage culture activity in Ukai reservoir • Demonstration of 'CIFRI HDPE Pen Technology' at Ukai Reservoir
	HRD	• Capacity building on enclosure culture in reservoirs to 30 fish fishers/fish farmers of Gujarat
Haryana	River	• Eco-variability study of river Yamuna
Jharkhand	River	• Ranching of IMC seeds into the river Ganga
	Reservoir	• Experiment with new design of pens at Maithon reservoir • Distributed outboard engines to the cooperative societies of ST fishers of 5 reservoirs situated in two districts, namely Ranchi and Simdega
	HRD	• Capacity building of 23 JOHAR officials and 25 farmers from ATMA Pakur • Exposure visit and training of women fish farmers
	Reservoir	• Testing of new design of net pen suitable for the deep water body in Maithon reservoir • Experiment on HDPE circular cage and square GI cages at Maithon reservoir with *Pangasaianodon hypophthalmus* • Scampi production at Ghagra in Hazaribag district, Kelaghagh in Simdega district and Masaria in Gumla district
Karnataka	River	• Developed report on "Fish diversity along the Paka and Nisargadhama areas of the Kaveri basin with notes on species of conservation important" • Stocks of *Mystus cavasius* from River Krishna and Cauvery using phenotypic traits • Pollution status of chemical contaminants in selected stretches of Cauvery river
	Estuary	• Assessment of water quality of Netravathi-Gurupur estuary
	Reservoir	• Time-dynamic simulation modelling of Gayatri reservoir • Biotic and abiotic study in Kanva reservoir, Ramanagara • Refinement of culture-based fisheries for Gayatri reservoir • Trophodynamic modelling of Gayatri reservoir • Exploratory survey on status of fish and fisheries, including habitat characteristics and fish assemblage of Gayathri reservoir
	HRD	• Awareness programme on "Culture based fisheries for enhancing fish production from reservoirs" as a part of National Fish Farmers Day at Aivark and apura village, Bangalore Rural • Training programme on "Fisheries Enhancement in Inland Water bodies" in Bangalore
Kerala	Estuary	• Assessment of Vembanad estuarine fisheries resources for sustainable management
	Reservoir	• Exploratory survey was conducted on fish diversity and habitat ecology in Bansurasagar reservoir, Wayanad • Evaluated the fisheries, fish assemblage structure and ecological status of Idukki reservoir • Developed ecopath model for Idukki reservoir • Distributed 2000 seeds of pearlspot (*Etroplus suratensis*) to the fishermen of Vazhani reservoir
	Wetland	• Demonstration of climate resilient culture based fishery of pearlspot (*Etroplus suratensis*) in Vembanad wetland • Distributed 2000 seeds of pearlspot (*Etroplus suratensis*) to fishermen of Ochanthuruth, Vypin for culture based fishery
	HRD	• Sensitization programme on "Management of reservoir fisheries for enhanced fish production" in Banasurasagar, Wayanad • Distribution of coracle under TSP at Banasurasagar • Seed distribution programme in Vazhani reservoir for fishery enhancement • Capacity building in 'Reservoir Fisheries Management' for M.F.Sc.(AEM) students of KUFOS, Kochi • Exhibition stall in 16th Agricultural Science Congress and ASC Expo

State	Resource	Activity
Madhya Pradesh	River	• Assessed ecology and fisheries status in Gadarwara stretch of river Narmada • Study on impact of water intake due to Gadarwara STPP on Ecology of Narmada River • Fish catch estimation of river Tapti
	Wetland	• Assessment of ecology and fisheries of Govindgarh, Devendra Nagar, Lokpal Sagar, and Man Sagar wetlands
Maharashtra	River	• Fish catch estimation of river Tapti and Krishna
Manipur	Wetland	• Cage culture of *Ctenopharyngodon idella, Labeo bata* and *Osteobrama belangeri* in cages at Takmu lake, Bishnupur district • Pen culture of the small indigenous fish *Amblypharyngodon mola* along with *C. idella* and *L rohita* in HDPE pens in Takmu lake • Distribution of CIFRI CageGrow feed to pen culturists of Bishnupur District
	Reservoir	• Cage culture of *Hypophthalmichthys molitrix* in cages at different stocking densities in Mapithel reservoir • Distributed 4 tonnes CIFRI CageGrow feed to cage culturists of Kamjong District
Meghalaya	Reservoir	• Studied the ecology and fisheries of Umiam reservoir • Cage culture of *Cyprinus carpio* and *Barbonymus gonionotus* in cages at Umiam reservoir • Distribution of CIFRI CageGrow feed to cage culturists and fishers
	HRD	• Capacity building program under PIDPI through awareness programme at Ri-Bhoi district • Awareness-cum-fish feed distribution programme at Nongpoh, Ri-Bhoi District
Mizoram	Reservoir	• Development of ecosystem-based fisheries management strategies for Serlui-B reservoir • Assessment of ecology, fisheries and feasibility of cage culture in Serlui-B and Tuirial reservoirs, Kolasib district • Fish diversity study in Serlui-B reservoir of Kolasib
Nagaland	Reservoir	• Cage culture of Common carp, Pangas and Java puthi in Doyang reservoir
Odisha	Reservoir	• Fisheries and ecological status of Hirakud reservoir • Environmental and aquatic ecosystem health monitoring in Hirakud reservoir • Assessment of ecology and fisheries of Sunei and Kalo reservoirs • Refinement of culture-based fisheries for Sunei reservoir • Impact assessment of stocking and effectiveness of CBF practices in Sunei reservoir • Feasibility study and site selection of cage culture in three reservoirs (Kanjhari, Remal, Hadgarh dams) of Keonjhar district • Culture of fishes in circular cages installed in Hirakud reservoir
	Backyard ornamental fishery	• Three-day training program on "Opportunities in ornamental fish rearing and management for income generation" for the tribal women beneficiaries from Salia-sahi, Odisha • Ornamental farming kits to 16 tribal women
Sikkim	River	• Field visit to Dikchu Reservoir, Sikkim • Study of impact of dams on ecology and fisheries of River Rangit
	HRD	• Interactive workshop on 'Management of open water fisheries of Sikkim' • Training programme on 'Feed formulation and low-cost feed preparation' at Gangtok • Awareness cum input distribution programme in Geyzing, Soreng and Namchi districts. FRP tanks and accessories for starting up ornamental fisheries were distributed among 35 beneficiaries
Tamil Nadu	River	• Pollution status of chemical contaminants in selected stretches of Cauvery river • Monitoring of pesticides and emerging contaminants in River Cauvery • Assessment of genetic stocks structure of *Mystus gulio* for River Pazhayar, Kanyakumari, Tamil Nadu
	Reservoir	• Development of ecosystem-based fisheries management strategies for Poondi reservoir • Fish assemblage, plankton diversity, habitat parameters study on Sathanur reservoir • Technical assistance for the fisheries management and net distribution in Poondi reservoir
	HRD	• Mass awareness on responsible fishing in Hogenakkal, Dharmapuri District • Coracle was distributed under TSP in Hogenakkal, Dharmapuri District

State	Resource	Activity
Tripura	Reservoir	• Fish diversity and impact of fingerling stocking on fisheries of Dumbur reservoir • Cage culture of grass carp (*Ctenopharyngodon idella*) in Dumbur reservoir
	HRD	• Awareness programme cum feed distribution for popularizing cage culture at Dumbur reservoir in Dhalai district • Interactive meeting on 'Cage culture in Dumbur reservoir' at Narkelkunja, Dhalai district
Uttar Pradesh	River	• Assessment of ecology and fish and fisheries of river Ganga • River ranching programme at different stretches of river Ganga • Eco-variability and impact study of river Yamuna on river Ganga including environmental parameters and fish diversity
	Wetland	• The ecology and fisheries of the four wetlands *viz*.Kitaman (Kushinagar), Jatiya, Bakwa, and Ramgarh (Gorakhpur) tals
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 JalVidyut Nigam Ltd.
West Bengal	River	• 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 at Farakka under NMCG • Microbiometa-transcriptomics assessment of Ganga river basins for ecosystem health monitoring • Pollution status of chemical contaminants in selected wetlands of Murshidabad district • Study of impact of dams on ecology and fisheries of River Rangit • Imparting skill on fish breeding to the local fishermen for livelihood improvement and enhancing native fish population through ranching in River Ganga at Farakka • Estimation of fish landing and catch structure of lower stretch of River Ganga under NMCG component • Assessed the microbial diversity and functional profiling of the river sediment samples near urban Kolkata using meta-transcriptomics approaches. • Developed knowledge centre on fish breeding and rearing units for IMC for ranching
	Estuary	• Fish and shellfish assemblage study in relation to ecological variability at Hooghly-Matlah estuary • Assessment of environmental variability, nutrient fluxes and biotic community interactions of mangrove stands in Indian Sundarbans eco-region
	Reservoir	• Assessment of ecology and fisheries potential of Beko, Futiyari, Paltoi, Loharshol and Murguma reservoirs of Purulia • Refinement of culture-based fisheries for Beko reservoir • Testing of new design of net pen suitable for the deep water body in Maithon and Kangsabati reservoirs • Cage culture technology in Kangsabati reservoir

State	Resource	Activity
West Bengal	Ornamental fish units	• Development of ornamental fish culture villages in hilly region, Kurseong, Mirik, Sukhiya and Manju Tea Estates in the Hilly region of Darjeeling district under SCSP • Developed ornamental fish culture village cluster of women in Sajnekhali, Sonarpur, Balagarh and Dakshin Dinajpur under SCSP
	Pond	• Fish seed, feed and lime was distributed to 297 farmers of Kultali, Sagar Island of Sundarbans • Exploration for new and exotic infectious diseases in aquatic animals, implementation of national information management system for aquatic animal diseases under NSPAAD project • Experiment with Hilsa in ponds of Kolaghat
	Wetland	• Exploratory survey and stakeholder vulnerability assessment at four estuarine/coastal sites (Sahidpur, Kulti, Diamond harbour, Madanganj, Bherua and Haroa). • Carbon sequestration in Khalsi and Bhomra and East Kolkata wetlands • Study of the emerging contaminants in East Kolkata Wetlands • Analysis of methanogen and methanotroph in Malencho, Bhomra and EKW • Demonstration of culture based fisheries and seed raising of fish seed in pen in Beledanga, Chamardaha, Duma, Sindrani and Chamta wetlands • Drone based survey was conducted to assess macrophyte infestation in Beledanga wetland • Monoculture of *S. sarana* in pens at Chamta and Sindrani wetland • Assessment of ecology and fisheries and heavy metals in water of the five wetlands *viz*. Rampara, Chhar, Beloon, Daserchak and Magradaha of Murshidabad • Disease surveillance in the farmers' field of East Medinipur, Howrah, South 24 Parganas districts of West Bengal • Advisory service and input distribution for pen culture technology and CBF in wetlands of North 24 parganas, Nadia and Murshidabad under SCSP • Fish seed stocking in the captive nursery pond adjacent to Beledanga wetland • Women empowerment through penculture, backyard poultry farming, kitchen gardening, mushroom cultivation
	HRD	• Training on ornamental fish culture for women of Kultali, Sundarbans, West Bengal • Training on "Inland ornamental fisheries management for income generation and livelihood enhancement in Hilly region" for the people of Sittong, Manju Gaon and Mongu of Darjeeling district, West Bengal • Hill fisheries development to farmers/farmers from Sittong, West Bengal • Capacity building on 'Inland fisheries management for livelihood improvement' fishers/farmers from rural populace of Sundarbans • Stakeholder meeting cum awareness program on pen culture technology for integrated wetland management at Beledangabeel and Chamtabeel • The Barrackpore HQs conducted 28 training programmes for fishers/fish farmers, 5 for students and 6 for State Govt. Officials

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Demonstration and Transfer of Technology



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Demonstration and Transfer of Technology

Demonstration of cage culture in reservoirs of Northeast India

The institute demonstrated cage culture in Umiam (Meghalaya), Mapithel (Manipur) and Dumbur (Tripura) reservoirs of Northeast India. In Umiam reservoir, polyculture of *Cyprinus carpio* (common carp) and *Barbonymous gonionotus* (silver barb) was demonstrated. Cage culture of *Hypophthalmichthys molitrix* (silver carp) for production of table fish was demonstrated in Mapithel reservoir in different stocking densities.



Demonstration of cage culture of *Ctenopharyngodon idella* (grass carp) was also carried out in Dumbur reservoir, with an estimated production of 5.9-6.5 kg m^{-3} for rearing period of 10 months.

Demonstration of pen culture in floodplain wetland of Manipur

Guwahati Regional Centre of the institute demonstrated polyculture of the small indigenous fish *Amblypharyngodon mola* along with major carps (grass carp and rohu) in Takmu pat, Bishnupur district, Manipur. Rearing of *A. mola* along with major carp was found to be more economical, giving additional income to the fishers rather than rearing major carps alone.

Demonstration and cull harvesting of *Etroplus suratensis* in Vembanad wetland

The Kochi Centre of the institute successfully demonstrated farming of *Etroplus suratensis* under NICRA and SCSP









programmes. On 18th February 2023, the fish farmers belonging to the SC community of Ochanthuruthu village in Vypin (Ernakulam, Kerala) were provided with two batches of 1000 pearlspot (*E. suratensis*) seeds of 3-5 cm size to stock in CBF (400 m^2) and CIFRI HDPE climate resilient pens (400 m^2). Nearly 35 kg of *E. suratensis* (average weight of 200g) were size graded while cull harvesting on 22ndSeptember 2023. The culture recorded an average growth rate of 30g/month and indicated that successful culture of *E. suratensis* can be taken up by small-scale farmers associated with Vembanad wetland.

Demonstration of nutritional value of small fishes in wetlands of Muzaffarpur, Bihar

In the wetlands of Muzaffarpur district, Bihar the fishers discard the small fishes as trash fish. ICAR-CIFRI team visited to Manika and Bhusramaun of Muzaffarpur (Bihar). The farmers were sensitized through mass awareness programme and the knowledge on conservation protocols of small fishes was imparted to them.

Demonstration of backyard pond culture

Backyard ponds fish culture was demonstrated in a co-management mode for SC women indifferent parts of West Bengal including 470 SC women from Gosaba and Basanti block of Sundarbans, 100 SC women from six villages of Basanti, Sunderban, 102 women of Hashnabad, and 104 women of Dakshin Dinajpur.

Demonstration of ornamental fish culture

Ornamental fish culture was demonstrated for SC/ST community in different places of West Bengal and

Odisha under SCSP and STC. The details are given in the table.

Demonstration of penculture and CBF in North 24 parganas, Nadia and Murshidabad districts of West Bengal and in five small reservoirs of Chhattisgarh

Technical assistance and demonstration of pen culture and culture-based fisheries (CBF) was carried out under SCSP in a participatory mode in wetlands of North 24 parganas, Nadia and Murshidabad, districts of West Bengal. ICAR-CIFRI also organized Penculture demonstration in collaboration with DOF, Chhattisgarh in five small reservoirs *viz*. Baherakhar, Sutiyapath, Rabo, Paralkot and Ghunghutta of Chhattisgarh state during 24th May to 04th June, 2023 aiming to raise fingerlings in the pen for enhancing the production of the reservoir cost-effectively under STC. Two scientific teams from the Institute demonstrated CIFRI HDPE installation and stocking in the selected reservoirs.

Location/Area	State	No. of beneficiaries
Shitong, Kurseaong, Mirik, Sukhiya and Manju tea estate of Darjeeling district	West Bengal	SC-140; ST-30
Sajnekhali, South 24 Parganas	West Bengal	SC-50 Women
Sonarpur, South 24 Parganas	West Bengal	SC-22 Women
Balagarh	West Bengal	SC-28 Women
Dakshin Dinajpur	West Bengal	SC-50 Women
Birbhum	West Bengal	ST-30 Women
SaliaSahi	Odisha	ST-16 Women



वार्षिक प्रतिवेदन

Annual Report

2023

Training and Capacity Building



वार्षिक प्रतिवेदन

Annual Report

2023

Training and Capacity Building

Training conducted for fishers/ fish farmers during January-December 2023

Sl. No.	Title of the training programme	Date	No. of participants	Venue
1.	DOF Bihar sponsored training on inland fisheries management	04-10 January	30 fish farmers from Sitamarhi district, Bihar	CIFRI HQ
2.	DOF Bihar sponsored training inland fisheries management	01-07 February	30 fish farmers from Sheohar district, Bihar	CIFRI HQ
3.	Hands-on training and field demonstrations on Brood stock development and fish breeding of carps under the funding support of NTPC, Farakka' conducted in association with the ICAR-CISH, KVK, Malda	08-10 February	75 Fish farmers of Farakka	ICAR-CISH-KVK, Malda
4.	Training on ornamental fish farming training under SCSP	14-16 February	19 rural women of Kultali, Sundarbans	CIFRI HQ
5.	DOF Bihar sponsored training inland fisheries management	14-20 February	24 fish farmers from Saran district, Bihar	CIFRI HQ
6.	NABARD sponsored training on inland fisheries management	21-23 February	25 fish farmers of Haroa Block, North 24 PGS, WB	CIFRI HQ
7.	DOF Bihar sponsored training inland fisheries management	21-27 March	30 fish farmers from Darbhanga district, Bihar	CIFRI HQ
8.	ATMA sponsored training on inland fisheries management with special emphasis on IFS	27-29 March	17 farmers from Berhampore Block, Murshidabad, WB	CIFRI HQ
9.	DOF Bihar sponsored training on inland fisheries management	04-10 April	30 fish farmers from Madhepura district, Bihar	CIFRI HQ
10.	DOF Bihar sponsored training on inland fisheries management	18-24 April	30 fish farmers from Katihar district, Bihar	
11.	Inland ornamental fisheries management for income generation and livelihood enhancement in the hilly region under SCSP	28 April to 1 May	26 fishers from Sittong, Manju Gaon, and Mongu of Darjeeling district, West Bengal	CIFRI HQ
12.	DOF Bihar sponsored training on inland fisheries management	16-22 May	30 fish farmers from Munger district, Bihar	CIFRI HQ
13.	DOF Bihar sponsored training on inland fisheries management	24-30 May	30 fish farmers from Bhagalpur	CIFRI HQ
14.	ATMA sponsored training on inland fisheries management	06-10 June	42 farmers from Parjang block, Odisha	CIFRI HQ
15.	DOF Bihar sponsored training on inland fisheries management	22-28 June	30 fish farmers from Jamui district, Bihar	CIFRI HQ

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Sitamarhi district fishers/fish farmers



Madhepura district fishers/fish farmers

Sl. No.	Title of the training programme	Date	No. of participants	Venue
16.	Inland Fisheries Management	04-10 July	30 fishers and fish farmers from Rohtas district of Bihar	CIFRI HQ
17.	Inland Fisheries Management	13-19 July	30 fishers and fish farmers from Nawada district of Bihar	CIFRI HQ
18.	Inland Fisheries Management	02-08 August	30 fishers and fish farmers from Muzaffarpur district of Bihar	CIFRI HQ
19.	Management of open water fisheries for doubling the farmers income	21-28 August	14 fishers and fish farmers	ICAR-CIFRI, Prayagraj
20.	Inland Fisheries Management	05-11 September	30 fishers and fish farmers from Sheikhpura district of Bihar	CIFRI HQ
21.	ATMA sponsore d training on inland fisheries management	18-22 September	22 farmers from Pakur, Jharkhand	CIFRI HQ
22.	Fisheries Enhancement in Open Waters of North-Eastern (NE) India	25-29 September	12 fishers and fishers and fish farmers	ICAR-CIFRI, Regional Centre Guwahati
23.	Inland Fisheries Management	05-11 October	30 fishers and fish farmers from Gopalganj district of Bihar	CIFRI HQ
24.	Inland Fisheries Management	03-09 November	30 fishers and fish farmers from Nawada district of Bihar	CIFRI HQ
25.	Fisheries enhancement in inland water bodies (on-line mode)	07-09 November	19 fishers and fish farmers	ICAR-CIFRI, Bangalore
26.	Enclosure culture in inland open water for production enhancement	08-10 November	26 fishers and fish farmers	ICAR-CIFRI, Regional Centre Guwahati
27.	"Fish production enhancement through cage culture in inland open waters of West Bengal"	07-10 November	29 fishers and farmers from Bankura district, West Bengal	CIFRI HQ
28.	Inland Fisheries Management	28-30 November	25 fishers and fish farmers	ICAR-CIFRI, Prayagraj
29.	Inland Fisheries Management	05-11 December	30 fishers and fish farmers from Sitamarhi district of Bihar	CIFRI HQ
30.	Methods and practices for fisheries enhancement in open water of Northeast India	12-14 December	25 fishers and fish farmers	ICAR-CIFRI, Regional Centre Guwahati

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Training during 08-10 November, 2023 at Guwahati Regional Centre



Training during 28-30 November at Prayagraj Regional Centre

Contd.....

Sl. No.	Title of the training programme	Date	No. of participants	Venue
31.	Inland Fisheries Management	14-20 December	30 fishers and fish farmers from East Champaran district of Bihar	CIFRI HQ
32.	Genetically Improved Fish Stocks for Aquaculture	18-20 December	38 fishers and fish farmers	ICAR-CIFRI, Regional Centre Guwahati
33.	Enclosure Culture for Enhancing Fish Production from Reservoir	18-20 December	30 fishers and fish farmers	ICAR-CIFRI, Vadodara
34.	ATMA sponsored Training on Inland Fisheries Management	18-22 December	22 fishers and farmers from Pakur, Jharkhand	CIFRI HQ
35.	Feed formulation and low-cost feed preparation	20-22 December	40 fishers and fish farmers	Directorate of Fisheries, Govt. of Sikkim, Gangtok
36.	Opportunities of inland open water ornamental fisheries management for income generation under STC	21-23 December	12 ST fisherwomen from Saliasahi, Odisha	CIFRI HQ
37.	Ornamental fisheries and culture: scope and opportunities under PMMSY	22-24 December	30 women fishers and fish farmers from Jharkhand	CIFRI HQ



Glimpses of training programmes conducted by the Institute

Students Training

Sl. No.	Title of the training programme	Date	No. of participants	Venue
1.	Fisheries work experience programme	21-23 February	32 nos. of 4th year B.F.Sc students of the WBUAFS, WB	CIFRI HQ
2.	One-day practical demonstration of use and handling of ArcGIS software	13 September	5 nos. of Ph.D. students of FRM Dept. of WBUAFS, Kolkata, West Bengal	CIFRI HQ
3.	Recent advances in river ecology and fisheries management	07-13 November	15 participants including teaching and research faculties and students from various Universities of Odisha, Chhattisgarh, West Bengal, and Andhra Pradesh	CIFRI HQ
4.	Advances in aquatic health management in inland open water fisheries	04-08 December	15 students	CIFRI HQ
5.	Advances in heavy metals and microplastics analysis (IC-PMS and µFTIR)	11-15 December	23 students	CIFRI HQ
6.	Fish disease diagnosis and health management in inland open waters	18-22 December	16 students	CIFRI HQ



Glimpses of students training programmes conducted by the Institute

Official Training

Sl. No.	Name of the training	Date	Participants	Venue
01.	NABL Laboratory Assessors' Training Course	17-21 January	22 Scientists from 12 ICAR Institutes	CIFRI HQ
02.	Demonstration of *eMatsyaApp* for collection of fish catch data from inland open water	21 February	47 participants from Dept. staffs and fish farmers	Directorate of Fisheries, Guwahati
03.	Inland fisheries management	24-28 July	21 Directorate of Fisheries, Chhattisgarh officials	CIFRI HQ
04.	Concept building in basic statistics for inland fisheries data analysis	22-24 August	15 Students	ICAR-CIFRI Regional Centre, Guwahati
05.	Strategies for openwater fisheries management in Northeast India	22-24 November	25 Students, enterpreneure officials	ICAR-CIFRI, Regional Centre Guwahati
06.	Advances in aquatic health management in Inland open water fisheries	4-8 December	9 Participants from ICAR-CIFE,Mumbai, WBUAFS, College ofFisheries, Kishanganj, Bihar	CIFRI HQ
07.	Advances in heavy metals and microplastics analysis (ICP-MS &μFTIR)	11-15 December	22 Participants from ICAR-IIHR, ICAR-CIRCOT, Calcutta University, Kalyani University, Burdwan University, Vidya Sagar University, WBUAFS, Kamdhenu University	CIFRI HQ
08.	International training-cum-workshop on "Sustainable fisheries and dairy"	06-19 December	24 participants representing Cambodia, Lao PDR, Myanmar, and Vietnam	CIFRI HQ
09.	Methods and practices for fisheries enhancement in openwaters of Northeast India	12-14 December	25 fisheries officials from different NE states (Assam, Meghalaya, Manipur, Tripura, and Mizoram); Kolong-Kopili (NGO), Bogibari, Assam and Ri-Bhoi Farmers Union, Meghalaya.	Guwahati Regional Centre, CIFRI
10.	Feed formulation and low - cost feed preparation	20-22 December	40 fishery officials from Directorate of Fisheries, Govt. of Sikkim, fish feed entrepreneurs and progressive fishers of Sikkim	Gangtok, Sikkim
11.	Inland fisheries management	26-30 December	23 nos. of officials under JOHAR programme, Jharkhand State Livelihood Promotion Society under Dept. of Rural Development, Jharkhand	CIFRI HQ



Glimpses of official trainings conducted by the Institute

Mass Awareness Camp

Title of the awareness camp	Purpose	Date	Venue	No. of participants
Mass awareness camps on pen culture at four reservoirs of Chhattisgarh	Mass awareness camps on pen culture	24 May to 4 June	Baherakhar, Sutiyapath, Rabo, Paralkot and Ghunghutta reservoirs of Chhattisgarh	340
Dolphin and hilsa conservation under the 'NamamiGange" programme	Dolphin and hilsa conservation	6 February 7 February 8 February 9 February	Budge Budge ferry ghat, Pujali fish landing sites, Birlapur, and Godakhali fish landing sites Burul, Raichak, and Falta fish landing sites Diamond Harbour fish landing sites Tyangra char fish landing sites	More than 250 active fishers, including social activities, and students
Awareness on importance of fish and dolphins to riverine ecology as part of the "NamamiGange" programme	Awareness on importance of fish and dolphins to riverine ecology	9 February	LakshmipurPrabartak Junior High School, Fraserganj, Sundarbans	90 school students
Public Interest Disclosure and Protection of Informers, 2004 (PIDPI) awareness camp	Preventive vigilance campaign to fight against corruption	11 October	Tamrangabeel, Bongaigaon, Assam	15 beel fishers
		12 October	Dhirbeel, Dhubri, Assam	20 beel fishers
		18 October	Nongpoh, Ri-Bhoi district, Meghalaya	60 beel fishers
		31 October	Barak Valley, Assam	50 beel fishers
		09 November	Kalong-Kapili, Assam	30 beel fishers
		11 November	Gandacherra, Tripura	120 beel fishers
Awareness-cum-feed distribution programme	To create awareness among fishers on pen culture in beels	16 October	Dhemaji, Assam	130 beel fishers
Awareness-cum-input distribution programme	For popularizing pen and cage aquaculture in floodplain wetlands	31 October	Cachar College, Silchar	50 beel fishers
Input distribution-cum-awareness programme	For popularizing cage aquaculture in reservoir	04 November	Dumburreservoir, Tripura	120 beel fishers
Awareness programme for the fishermen of Vazhani reservoir, Thrissur, Kerala	Reservoir fisheries management	21 November	Thrissur, Kerala	50 reservoir fishers
Mass awareness on responsible fishing	Responsible fishing	02 December	Hogenakkal, Dharmapuri, Tamil Nadu	50 reservoir fishers
Management of reservoir fisheries for enhanced fish production	Reservoir fisheries management	06 December	Banasurasagar, Wayanad, Kerala	50 reservoir fishers
Awareness-cum-input distribution programme	FRP tanks and accessories for starting up ornamental fisheries	20-21 December	Geyzing, Namchi and Soreng districts	45 beel fishers

Glimpses of awareness programmes



Lakshmipur Prabartak Junior High School



Diamond Harbour fish landing site



Awareness-cum-input distribution programme in Sikkim on 20-21 December



Fish feed distribution-cum-awareness at Silchar, Assam on 31 October



Exposure / Educational Visits to ICAR-CIFRI, Barrackpore

Sl. No.	Particulars of visitors	Date of visit
1.	42 nos. students of TNJFAU, Tamil Nadu	21 February
2.	32 students of Vidyasagar Women's College, Kolkata, WB	20 March
3.	37 students of Santoshpur Rishi Aurobinda Balika Vidyapith, Kolkata, WB	29 March
4.	42 nos. of B.Sc (Ag) students of CoA, Bhabanipatna, Odisha	04 April
5.	36 students of St. Joseph College, Darjeeling, WB	27 April
6.	42 students of CoF, Mangalore	01 May
7.	38 B.Sc (Ag) students of CoA, Bhabanipatna, Odisha	04-06 May
8.	23 students of Dept. of Zoology, Ramanuj Gupta Degree College, Silchar, Assam	08 May
9.	8 school students of Army Public School, Barrackpore	16 May
10.	16 students of 3rd Year B.Sc students Bidhannagar College, Salt Lake, WB	17 May
11.	43 nos. of 4th year B.F.Sc students of CoF, Lembuchera, Tripura	08 June
12.	13 nos. of M.Sc. 4th Semester Zoology Hons. Students of Vidyasagar College, Kolkata, WB	08 June
13.	36 students of Class IX of UdaypurHaradayal Nag Adarsha Vidyalaya for Girls, Kolkata, WB	13 June
14.	30 nos. of B.F.Sc students of CoF, Gopal Narayan Singh University, Sasaram, Bihar	30 June
15.	21 officials from DoF, Tripura	07 July
16.	12 students of 3rd year BBA of FBS under TNJFU, Tamilnadu	07 August
17.	28 B.F.Sc. students of CoF, Andhra Pradesh Fisheries University	23 September
18.	6 nos. of M.Sc. Zoology 2nd year students of Vidyasagar College, Kolkata	22 November
19.	41 B.F.Sc 4th year students of RPCAU, Pusa, Bihar	24 November
20.	31 M.Sc. Zoology 2nd year students of North Bengal University, Kolkata	06 December
21.	82 Class XII students of Kendriya Vidyalaya (Air Force), Barrackpore, WB	19 December



Students of TNJFAU, Tamil Nadu



Students of Vidyasagar Women's College, Kolkata, WB



Students of R. G. D. College, Silchar, Assam



Students of St. Augustine's Day School, Barrackpore

Exhibitions participated

Sl. No.	Particulars	Date	Place
1.	Krishi Samridhi Mela-cum-National seminar 2023	12-16 January	Sargachi, Murshidabad, WB
2.	Exhibition organized by Alumni Association, Govt. High School, Avana, Balasore, Odisha	14-16 January	Balasore, Odisha
3.	Exhibition/fair Bajarpore Gramin Pradarshini o Mela 2023	15-17 January	PurbaMedinipur, WB
4.	International conference on agriculture & rural development 'AGRI VISION-2023' organized by SARM	27-29 January	Cuttack, Odisha
5.	National seminar on 'Ecology Vs Economic Development with spl Reference to the Ganga Basin' (NEED-2023) by NGB University, Prayagraj& ICAR-CIFRI Centre, Prayagraj	28-29 January	Prayagraj, UP
6.	Aqua Goa mega fish festival, Goa	10-12 February	Goa
7.	Krishi mela-cum-National seminar at Sashyashyamala KVK	14-16 February	Sonarpur, South 24 PGS, WB
8.	*Pashu sanrakshan, udyan pradarshani evum atmanirbhar krishi mahotsav* 2023 organized by KVK, Piprakothi	18-20 February	Piprakothi, Bihar
9.	Exhibition at National Seminar on Ecology Vs Economic Development with special reference to the Ganga basin Prayagraj	25-26February	Allahabad, Prayagraj
10.	"Acharya Prafulla Chandra Roy Smarak Vigyan Mela O Pradarshani" at the West Bengal University of Animal & Fishery Sciences	16-18 March	Belgachia, WB
11.	"Northeast Livestock -Aqua-Poultry Expo, 2023 & Conference" organized by P2C Communications, New Delhi along with Aqua Post and Smart Agri Post Magazines and ICAR-CIFRI, Barrackpore	18-20 April	Maniram Dewan Trade Centre, Guwahati
12.	34th AICZ organized by ZSI & Dept. of Zoology, Kashmir University, Srinagar	05-07 June	Kashmir University, Srinagar
13.	Exhibition at 'Fish Fair' organized by CoF, Kishanganj	19-21 July	Kishanganj, Bihar
14.	Exhibition on the occasion of 3rdAnniversary of PMMSY	15 September	Indore, MP
15.	Exhibition at XVI Agricultural Science Congress 2023& ASC Expo.	10-13 October	Kochi, Kerala
16.	Exhibition in the International Conclave on Climate Change organized by FAO, BoBP, DoF, GoI	16-19 October	Chennai, TN
17.	Global Fisheries Conference	21-22 November	Ahmedabad, Gujarat
18.	Exhibition at 3 rdInternational Conference on Aquatic Animal Epidemiology organized by ICAR, New Delhi in collaboration with ISAAE, NFDB, Hyderabad and ABCS, Lucknow	29 November -01 December	ICAR-NBFGR, Lucknow, UP
19.	Exhibition at Yuba Mela – 2023 organized by TaldiBahurpee Sangha	22-31 December	Taldi, South 24 PGS, WB



ICAR-CIFRI stall at Start-up Conclave 2023 at Gandhinagar, Gujarat



ICAR-CIFRI stall at Indore, M. P.











ICAR-CIFRI participated in exhibitions across the country

'Mahila Matsyajeebi Sammelan' at Kultali, Sundarban

The Indian Sundarbans has been combating various forms of natural calamities including tropical cyclones associated with huge tidal surges. A large section of the Sundarbans population is engaged in fisheries and allied activities. Since last decade, ICAR-CIFRI has been extending the support to the rural populaceof this area by providing various technological inputs for rejuvenating their livelihood through fish farming under the SCSP/STC development programmes. Since 2013, ICAR-CIFRI motivated more than 4500 fishers to initiate small-scale homestead aquaculture in their backyard ponds and also ornamental fish farming as an alternative source of livelihood to boost the rural economy.





The beneficiaries of Gosaba, Hingalgunj, Kochukhali, Amtoli, Gangasagar, Bali Island, Namkhana, Kakdwip, Kultolihave been immensely benefitted by the institue's interventions and their annual income has also been increased significantly. In Kultali since 2020 the instiute has adopted 1356 beneficiaries, among them 7% are women.



Place	Year	No. of beneficiaries	
		Pond/Canal/Derelict/Ornamental fishers	Women beneficiaries
Kultali	2020 -21	256	-
	2021 -22	550	50
	2022 -23	550	50

Mahila Matsyajeebi Sammelan



The International Women Day's theme for the year 2023 was "Accelerating Equality & Empowerment". Keeping this in view in the year 2023-24 ICAR-CIFRI has taken up "Mission 3000" *i.e* to adopt 3000 women across the country under SCSP/STC/NEH schemes for empowering them economically. In this regard, Mahila Matasyajibi Sammelan (Women Fishers Meet) was organized at Kultali, Sundarban, West Bengal in collaboration with Kultali Milantirtha Society on 19 May 2023. On this occasion, fisheries inputs were distributed to 500 women of vulnerable communities with the objective to generate an alternative source of income generation.



Dr. Himanshu Pathak, Secretary, Department of Agricultural Research and Education, Govt. of India and Director General, Indian Council of Agricultural Research inaugurated the programme as the Chief Guest. Other distinguished guests were Dr. B. K. Das, Director, ICAR-CIFRI, Dr. Gouranga Kar, Director, ICAR-CRIJAF and Dr. D. B. Shakyawar, Director, ICAR-NINFET.

Felicitation of DG ICAR by fisherwomen and the community



More the 100 women greeted Dr. Himanshu Pathak with roses while Sri Lokman Molla along with the community representatives felicitated Dr. Pathak with a huge garland and traditional attire (turban) made of leaves.





Inaugural programme

The programme was started with a welcome address by Dr. B. K. Das, Director, ICAR-CIFRI. Dr. Himanshu Pathak addressed the participants and said that the rural population of Sundarban is suffering due to various natural disasters like cyclones. He remarked that the ICAR-CIFRI is doing an excellent and exceptional work for the livelihood enhancement of women fishers of Sundarban. He stressed that all the ICAR institutes and Krishi Vigyan Kendra of this region will wholeheartedly support the farmers of Sundarban in implementing new agricultural technology and livelihood enhancement. Dr. Gauranga Kar and Dr. D. B. Sakyawar also addressed the gathering and assured them of all possible help from ICAR institutes.







Distribution of Inputs

The Secretary, DARE & DG, ICAR distributed fisheries inputs like fingerlings, ICAR-CIFRI Cagegrow feed etc. to 500 SC and ST women fish-farmers who have backyard ponds. These women beneficiaries have been selected from a vast area covering 38 hamlets under 17 GPs of two Community Development Blocks namely Gosaba and Basanti of Sundarbans.



Press Meet

Dr. Pathak met the journalists of print as well as electronic media and expressed his views regarding the way forward to support the vulnerable populace of Sundarbans through ICAR.

Interaction with fisherfolk community

An interaction meet was also organized. Dr. Pathak interacted with the men and women of fisherfolk community.

More than five thousand fishers including 2700 women fishers participated in the meet. Officers and staff members of state departments, ICAR institutes and Krishna Vigyan Kendra were also present on this occasion.



Media Coverage



The Telegraph

Fish seeds for 500 women

इंडियन पंच

सुंदरबन में 500 महिला मछुआरों को सिफरी ने दिया मछली पालन का उपकरण व साधन

महिला मत्स्यजीवी सम्मेलन

আজকাল

আলিপুর বার্তা

রবীন্দ্রনাথের চলচ্চিত্র ভাবনা

মহিলা মৎস্যজীবীদের পাশে কেন্দ্রীয় অন্তস্থলীয় মৎস্য গবেষণা সংস্থা



କୁଲତଲିରେ ମହିଳା ମତ୍ସ୍ୟଜୀବୀ ସମ୍ମିଳନୀ





THE KALINGA CHRONICLE

Popular People's Daily of Odisha

ICAR-CIFRI organized Mahila Matsyajeebi Sammelan at Kultali Sundarban



সাহায্য মহিলা মৎস্যজীবীদের

বাসন্তী: সুন্দরবনের মহিলাদের স্বনির্ভর করার লক্ষ্যে পাঁচশো মহিলা মৎস্যজীবীর হাতে মাছের পোনা-সহ মাছ চাষের সামগ্রী তুলে দিল কেন্দ্রীয় অন্তঃস্থলীয় মৎস্য গবেষণা সংস্থা (সিফ্রি)। দীর্ঘ দিন ধরেই এই সংস্থা সুন্দরবনের মহিলাদের স্বনির্ভরতার লক্ষ্যে কাজ করছে। ইতিমধ্যেই বাসন্তীর এক স্বেচ্ছাসেবী সংগঠনের সঙ্গে যৌথ উদ্যোগে হাজার দু'য়েক পরিবারকে মৎস্যচাষের মাধ্যমে স্বনির্ভরতার দিশা দেখিয়েছে সংস্থা। সম্প্রতি সংস্থার উদ্যোগে বাসন্তীতে একটি মহিলা মৎস্যজীবী সম্মেলনের আয়োজন করা হয়। সেখানেই পাঁচশো মহিলার হাতে পুকুরে মাছ চাষের জন্য মাছের চারা, খাবার, চুন এবং রঙিন মাছ তুলে দেওয়া হয়। সংস্থা সূত্রের খবর, চলতি বছরে আরও দু'হাজার মহিলাকে কর্মসূচির আওতায় আনার পরিকল্পনা রয়েছে। ভারতীয় কৃষি অনুসন্ধান পরিষদের মহানির্দেশক হিমাংশু পাঠক বলেন, "আমাদের উদ্দেশ্য সুন্দরবনের পিছিয়ে পরিবারগুলিকে স্বনির্ভর করে তোলা। সে কারণে প্রাথমিক ভাবে এঁদের সাহায্য করা হচ্ছে। মাছ বড় হলে তা বিক্রি করে পরবর্তী সময়ে এরা নিজেরাই নতুন করে চাষ করতে সক্ষম হবেন। মাছ চাষে কোনও রকম সমস্যা যাতে না হয়, সেটা আমরা নজর রাখব।" স্বেচ্ছাসেবী সংগঠনের তরফে লোকমান মোল্লা বলেন, "সুন্দরবনের এই পিছিয়ে পড়া মানুষের কথা মাথায় রেখে সিফ্রি যে উদ্যোগ নিয়েছে, তাতে সুন্দরবনবাসী হিসেবে আমরা কৃতজ্ঞ।"


21 MAY '23


আকাশবাণী কলকাতার সংবাদ বিভাগ
প্রযোজিত সাপ্তাহিক অনুষ্ঠান
খবরের আয়নায়
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CIFRI pen culture technology package enhanced the livelihood of displaced tribal fishers of Mapithel reservoir

The Mapithel reservoir, located in Kamjong district of Manipur, is a medium reservoir and the largest in the state, with a water spread area of 1100 hectares. The dam has displaced over 12,000 people. All the population affected by the reservoir belongs to the Tangkhul tribe. Fishing is the primary source of livelihood for the displaced people. To support the livelihood of the displaced tribal populace of the reservoir, ICAR-CIFRI has given two Pens (0.1 ha) along with 50,000 fish seeds and 2 tonnes of CIFRI CAGEGROW feed for raising fish as stocking material for reservoir fisheries enhancement to the society called "The Mapithel Dam Affected Fishery Co-operative Society". Additionally, a motorised FRP boat of 10 m OAL was also given to the society by CIFRI. The tribal fishers were also trained at the Institute headquarters and a mass awareness programme was also conducted at Ramrei village, Mapithel Reservoir site, to raise awareness among the fishers of reservoir fisheries management.



Fishermen of Mapithel Reservoir with the motorized FRP boat distributed by ICAR-CIFRI


Maintaining of HDPE pen in Mapithel Reservoir by fishermen

The pen culture of Indian Major Carps (IMCs) was managed by the society. *Labeo catla* (18.28±0.23 g), *Labeo rohita* (5.2±0.12 g), and *Cirrhinus mrigala* (5.5±0.08 g) were stocked in the ratio 2:1:1 at the rate of 250 nos./m2 in duplicate. The fish were fed with CIFRI CAGEGROW feed twice a day at a rate of 2–3% of body weight. The fish were raised for five months, from September 2022 to January 2023. The average weight recorded at the end of the culture period was 283.13±1.70 g, 186.26±47.02 g, and 116.00±0.87 g in *L. catla, L. rohita*, and *C. mrigala*, respectively. The survival rate of fish ranged from 80 to 88%. The specific growth rates (SGR) of *L. catla, L. rohita*, and *C. mrigala* were 1.82, 2.56, and 2.03, respectively. The species-specific net fish production per pen was recorded as 2601 kg, 898.8 kg, and 546 kg for catla, rohu, and mrigal, respectively. The fish from the pens were released into the reservoir for stock enhancement, resulting in livelihood support for the displaced tribal fishermen of the affected villages.

This technology was an eye-opener for the 370 fishers of the cooperative society, which yielded 8.1 metric tonnes of fish from two pens, which could ultimately produce 36 metric tonnes in a year from the reservoir with an additional average income of Rs. 24,000 per fisher (at Rs. 250 per kg). Society is highly motivated by this demonstration and interested to implement it for reservoir productivity enhancement in the coming years.

T. N. Chanu, B. K. Das and Aparna Roy

Women empowerment through cage culture in reservoirs: success stories of Chhattisgarh

In the state of Chhattisgarh, cage culture has emerged as a promising practice for both economic development and food sustainability. Traditionally, fisheries and aquaculture have been perceived as male-dominated sectors, with women's roles often confined to post-harvest activities. Cage culture presents an opportunity for a more inclusive participation of women, as it involves a range of activities from cage installation to feeding, monitoring, and harvesting. Women's involvement in these aspects can potentially empower them and can enhance economic agency within the community. One of the notable impacts of cage culture on gender roles is the potential for income generation among women. In Chhattisgarh, where many families rely on agriculture and allied activities, cage culture diversifies income sources. Women's active participation in cage culture not only contributes to household finances but also enables them to have a greater say in decision-making processes, thereby challenging traditional gender norms. In a recent study it was found that in the state, out of sampled cage culture sites, 20 percent are owned and cultured by women fish farmers. A self-help group in cage culture were also formed and run exclusively run by females. Such activities have allowed women to generate income and become economically independent. By earning their own income, women gain financial autonomy, enabling them to support themselves and their families, make financial decisions, and improve their overall socio-economic status.



Cage culture unit owned by female-led SHG in Kuwarpur reservoir



Cage culture unit owned by Gayatri Dhruw, in Ballar reservoir

To ensure effective women empowerment through cage culture, it is crucial to address gender-specific barriers, provide equal access to resources and training, and promote gender equality in the fisheries sector. Encouraging supportive policies, fostering inclusive environments, and creating opportunities for women's capacity building and leadership development are essential for realizing the full potential of women empowerment in cage culture in reservoirs.

Anjana Ekka and Arun Pandit

Adoption of pen aquaculture technology in Sone beel, Karimganj district, Assam proved to be a remunerative livelihood option for beel fishers

A successful model of adoption of pen aquaculture technology in the Sone beel of Assam was documented. A group of three fishermen-initiated pen culture in 2012–13 in Sone Beel, Karimganj district, and presently own three pens (one of 2 ha and two of 1 ha area each) constructed with mosquito netting materials supported by bamboo poles. Ten different species (*viz*., *Labeo catla*, *L. rohita*, *Cirrhinus mrigala*, *Hypophthalmichthys nobilis*, *H. molitrix*, *Cyprinus carpio*, *Barbonymus gonionotus*, *Oreochromis niloticus*, *L. calbasu,* and *L. angra*) were stocked with an average size of more than 115.5 g each in April 2022. Fishes were reared for up to five months, after which periodical harvesting was done. The average size of the harvested fish was 737 g. The average survival and growth rates of the cultured fish ranged between 83.3 and 95% and 229.4 and 866.7%, respectively. Total fish production achieved after one cycle of pen culture was 5437.4 kg/ha. Total expenditure (capital plus operational) was worked out ₹ 6.75 lakh and total income to be ₹ 10.43 lakh hence the net income from one ha of pen culture was ₹ 3.68 lakh. The benefit-cost ratio was worked out at 1.55. According to stakeholders' perception, productivity, cost efficiency, ease of management, control over production, technology complementarity, input complementarity, lesser complexity, trialability, and observabilitywere the major factors for the adoption of the technology. The availability of fish seed for pen culture was not recognized as an issue by the farmers (70%). About 63% of the respondents confirmed that investment in fish culture in ponds was higher than pen culture and therefore a major incentive for its adoption. However, 1/3rd of the farmers thought that there was high financial risk in pen fish farming compared to pond fish farming, and 57% thought that there was less risk in the former than the latter.



Pen aquaculture in Sone beel, Karimganj district, Assam

D. Debnath, S. C. S. Das, S. Yengkokpam, P. Das, A. K. Yadav, S. Borah, N. Sharma, B. K. Bhattacharjya, A. K. Das, B. K. Das and S. K. Majhi

Developed catch estimation software CAS 2.0

Department of Fisheries, Govt. of Chhattisgarh approached ICAR-CIFRI to develop a software for fish catch estimation of waterbodies below 10 ha for IMC, pangas, tilapia, and prawn, specifically customized according to their requirements. The ICAR-CIFRI successfully developed the software, named as CAS ver. 2.0, in a participatory mode to satisfy the client's needs. In an auspicious occasion, Dr. B. K. Das, the Director, ICAR-CIFRI has handed over the CAS ver. 2.0 to Mr. Y. P. Singh, Assistant Statistical Officer-the representative of Department of Fisheries, Government on 20th September 2023.



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Meetings and Events Organized



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Meetings and Events Organized

World Hindi Day

World Hindi Day is celebrated globally on 10 January 2023. The institute also observed the day with great enthusiasm in which Dr. B. K. Das, Director highlighted the work done by the institute in the promotion of Hindi. He said that under the patronage of the present regime, Hindi has a got global dimension. Today, there is widespread acknowledgment of Hindi's contribution to our social, cultural, and economic progress, leading to its expanded usage and significance even in non-Hindi-speaking states.



World Hindi Day

First Technical Advisory Committee Meeting of NePPA Project

The institute organized the 1st Technical Advisory Committee (TAC) meeting of the ICAR-Network Program on Precision Agriculture (NePPA) on 10–11 January 2023 at the Institute HQ, Barrackpore. Dr. S. K. Chaudhari, DDG (NRM), ICAR chaired the meeting. The program is monitored by a technical advisory committee, which is constituted involving twelve eminent experts from ICAR, IITs, and Universities. Dr. Amitabha Bandyopadhyay is the chairman of the Technical Advisory Committee. A total of sixteen ICAR institutes are working under this program.



First Technical Advisory Committee meeting of NePPA project

Annual Sports for the Institute Staff

The institute organized the Annual Sports Meet 2023 for the staff at the headquarters, Barrackpore on 12-13 January 2023. Dr. B. K. Das, the Director, inaugurated the event and emphasized the importance of sports in maintaining a healthy life. He also commended the staff for their achievements in ICAR sports and encouraged everyone to actively participate in the two-day event. On the occasion, the institute paid tribute to Swami Vivekananda on his birth anniversary, which coincides with



Inauguration of annual sports of the institute



Annual sports of the institute



Workshop on IPR issues



Republic Day at the institute headquarters

January 12. The Director highlighted Swamiji's passion for sports and mentioned that this day is celebrated as National Youth Day.

Workshop on IPR Issues in Fisheries Science

The institute organised a workshop on "IPR issues in Fisheries Science" on 18 January 2023 with the goal of sensitising scientists to the need for intellectual property protection in the development and commercialization of inventions. The Director Dr. B.K. Das informed that ICAR-CIFRI has submitted seven patents, four industrial designs, and eight trademarks in the last five years. The Institute has commercialised and licenced seven technologies in the inland fisheries sector, with another six in the pipeline at Agrinnovate India Ltd., ICAR's commercial arm. The workshop was attended by 55 scientists from the Institute headquartersas well as from its regional centres.

Republic Day

The institute celebrated the 74th Republic Day on 26 January 2023, at its headquarters in Barrackpore and in all the regional centres and station. The Director greeted the gathering on the auspicious occasions of Republic Day and Basant Panchami. He reminiscedthe great CIFRIans who made the country pride. Among them Dr. M. V. Gupta, who has a long association with our Institute, has been awarded the Padma Shri this year. Dr. Gupta is also a World Food Prize laureate. The Director wished long live of the Indian republic.

World Wetland Day

The Institute organised a hybrid brainstorming session at the Guwahati Regional Centre to mark World Wetlands Day (WWD) on 02 February 2023 with the theme 'It's time for wetlands restoration'. Representatives from various

organizations including the Departments of Fisheries, Assam and West Bengal, Assam Fisheries Development Corporation Ltd., College of Fisheries (AAU) in Raha, Assam State Wetland Authority, Gauhati University, National Fisheries Development Board NERC, Department of Environment & Forest from the Government of Assam, Assam Agribusiness and Rural Transformation Project (APART), WorldFish, Aaranyak (NGO), and progressive beel fishers participated in the session. Dr. B.K. Das, Director of ICAR-CIFRI, provided a brief overview of the valuable goods and services offered by wetlands, which serve as a vital source of livelihood for local communities. Scientists and staff from ICAR-CIFRI, Guwahati Regional Centre, engaged in fruitful discussions with the delegates, leading to the formulation of several recommendations emerging from the session.



World wetland day

National Seminar by ICAR-CIFRI and NGB (DU) at Prayagraj

A national seminar on "Ecology vs. Economic Development with Special Reference to the Ganga Basin (NEED-2023)" was jointly organised by ICAR-CIFRI and NGB (DU), Prayagraj, Uttar Pradesh, from 25-26 February 2023. The seminar focused on raising awareness about the aquatic biodiversity of the Ganga River, which is directly correlated to the economy of the fish farmers. The programme started with a welcome address by Dr. Dharm Nath Jha, Senior Scientist and HOC. Prof. R. S. Verma, Director, MNIT and IIIT, Prayagraj, was the Chief Guest. He highlighted the importance of molecular biology and shared his experiences in that field.



Inauguration of the National Seminar at Prayagraj



Delegates of the National Seminar at Prayagraj

Institute Management Committee (IMC) Meeting

The 51st IMC meeting was held under the chairmanship of Dr. B. K. Das on



IMC meeting

28 February 2023. He welcomed all members and briefed them on the Institute's research and development activities since the last IMC meeting, overall Institute management, and links established with other stakeholders. The meeting discussed 17 agenda points of various issues, followed by a scientific presentation on "Arsenic contaminations in the aquatic ecosystems: its mitigation for food safety and health," delivered by Dr. Srikanta Samanta, Principal Scientist and HoD, FRAI Division.

Research Advisory Committee (RAC) Meeting

The RAC Meeting of the Institute was held on 02-03 March 2023. Dr. B. Meenakumari, Chairperson of the RAC, presided over the meeting. The meeting was also attended by the members of the Committee, namely Dr. Madan Mohan, Dr. A. K. Singh, Dr. V. P. Saini, Prof. Subhashisa Dutta, Dr. B. P. Mohanty and all the scientists of the institute. Dr. B. K. Das, Director briefed on the activities and accomplishment of the institute, including river ranching, automation in cage culture, big data, drone technology, climate resilient pen culture, outreach initiatives in the Sundarbans, and the introduction of artificial intelligence (AI) in inland open water research. All the HoDs presented the achievements of their projects. The Chairperson and all the members of RAC showed their satisfaction with the achievements and activities of the institute. A total of 14 recommendations were suggested in the meeting.



RAC meeting of the Institute



International women's day

International Women's Day

The institute celebrated International Women's Day on 08 March 2023 on the theme "Embrace Equity". On this occasion, Dr. B. Meenakumari, Former Deputy Director General (Fishery Science), ICAR and Chairperson, RAC encouraged women staff members of the institute and enlightened them that gender equity needs to be part of every society's DNA. Equality is the goal, and equity is the means to achieve that.

Institute-Industry Interface Meeting on Waste-to-Wealth Products

The institute organised an Institute-Industry Interface meeting on waste-to-wealth products on 15 March 2023. The meeting was focussed on the recently developed technology of silkworm pupae-based fish feed. The meeting was attended by Dr. B. K. Das, Director, and staff of the ICAR-CIFRI; Dr. K. Satyanarayana, Director, CSB-Central Tasar Silk Research and Training Institute, Ranchi; and industry representatives.



Institute-industry interface meeting on waste-to-wealth products

77th Foundation Day

The 77th Foundation Day of the Institute was celebrated on 17 March 2023 at the headquarters of the Institute. Since 1947, ICAR-CIFRI has been conducting research, training, and extension programs in inland open waters to promote the holistic development of fisheries. Shri Avanindra Singh, IAS, Secretary to West Bengal Department of Fisheries, was the Chief Guest; Dr. Dhriti Banerjee, Director, Zoological Survey of India; Dr. D. B. Shakyawar, Director, ICAR-NINFET; and Dr. Gouranga Kar, Director, ICAR-CRIJAF, were the Guests of Honour. One hundred fifty farmers and entrepreneurs and 150 students of local schools were also present on this occasion.



77th Foundation Day

3rd Advisory Committee Meeting of Hilsa Project

The 3rd Advisory Committee Meeting of the NASF project on Captive breeding of hilsa, *Tenualosa ilisha*, Phase II, was held on 28-29 March 2023 under the Chairmanship of Dr. K. K. Vass. Dr. J. K. Jena, DDG (Fishery Sciences) and Dr. Ashok Kumar, Principal Scientist, NASF, joined the meeting in online mode. Dr. S. Raizada and all the CCPIs, including Dr. Debasis De, Dr. S. Adhikary, and Dr. G. Biswas, attended the meeting physically. The Chairman and members expressed



Advisory Committee Meeting of Hilsa project



A & B : Northeast Livestock-Aqua-Poultry Expo, 2023



World intellectual property day

their satisfaction with the progress of the project with respect to the gonadal maturity of the captive stock. The first day of the meeting was held at ICAR-CIFRI, Barrackpore. A visit to captive stock farm facilities maintained at ICAR-CIBA, Kakdwip was made on the second day.

Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference

P2C Communications, New Delhi, along with Aqua Post and Smart Agri Post Magazines as media partners and ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore, as a knowledge partner, organised "Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference" during 18-20 April 2023 at Maniram Dewan Trade Centre, Guwahati. In the programme, concerned research institutes, private companies, government agencies, line departments, entrepreneurs, and others put up exhibition stalls to display their products and technologies. More than 5,000 people (including women and professional students) from the entire North-eastern region visited the exhibition stalls and interacted with the exhibitors.

World Intellectual Property Day

On 'World intellectual property day' 2023, the Institute highlighted the "can-do" spirit and groundbreaking work of women innovators, creators, and entrepreneurs around the world. Celebrating the innovative and creative scientific activities of all ICAR-CIFRI women researchers, a hybrid workshop on the theme "Women in IP: Accelerating Innovation and Creativity" was held on 26 April 2023. Dr. Poonam J. Singh, Sr. Scientist, ICAR-NBFGR delivered a lead lecture on “Thinking out of box: Innovationand Creativity in Science”. She discussed about helping young inventors, creators, andentrepreneurs to use intellectual property (IP) to achieve their goals, generate income, createjobs, and

tackle local and global challenges by supporting community and nationaldevelopment.The programme drew 150 scientists, technical personnel, and research scholars from the institute headquarters in Barrackpore and regional centres.

IRC Meeting

The Institute Research Committee Meeting for the year 2022–23 was held on 2-4 May 2023, at the Institute headquarters in off-line mode. The achievements of 18 institutional as well as network projects were discussed, and recommendations were made by the house under the chairmanship of Dr. B.K. Das, Director. In addition to these, the RAC recommendations, ICAR regional committee reporting, reporting done by the PME Cell, KRISHI, animal ethics for experiments, and administrative and financial issues of project management were discussed by the house. Four new projects were also presented at this IRC meeting.







A





B

A & B : Interactive Workshop on 'Management of Openwater Fisheries of Sikkim'



International Yoga Day

Interactive Workshop on 'Management of Openwater Fisheries of Sikkim'

The Institute organised the workshop at Gangtok in collaboration with the Directorate of Fisheries (DoF), Govt. of Sikkim, on 29 May 2023. Alongwith Dr. B. K. Das, Shri N. Jaswant, and Dr. B. K. Bhattacharjya, the programme was attended by Dr. Thangapandiyan, Head, Zoology Department, SRM University, Sikkim; Ms. Niti Sharma, Scientist, ICAR-CIFRI Regional Centre, Guwahati; officers from DoF, Sikkim; M.Sc. students of SRM University; fishers, fish farmers, and members of the Sikkim Anglers' Association. Representatives from local print and media were also present.

International Yoga Day

Originating in India, yoga is an ancient practice encompassing physical, mental, and spiritual elements. Since its adoption by the United Nations General Assembly in 2014, International Yoga Day has been observed annually on June 21 worldwide. Today, yoga is practiced in diverse forms across the globe and continues to gain popularity. The institute commemorated this occasion on 21 June at its headquarters, regional centers and stations. The theme of the event was, *'Vasudhaiva Kutumbakam'* or 'One Earth, One Family,' and *'Har Aangan Yog*'. Shri Sujit Ghorui, a yoga instructor, delivered a lecture on "The Role of Yoga in Health and Wellbeing" to raise the awareness of the staff regarding the benefits of yoga. In the morning, the staff did a practical yoga session with the guidance of the instructor.

National Fish Famers' Day

The institute celebrated "National Fish Farmers Day" on 10 July 2023. This Day is celebrated to commemorate the stupendous achievement of the induced breeding

technique, which is contemplated as the torchbearer of the 'First Blue Revolution' in India. Prof. Hiralal Chaudhary and Dr. K. H. Alikunhi pioneered the 'Induced Breeding Technique, which was successfully developed in Angul Fish Farm, Odisha, on this day in 1957. The programme was commenced with a tribute to Dr. Hiralal Choudhury and Dr. K. H. Alikunhi. Dr. B. K. Das, Director, ICAR-CIFRI informed that the institute has initiated a program that assist the fisher women to establish fish culture units, including ornamental fish culture under the SCSP project with the goal of empowering 3,000 women. Dr. B. B. Jana, a retired professor from the University of Kalyani, West Bengal appreciated CIFRI's attempt to enhance farmers' livelihoods.



National Fish Famers' Day

IJSC Meeting

The Institute Joint Staff Council (IJSC) had its 75th meeting on 03 August 2023 which was chaired by the Director, Dr. B. K. Das. The IJSC staff members were present in the meeting. Various staff welfare-related activities were discussed in the meeting.



IJSC Meeting

Independence Day

The institute celebrated the 77th Independence Day on 15 August 2023, with great fervour and enthusiasm. As a part of *Aazadi Ka Amrit Kaal*, the *Har Ghar Tiranga* campaign was conducted on 13–15 August 2023 at the institute headquarters in Barrackpore, and the regional centers. The Director hoisted the National Flag at this grand event. Officers, staff members, research scholars and contractual staff were present along with their family members on this occasion.



77th Independence Day

Parthenium Awareness Week

In observance of Parthenium Awareness Week during 16-22 August 2023, the institute organized a number of events with the goal of



Awareness on ill effects of parthenium



Workshop on "Livelihood Development of Wetland Fishers addressing SDGs"



Distribution of inputs of ornamental fish culture

raising awareness among the staff, construction workers, and research scholars regarding the ill-effects of the parthenium. Employees of the institute removed weeds from the institute premises as part of their active participation in the endeavour to get rid of parthenium. As a result of the initiatives,parthenium has been eradicated from the ICAR-CIFRI campus and the surrounding areas.

Workshop on Livelihood Development of Wetland Fishers addressing SDGs

The institute conducted an interactive one-day workshop entitled "Livelihood development addressing SDGs through inland open water fisheries" under SCSP and NICRA on 18 August 2023. The workshop was attended by the scientists, technical staff, research scholars, and 32 fisherman representatives from 16 wetland fishery cooperative societies of Murshidabad, Nadia, and North-24 Parganas districts of West Bengal, adopted under the SCSP program and the NICRA project. Since 2019, ICAR-CIFRI has extended its support to the livelihood improvement of Scheduled Caste communities across the country under the SCSP plan through inland fisheries activities like culture-based fisheries, stock enhancement, pen culture, etc.

Distribution of Inputs of Ornamental Fish Culture among the Rural Women

An input distribution and awareness program on ornamental fish culture for the livelihood development of rural women was organized in collaboration with Sasya Shyamala Krishi Vigyan Kendra, Sonarpur, West Bengal under the Ramakrishna Mission on 19 August 2023. The program was organized to enhance the livelihood opportunities of the SC women's community. Ornamental fish rearing units consisting of FRP tanks and other accessories were

distributed as start-up materials by Dr. B. K. Das, Director.

Review Meeting of the NASF Project on Hilsa

The review meeting of the NASF project "Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II" was held on 08 September 2029 at the Institute headquarters. Dr. Jitendra Kumar, ADG chaired the meeting in which the advisory committee members, Dr. K. K. Vass and Dr. S. Raizada were present in online mode. Dr. Samanta, Consortium PI, other CCPIs of the cooperating institutes, *viz*. Dr. Debasis De from ICAR-CIBA, Kakdwip, Dr. S. Adhikari from ICAR-CIFA, Rahara and Dr. Gouranga Biswas from ICAR-CIFE, Kolkata were present in the meeting. Other Co-PIs of the project, Dr. R. K. Manna, and Dr. A. K. Sahoo from ICAR-CIFRI, Dr. T. K. Ghosal from ICAR-CIFE were also present whereas Dr. Gayatri Tripathi from ICAR-CIFE and Dr. Babita Mandal from ICAR-CIBA attended the meeting in online mode.



Review meeting of the NASF Project on Hilsa

Hindi Saptah

The Hindi Saptah 2023 was organized in the institute during 14–20September2023. It was inaugurated on 14 September 2023, at the Institute Headquarters, in which various regional centers of the Institute participated in online mode. Dr. Puneet Kumar Singh, Research Officer, Central Ayurveda Research Institute, CCRAS, Ministry of AYUSH was the Chief Guest of the function arranged in Guwahati Regional Centre. In his speech he highlighted that promotion and propagation of Hindi is not only the responsibility of the Central Government but also our responsibility and stressed on 'समर्थन से ही समर्पण की भावना उत्पन्न होती है'. The Hindi monthly newsletter "CIFRI Masik Samachar" (August 2023) was released in the program. A





Hindi Saptah at Institte Headquarter



Hindi Saptah at Guwahati Centre





Handed Over the Catch Assessment Survey Software



Workshop on "Vulnerability of Inland Fisheries Due to Climate Change"

workshop on "*Deshke Vikas me Raajbhasha ki Bhoomika*" was organized at the Bangalore regional centre on 14 September 2023.

Handed Over the Catch Assessment Survey Software to the Department of Fisheries, Government of Chhattisgarh

The institute successfully developed CAS ver. 2.0software in a participatory mode specifically customized for the Department of Fisheries, Government of Chhattisgarhfor fish catch estimation of waterbodies below 10 ha for IMC, pangas, tilapia, and prawn. Dr. B. K. Das, Director, ICAR-CIFRI, handed over the software to Mr. Y. P. Singh, Assistant Statistical Officer, Department of Fisheries, Government of Chhattisgarh on 20 September 2023.

Workshop on "Vulnerability of Inland Fisheries Due to Climate Change"

A concluding workshop under the NICRA project "Impact of Climate Change in Inland Fisheries and Development of Adaptive Strategies" was organized at ICAR-CIFRI, Kolkata, on 25 September 2023. Dr. B. K. Das, Director and PI, NICRA project outlined the purpose of the workshop with a brief discussion on achievements under the different phases of the NICRA project in the last 12 years. Dr. P. Dey, Director, ICAR-ATARI, Kolkata was the Chief Guest and invited experts and fish farmers were also present.

Concluding Workshop under the NMCG Project

The institute organized a one-day stakeholders' consultation-cum-consultative workshop on 'Fish conservation and ranching in the Ganga' on 26 September 2023 to review the accomplishments of the three-year project of NMCG under

the Ministry of Jal Shakti, Government of India. Dr. B. K. Das, Director and Principal Investigator, NMCG, presented the outcome of the project and highlighted the mission of ranching, where more than 65 lakh of fish fingerlings were released during 2020–23, covering five states, namely Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. He also highlighted the increase in the landing of IMC by 24.70% in Prayagraj, 41.03% in Varanasi, Uttar Pradesh, and more than 25% in Patna, Bihar as a result of the ranching. He informed that around 140 public awareness programs covering 10 thousand fishers were conducted under this project for conservation of aquatic biodiversity and restoration of fish habitat in the Ganga.

Stakeholders Consultation-cum-Consultative Workshop on Hilsa Fisheries Improvement

A stakeholders consultation cum consultative workshop on 'Hilsa fisheries improvement for sustainable fisheries and conservation in the Ganga under the NMCG project" was organized at ICAR-CIFRI, Barrackporeon 27 September. Dr. B. K. Das, Director highlighted the importance of hilsa and dolphin conservation in the river Ganga and the scientific interventions taken up by ICAR-CIFRI since 2018. Dr. Sandeep Kumar Behera, Consultant, National Mission for Clean Ganga (NMCG), Mr. Rajdeep Mukherjee, Policy Analyst, Bay of Bengal Programme (BoBP-IGO), Mr. G. C. Das, Wildlife Institute of India (WII); Dr. D.K. De, Retired Principal Scientist of ICAR-CIFRI; Dr. U. Bhowmik, Retired Principal Scientist & Former HoD, REF Division, ICAR-CIFRI; Dr. Subrata Dasgupta, Retired Principal Scientist of ICAR-CIFE; Dr. Ashim Kumar Nath, Professor, Department of Zoology, SBKU University; Prof. Sudhir Kumar Das, WBUAFS and Dr. Gayatri Tripathi, Principal Scientist, ICAR-CIFE graced the occasion as expert members.



A & B : Concluding Workshop under the NMCG Project



Workshop on hilsa fisheries improvement

ICAR-CIFRI observed 'National Dolphin Day'

Healthy aquatic environment contribute to the planet's overall well-



Awareness on dolphin conservation at Barrackpore ghat



Awareness drive under the vigilance awareness week



School students with their prizes under the vigilance awareness week

being. Dolphins are the ideal ecological markers of a healthy aquatic ecosystem. On 15 August 2020, "Project Dolphin" was launched by the Hon'ble Prime Minister,Shri Narendra Modi Ji to include both river dolphins and marine dolphins in its conservation program. The 05th October has been observed as the National Dolphin Day to raise awareness for dolphin conservation. The institute organized an awareness programme at the Sheoraphuli ghat on the bank of river Ganga on the occasion.

Vigilance Awareness Week

The Institute observed "Vigilance Awareness Week" from 30 October to 05 November 2023 on the theme "Say No to Corruption, Commit to the Nation." The week-long observance started with the administration of a pledge to the officials and staff on 30th October by the Director-in-Charge, ICAR-CIFRI. Several staff members of the institute took an e-pledge. Large numbers of posters, banners, and placards were displayed on the campus premises, showing the ill effects of corruption at work and in society and the commitment of ICAR-CIFRI towards zero tolerance for corruption.

Antimicrobial Resistance Awareness Week

The institute organized the World Antimicrobial Awareness Week (WAAW) from 18 to 24 November 2023 with a major theme of "Preventing Antimicrobial Resistance Together." The aim of the program was to increase awareness of global antimicrobial resistance and encourage best practices among the public, health workers, and policymakers to avoid the further emergence and spread of drug-resistant infections. A series of





Awareness on antimicrobial resistance

lectures to the students and faculties from different colleges in and around Kolkata, awareness among the fishers and agriculture farmers in KVK, Malda and the river Ganga at Farakka were organized.

Communal Harmony Campaign and Flag Day

Communal harmony campaign, fund-raising week, and Flag Day were observed at the institute during 19-25 November 2023 to spread messages on peace, harmony, and national integration and to foster and reinforce the spirit of communal harmony among the staff of the organization. The institute observed this campaign as a partner of the National Foundation for Community Harmony, New Delhi. A pledge on secularism, anti-communalism, and non-violence was taken by all the staff members on 19 November 2023.



Taking of pledge under the Communal harmony campaign

World Fisheries Day

The institute celebrated World Fisheries Day on 21 November 2023 at various places of the country under the theme "Build enabling policy environments for small-scale artisanal fisheries." On this occasion, ICAR-CIFRI conducted three mass awareness camps at Hasnabad, West Bengal; Vazhani Reservoir, Kerala;



World Fisheries Day being observed at Hasnabad, West Bengal





A & B : Fish harvest at Kangsabati reservoir

and at Sangam, Prayagraj, Uttar Pradesh. More than 350 small-scale artisanal fishermen were sensitized on ecosystem health management and the importance of conservation through these awareness programs. The Guwahati Regional Centre participated in the exhibition organized by the Directorate of Fisheries, Govt. of Assam. The Bangalore Regional Research Centre participated in the exhibition conducted by the Department of Fisheries, Karnataka. More than 1000 people all over Karnataka witnessed the event.

Fish Harvest Mela at the Cage Culture site of Kangsabati Reservoir, Bankura

A fish harvest-cum-auction program was organized by the institute at the cage culture site, Kangsabati reservoir, Mukutmanipur on 02 December 2023. The program was organized under the project “Cage Culture in Kangsabati Reservoir," implemented by the Department of Fisheries, West Bengal, with the technical collaboration of ICAR-CIFRI. The purpose of the project was to showcase the potential of cage culture for fish production enhancement in reservoirs in West Bengal and build the capacity of fishers in different aspects of cage culture. The program was graced by Hon'ble Minister of State, Sri Biplab Roychowdhury. Special Commissioner Sri. Atanu Kumar Roy, IAS; Karmadhakshya Ms. Sujata Mondal; ADM Sri Vivek Basmay, IAS; SDO Ms. Neha Banerji, IAS; and officials of the Fisheries Department were also present at the occasion. Many fishermen from the reservoir, belonging to 7 cooperative societies and local fish vendors and traders, participated in the program.

World Soil Day

World Soil Day 2023 was celebrated on the United Nations declared theme "Soil and Water: A Source of Life" on 05 December 2023 at the institute headquarters in hybrid mode, connecting all the regional centers. A total of 150 participants, including scientists, students, research scholars, and fishermen participated in the program. Dr. Niharendu Saha, Professor, Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, Chief Guest focussed on importance of soil and water, their inter-relationships, and balanced nutrition in fish production.



World Soil Day

The Institute Hosts the Green Corner Platform

"Green Corner: Suitable Environment for All" is a program conducted to welcome and felicitate Mrs. Sudeshna Pal Kar, a solo expeditioner who is undertaking 400 km solo kayaking from Murshidabad to Kolkata for the "Save River, Save Life" campaign. The 15-day kayaking trip was flagged off by Team WALK on 28 November 2023, from Ahiron Ghat, Murshidabad. The team WALK used kayaking as a medium to uphold the sport as a means of salvaging the environment in our lives; they had interacted with various stakeholders in the Ganga River during the expedition on various issues related to aquatic life diversity, including Gangetic Dolphins, tributaries, and other water bodies associated with the river Ganga.



Mrs. Sudeshna Pal Kar (at the middle) under the Green Corner Platform

Other Important Events



New Year celebration on 01 January 2023



Saraswati Puja on 26 January 2023



Institute staff attended the post budget discussion on 24 February 2023



Workshop on stress management by Bramha Kumaris on 31 March 2023



'CIFRI Cage Grow feed' technology license transfer on 27 April 2023



FPC Meet on "Capacity building for livelihood enhancement & Sundarban Dream Krishak Samman" on 29 April 2023



World Environment Day on 5 June 2023



Women in Agriculture Day



Kali Puja at ICAR-CIFRI Barrackpore residential campus



Mahila Kisan Diwas, 13 October 2023

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Towards Viksit Bharat



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Marching towards Viksit Bharat: ICAR-CIFRI's Initiatives

'*Viksit Bharat* 2047' is the Union Government's roadmap to make India a developed nation by 2047 which is the 100th year of country's independence. The vision of *Viksit Bharat* encompasses the contribution of every sector of the economy, agriculture, industry, infrastructure, education, healthcare, service sector and technology upgradation and adoption. The journey towards a *Viksit Bharat* involves addressing numerous challenges while leveraging the country's vast resources, human capital, and cultural diversity to propel growth and progress.

The inland fisheries sector can play a crucial role in achieving the vision. Addressing the nutritional security concern amidst the increasing population, the government places particular emphasis on boosting the fish production. Leveraging technological interventions and research advancements, the *Prime Minister's Matsya Sampada Yojana* (PMMSY) has emerged as a pivotal initiative to tackle food security challenges, yielding significant progress in the fisheries sector. Currently, India stands as the world's third-largest fish-producing country, contributing 16.25 million metric tonnes, which accounts for 7.96% of global fish production (DoF, GoI, 2023). India takes the lead in inland capture fish production globally, contributing around 2 million tonnes to the food basket. A WorldFish, ICAR and IFPRI study found that at national level the per capita fish consumption is 8.89 kg in 2023. The study forecasted that at the present level of growth the fish consumption in India is projected to double and reach 26.50 million metric tons (MT) in 2047–2048. However, if the growth rate in economy increases and in the moderate growth scenario the production level of 57 million tonnes would be required to fulfil the demand of consumption and exports. The Average annual growth rate of the fisheries sector in last 8 years was around 8%. Thus, growth rate need to be maintained to achieve the target during 2047. The inland capture fisheries sector has a great role to play to contribute significantly to *Viksit Bharat*@2047's through sustainable exploitation of the abundant inland open water resources in the country.

ICAR-CIFRI's initiatives towards Viksit Bharat

Bridging the yield gap

- Refined fisheries enhancement practices and species diversification for CBF
- In-situ seed production for supply of quality stocking material
- Empowerment of communities and societies for sustaining CBF

Refinement of technology

- Optimization of stocking density and ratio for CBF based on natural food resources
- Region and species-based customization of enclosure culture and automation
- Use of eco-friendly feed, demand feeding or automatic feeders for enclosures

Focus on ecosystem-based approach

- Application of ecosystem modelling
- Promotion of natural farming and community based management

Climate resilient fisheries

- Assessment of ecosystem and species vulnerability
- Assessment of carbon foot prints of fish production methods and management regimes
- Development and implementation of adaptation and mitigation strategies

The initiatives taken by the ICAR-CIFRI are key for fisheries enhancement as envisioned to meet the targets of the *Viksit Bharat*@2047 goals. Challenges like yield gap, unscientific practices, habitat degradation, and climate change require an inclusive approach involving refined practices, effective management, biodiversity conservation, and innovative technologies for smart CBF and enclosure culture. Bridging yield gaps, ecosystem-based approaches and data-driven decision-making are essential. Emphasizing and advocating for supportive governance, policies, and innovative technologies will contribute to the long-term sustainability and growth vision targets a yield realization of 450 kg/ha/year from small reservoirs and 1250kg/ha/year from floodplain wetlands through concerted efforts and strategic planning.



Swachh Bharat Activities



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Swachh Bharat Activities

The activities included oath taking, display of banners, regular cleaning, discarding of old files, bleaching and fumigation activities of the campus. Awareness session was conducted among students and farmers in villages and other outreach sites. A demonstration session of the vermicompost unit of the Institute was also undertaken among the farmers.



Paying homage to the Father of Nation



Demoinstration on vermicompost



Swahhta hi seva - awareness at Barrackpore Ferryghat



Regular campus cleaning activities at Barrackpore



Swachhata activities at Guwahati Centre



Swachhta activities in outstation



Swachhata activities at Prayagraj Regional Centre



Swachhata activities at Vadodara Centre



Swachhata activities at Kochi Research Station



Swachhata activities at Bengaluru Centre

राजभाषा कार्य



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राजभाषा कार्य

भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान में हिन्दी सप्ताह 2023 का आयोजन

भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान में हिन्दी सप्ताह दिनांक 14 से 20 सितंबर 2023 के बीच आयोजित किया गया। इसका उद्घाटन दिनांक 14 सितंबर 2023 को संस्थान मुख्यालय में ऑफ़लाइन तथा ऑनलाइन दोनों ही मोड में किया गया, जिसमें संस्थान के विभिन्न क्षेत्रीय केंद्रों ने ऑनलाइन मोड में भाग लिया। इस समारोह का शुभारंभ श्री संजीव कुमार साहू, वैज्ञानिक 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। तत्पश्चात, संस्थान के वरिष्ठ अधिकारियों और क्षेत्रीय केंद्र प्रमुखों ने अपने–अपने विचार साझा किए। संस्थान के प्रभारी निदेशक तथा सर्वकार्याधिकारी, हिन्दी कक्ष, डा. श्रीकान्ता सामन्ता ने राजभाषा हिन्दी के कार्यकलापों और उपलब्धियों पर प्रकाश डाला। गुवाहाटी क्षेत्रीय केंद्र से मुख्य अतिथि डॉ पुनीत कुमार सिंह, अनुसंधान अधिकारी, केन्द्रीय आयुर्वेद अनुसंधान संस्थान, केन्द्रीय आयुर्वेदीय विज्ञान अनुसंधान परिषद्, आयुष मंत्रालय, भारत सरकार ने अपना वक्तव्य रखा। उन्होंने हिन्दी दिवस का परिचय देते हुए बताया कि हिन्दी का प्रचार–प्रसार सिर्फ केन्द्रीय सरकार का ही नहीं अपितु हमारा भी दायित्व है। 'समर्थन से ही समर्पण की भावना उत्पन्न होती है' को उक्त करते हुए उन्होंने हिन्दी के प्रति समर्पित होने के लिए सभी से अनुरोध किया । संस्थान के मुख्य प्रशासनिक अधिकारी, श्री कुमार विवेक ने हिन्दी को प्रगामी रूप से अपनाने की बात कही। कार्यक्रम में हिन्दी "सिफरी मासिक समाचार– अगस्त 2023' का विमोचन किया गया ।

संस्थान में हिन्दी सप्ताह के दौरान कई प्रतियोगिताएं आयोजित की गईं। दिनांक 14 सितंबर 2023 को हिन्दी निबंध प्रतियोगिता से इसका शुभारंभ किया गया। इसके बाद दिनांक 15 सितंबर 2023 को अंकन एवं स्लोगन; कविता पाठ; 18 सितंबर 2023 को आशुभाषण प्रतियोगिता और हिन्दी अनुवाद; दिनांक 19 सितंबर 2023 को कार्य समीक्षा और क्विज (प्रश्नोत्तरी)। ये प्रतियोगितायें दो वर्गों में आयोजित की गईं– हिन्दी भाषी तथा हिंदीतर भाषी। प्रतियोगिताओं में सभी कर्मियों और शोध छात्रों ने बढ़–चढ़ कर भाग लिया।

हिन्दी सप्ताह का समापन, 20 सितंबर 2023 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 साथ ही उन्होंने गृह पत्रिका, नीलांजलि को विषय संदर्भित बनाने पर जोर दिया जिससे किसी महत्वपूर्ण मुद्दे से संबंधित विभिन्न पहलुओं पर ध्यानाकर्षण किया जा सके। संस्थान के प्रभागाध्यक्षों ने अपने वक्तव्य में हिन्दी को संपर्क भाषा के तौर पर भाषित किया और कहा कि मछुआरों से संवाद में हिन्दी का विशेष महत्व है। इस समारोह के मुख्य अतिथि, डा सत्य प्रकाश तिवारी, एसोसिएट प्रोफेसर (हिन्दी), शिबपुर दीनबंधु कॉलेज, हावड़ा, पश्चिम बंगाल ने नीलांजलि पत्रिका की सराहना की और इससे अपने जुड़ाव की चर्चा की । इस अवसर पर हिन्दी "सिफरी मासिक समाचार– सितंबर 2023 का विमोचन किया गया और प्रतियोगिता के विजेताओं को पुरस्कार दिया गया।

हिन्दी सप्ताह 2023 का सफल कार्यान्वयन संस्थान के निदेशक, डा. बि. के. दास के मार्गदर्शन में डा. श्रीकान्त् 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 25 अप्रैल 2023 को नगर राजभाषा कार्यान्वयन समिति (कार्यालय–2), कोलकाता के बैठक में सुश्री सुनीता प्रसाद, स.मु.तक. अधि. (हिन्दी) ने भाग लिया।
2. दिनांक 5–9 जून, 2023 को आयोजित उच्चस्तरीय अनुवाद प्रशिक्षण कार्यक्रम हेतु भाकृअनुप–केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान से सुश्री सुनीता प्रसाद, सहायक मुख्य तकनीकी अधिकारी (हिन्दी) ने भाग लिया।

हिन्दी प्रकाशन

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2. वार्षिक प्रतिवेदन 2022 (हिन्दी)
3. प्रशिक्षण मैनुअल, 2023 – "बिहार राज्य में अन्तर्स्थलीय मात्स्यिकी प्रबंधन (हिन्दी)
4. अर्द्ध वार्षिक न्यूजलेटर (द्विभाषिक)– जुलाई–दिसंबर 2022 तथा जनवरी–जून 2023
5. मासिक हिन्दी न्यूजलेटर – दिसंबर 2022 से नवंबर 2023 (हिन्दी)

इसके अलावा संस्थान के वेबसाइट पर संस्थान में आयोजित महत्वपूर्ण कार्यक्रमों का हिन्दी रिपोर्ट उपलब्ध है । साथ ही, समय–समय पर आयोजित कार्यक्रमों का रिपोर्ट विभिन्न हिन्दी समाचार पत्रों और सोशल मीडिया पर प्रकाशित होता रहता है।







Library and Informatics



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Library and Informatics

The library and informatics section is the primary repository of ICAR-CIFRI publications, such as books, annual reports, newsletters, bulletins, leaflets, and other publications. Relevant publications of the other agencies/institutes are also kept here. At present the library has 12,888 books including 62 acquired in 2023. In addition, the institute subscribed 15 Indian magazines and those are housed in the library. In the last year, 16 leaflets, and 15 ICAR-CIFRI publications which covered a broad range of topics were added to the collection. In addition to the libraries of the institute's own regional centres, the library is tasked with sending several ICAR-CIFRI publications to various SMDs, different government offices, and numerous other institutes and universities across the nation. Visitors can enjoy a large reading room and a well-equipped ARIS Cell. Users have access to a mini-conference room, equipped with an Android Smart TV and Wi-Fi internet connection for talks, small group meetings, and other activities. The library area also features a computer linked to the KOHA server and a book scanner for simple book and document scanning.

For simplicity of management, the Library and Informatics division is separated into four sections: scientific books, journals, ICAR-CIFRI publications, and Hindi literature. The KOHA Open-Source Library Management software oversees the library's digitalized cataloguing system, and users can access this database via the ICAR-CIFRI website and AGRICAT, a Union catalogue that is accessible to all NARS institutes. As a participating member of the CeRA Consortium, ICAR-CIFRI has used Document Delivery Requests (DDR) to send 28 documents to various NARS institutes during the year.

The subscription of the most Indian journals has been extended in this year as well. This year, a committee has been assigned to physically verify books and other papers in the library.



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Intellectual Property Rights



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Intellectual Property Rights

Project Title: National Agricultural Innovation Fund (NAIF) Component-1 ITMU

Project Code: 50313210011

Duration: 01.01.2023 to 31.12.2023

Funding Agency: Indian Council of Agricultural Research

Scientific Personnel: B. K. Das (PI), Ganesh Chandra

Patent Filed

- One patent application entitled "Synergistic immunity enhancer compositions of natural origin for fish and method of preparation thereof" has been filed at the Indian Patent Office, Kolkata on 13 May 2023 in the name of the Indian Council of Agricultural Research. Patent application No. is 202331033791.

Design registration granted

- "Fibreglass Reinforced Polymer Coracle" has been granted Registration of Design on 9 March 2023 in the name of the Indian Council of Agricultural Research. Design application No. is 359898-001.
- "Fibreglass Reinforced Polymer Ornamental Breeding and Rearing Tank" has been granted registration of design on 9 March 2023 in the name of the Indian Council of Agricultural Research. Design application No. is 359899-001.

Trademark granted

- Trademark entitled "CIFRI Circular Cage" has been registered on 15 September 2023, under class 22 in the name of the Indian Council of Agricultural Research. Trademark application No. 5703691.

Trademark filed

- Trademark application entitled "CIFRI NutrifishIn" has been filed on 12 August 2023, under class 35 in the name of the Indian Council of Agricultural Research. Trademark application No. 6063896.
- Trademark application entitled "Reshmeen" has been filed on 23 December 2023, under class 31 in the name of the Indian Council of Agricultural Research. Trademark application No. 6232063.

Copyright filed

Following copyrights application were filed in the year 2023

- "eMatsya – An innovative data acquisition system to collect fish catch data from inland water bodies" has been filed on 13 March 2023 in the name of the Indian Council of Agricultural Research with diary no. 6642/2023-CO/SW.
- "Mapping of Inland Water Bodies of Telangana" has been filed on 24 March 2023 in the name of the Indian Council of Agricultural Research with diary no. 7869/2023-CO/L.
- "GIS mapping of inland waterbodies of Odisha" has been filed on 21 November 2023 in the name of the Indian Council of Agricultural Research with diary no. 30751/2023-CO/L.
- "Inland waterbodies of Bihar" has been filed on 21 November 2023 in the name of the Indian Council of Agricultural Research with diary no. 30457/2023-CO/L.
- "Sarana-A lucrative species in Pen based model in wetland for auto recruitment" has been filed on 24 November 2023 in the name of the Indian Council of Agricultural Research with diary no. 31186/2023-CO/CF.
- "Success Stories of Wetlands" has been filed on 21 December 2023 in the name of the Indian Council of Agricultural Research with diary no. 34130/2023-CO/L.
- "Catch Assessment Software for the Chhattisgarh state, India" has been filed on 21 December 2023 in the name of the Indian Council of Agricultural Research with diary no. 34187/2023-CO/SW.
- "*Rangeen Maach Chaaser Pustika*" has been filed on 1 August 2023 in the name of the Indian Council of Agricultural Research with Regn No. L-130396/2023.
- "*Rangeen Maach Chass Margdarshika*" has been filed on 1 August 2023 in the name of the Indian Council of Agricultural Research with Regn No. L-131321/2023.

Copyright Registered/Granted

- "A Guide to Ornamental Fish Farming" has been registered on 11 September 2023 in the name of the Indian Council of Agricultural Research with Regn. No. L-132876/2023.
- "*Alankari Machhli Palan par Sandarshika*" has been registered on 11 September 2023 in the name of the Indian Council of Agricultural Research with Regn. No. L-133440/2023.

Commercialization and licensing of technologies

CIFRI Cagegrow feed

The institute signed technology license agreement of "CIFRI Cagegrow" floating fish feed with the Glaucus Agrochem Pvt. Ltd. today on 27 April 2023. The institute granted non-exclusive license for a period of five years for manufacturing and sale of ICAR-CIFRI Cagegrow floating fish feed in the territory of India. The commercialization process was completed through Agrinnovate India Ltd, commercial arm of ICAR.

MoU Signed

Sr. No.	Date	With whom	Specific purpose
1.	01 March 2023	Department of Fisheries, Government of West Bengal	Pisciculture activity in cages in Kangsabati reservoir, Bankura, West Bengal
2.	27 April 2023	Glaucus Agrochem Ltd., Agrinnovate India (AgIn)	Non-exclusive License agreement of "CIFRI Cagegrow feed" Technology
3.	09 January 2023	SCATEC ASA	Assessment of Fisheries and Ecology in Kameng Basin of Arunachal Pradesh in relation to proposed hydro power projects at Gongri and Dinchang
4.	10 April 2023	Odisha University of Agriculture and Technology, Bhubaneswar	Academic and research collaboration for facilitating Students training, postgraduate research and capacity building
5.	10 July 2023	Himalayan University, Arunachal Pradesh	Academic and research collaboration
6.	03 October 2023	Central Agricultural University, Imphal Manipur	Academic and research collaboration
7.	15 September 2023	The Neotia University, West Bengal	Academic and research collaboration



Publications



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Publications

Research and review papers

1. Adhikari A, Das BK, Ganguly S, Nag SK, Sadhukhan D and Raut SS (2023). Emerging contaminant triclosan incites endocrine disruption, reproductive impairments and oxidative stress in the commercially important carp, Catla (*Labeo catla*): An insight through molecular, histopathological and bioinformatic approach. *Comparative Biochemistry and Physiology Part C*: *Toxicology & Pharmacology* 268, 109605. doi:10.1016/j.cbpc.2023.109605.
2. Alam A, Verma SK, Kumar J, Jha DN, Thakur VR, Das SCS, Mishra SK and Das BK (2022). A new record of a small cyprinid, *Oreichthys cosuatis* (Hamilton, 1822) in the Ganga River, India. *Journal of Inland Fisheries Society* 54(2): 156-161.
3. Baisakhi B, Mohanty D, Das BK, S Ananta, Jena K and Pradhan J (2023). Synthesis of chitosan nanoparticles from Tasar silkworm, *Antheraea mylitta* pupae and its antioxidant efficacy and antibacterial activity against fish pathogens. *Journal of Environmental Biology* 44, 491-497.
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6. Behera BK, Patra B, Chakraborty HJ, Rout AK, Dixit S, Rai A, Das BK and Mohapatra T (2023). Bacteriophages diversity in India's major river Ganga: a repository to regulate pathogenic bacteria in the aquatic environment. *Environmental Science and Pollution Research* 30(12), 34101-34114.
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8. Bhakta D, Das BK, Singh U, Ray A, Johnson C, Thakur VR, Mishra SK, Verma SK, Alam and Jha DN (2023). Fishery, growth, mortality, and stock assessment of endangered *Tor putitora* from Tehri dam reservoir, Uttarakhand, Himalayan foothills of India in relation to environmental variables. *Environmental Monitoring and Assessment* 195(11), 1377.
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10. Bhakta D, Manna RK, Nair SM, Mandi RC, Samanta S and Das BK (2023). New Record of Cyprinid *Chagunius nicholsi* (Myers, 1924) from the River Torsa of Jaldapara National Park Complex, West Bengal, India. *National Academy Science Letters* 1-4. https://doi.org/10.1007/s40009-023-01347-3.
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12. Bhakta D, Manna RK, Ray A, Nair SM, Jana C, Mandal S, Samanta S and. Das BK (2023). First report of Indian frogfish, *Antennarius indicus* Schultz, 1964 from the Hooghly-Matlah estuary of India. *Indian Journal of Geo Marine Sciences* 52(03), 158-162.
13. Bisai K, Kumar V, Roy A, Parida SN, Dhar S, Das BK, Behera BK and Pati MK (2023). Effects of Di-(2-Ethylhexyl) Phthalate (DEHP) on gamete quality parameters of male koi carp (*Cyprinus carpio*). *Current Issues in Molecular Biology* 45(9),7388-7403.
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18. Chowdhury H, Bera AK, Raut SS, Malick RC, Swain HS, Saha A and Das BK (2023). In vitro antibacterial efficacy of *Cymbopogon flexuosus* essential oil against *Aeromonas hydrophila* of fish origin and in silico molecular docking of the essential oil components against DNA Gyrase-B and their drug-likeness. *Chemistry & Biodiversity* 20(3), 202200668.

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37. Ekka A, Jiang Y, Pande S and Van der Zaag P (2023). How economically and environmentally viable are multiple dams in the upper Cauvery basin, India? A hydro-economic analysis using a landscape-based hydrological model. *Hydrology and Earth System Sciences Discussions*. 1-40.

38. Ganguly S, Adhikari A, Sadhukhan D, Raut SS, Kumar VS, Nag SK and Das BK (2023). Endocrine disruptive toxicity of cypermethrin in *Labeo catla*: Involvement of genes and proteins related to the HPG axis. *Science of the Total Environment* 901,165958. DOI:org/10.1016/j.scitotenv.2023.165958.

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40. Gogoi P, Roshith CM, Manna RK, Chanu TN, Jana C, Bhakta D, Koushlesh SK, Das SK, Sinha A, Samanta S and Das BK (2023). Assemblage pattern, guild compositions and seasonal dynamics of ornamental and food fishes in the Indian Sundarbans estuarine system: a model-based approach for sustainability. *Aquatic Sciences* 85(4), 112.

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19. Sahu SK (2023). E-mapping National Water Resources for Efficient Resource Utilization. In:Mohanty BP, Das Sarkar S, Mohanty S, Parija SC, Nag SK and Bhattacharjya BK (eds.) Advances in Fish Research: Inland Aquatic Ecosystem Health and Fisheries. Narendra Publishing House, Delhi, India. ISBN 978-93-92851-21-6.

20. Sahu SK (2023). Geospatial technology in inland aquatic resources management In: Advances in fish research inland aquatic ecosystem health and fisheries In: Mohanty BP, Das Sarkar S, Mohanty S, Parija SC, Nag SK and Bhattacharjya BK (eds.) Advances in Fish Research: Inland Aquatic Ecosystem Health and Fisheries. Narendra Publishing House, Delhi, India. 10. ISBN 978-93-92851-21-6.

21. Sarkar DJ, Das Sarkar S and Das BK (2022). Occurrence, fate and removal of microplastics in wastewater treatment plants

drinking water treatment plants. In: Microplastics pollution in aquatic media (M. Sillanpää et al., eds), Springer Nature Singapore Pte Ltd. 223-245.

22. Sarkar SD, Gogoi P and Naskar M (2006). Impact assessment of barge movement in river Ganga (National Waterway 1). *In*: Mohanty BP, Das Sarkar S, Mohanty S, Parija SC, Nag SK and Bhattacharjya BK (eds.), Advances in Fish Research: Inland Aquatic Ecosystem Health and Fisheries. Narendra Publishing House, Delhi, India. Narendra Publishing House, Delhi, India.57-66.

23. Sethi SN, Meena DK, Sahoo AK, Nayak AP, Sahoo SN, Tiwari PK, Mohanta KN Pillai BR and Swain SK (2023). Organic aquaculture: an overview, In: Sarathchandran, Unni MR, ThomasSabu, Meena DK (Eds.), Woodhead Publishing Series in Food Science, Technology and Nutrition, Organic Farming (Second Edition), Woodhead Publishing, 561-598, ISBN 9780323991452,

24. Sharma N, Bhattacharjya BK, Debnath D, Das SCS, Kakati A, Das BK (2023). Assessment of Ichthyofaunal Diversity and Habitat Variables in Himalayan Brahmaputra River of Assam, North-Eastern India. In: Dutta S, Chembolu V (eds), Recent Development in River Corridor Management. RCRM 2022. Lecture Notes in Civil Engineering, 376: 147–157. Springer, Singapore.

25. Sinha A, Koushlesh SK, Kumari K, Chanu T, Roy A, Gogoi P (2023). Diversity and threat to cold-water fishes of the Torsa River at the Terai Region of West Bengal, India. In: Fisheries and aquaculture of the temperate Himalayas (Pandey et al. eds.). Springer Nature.

26. Swain HS, Baisakhi B, Ramteke MH, Kumar V and Upadhyay A (2023). Application of probiotics in aquaculture. In: Biotechnological tools in fisheries and aquatic health management 217-230. Singapore: Springer Nature Singapore.

Pamphlets/leaflets/folders

1. Chawdhury H et al. (2023). Technology poster on Argcure and CIFRI Fish Tanavhari.

Electronic/web publications

1. Sharma N, Bania B, Kakati A and Das P (2023).Biofloc Technology: Innovative approach towards sustainable aquaculture. *Biotica Research Today*, 5(1): 39-42.

Hindi Publications

1. धर्मनाथ झा, वेंकटेश आर. ठाकुर, अबसार आलम, जीतेन्द्र कुमार तथा विकास कुमार 2023. प्रशिक्षण पुस्तिका 'किसानों की आय दोगुनी करने के लिए खुले जल में मात्स्यिकी का प्रबंधन'. भाकृअनुप – केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान, क्षेत्रीय केंद्र – प्रयागराज – २११००२, उत्तर प्रदेश 89.

2. अबसार आलम, धर्मनाथ झा, वेंकटेश आर. ठाकुर, जीतेन्द्र कुमार तथा विकास कुमार 2023. प्रशिक्षण पुस्तिका 'अंतर्स्थलीय मात्स्यिकी प्रबंधन. भाकृअनुप – केन्द्रीय अन्तर्स्थलीय मात्स्यिकी अनुसंधान संस्थान, क्षेत्रीय केंद्र – प्रयागराज – २११००२, उत्तर प्रदेश 89.

3. सुमन कुमारी एवं सुभ्रा सिंह (2023) "सजावटी मछली पालन : आजीविका और रोजगार सृजन के लिए अवसर और संभावनाएं" पद सजावटी मछली पालन: आजीववका और रोजगार सृजन के लिए अवसर और संभावनाएं (प्रशिक्षण संयोजक : मोनिका गुप्ता, ताराचंद कुमावत एवं आदित्य कुमार. प्रशिक्षण पुस्तक, भा.कृ.अनु.प.–राष्ट्रीय मत्सस्य आन वुंशिक ससांधन ब्यूरो, लखनऊ – उत्तरप्रदेश 88–96.



वार्षिक प्रतिवेदन

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2023

Awards and Recognitions

- **Dr. B. K. Das**, Director received Prof G. K. Manna Memorial Award at the 108th Session of Indian Science Congress held at Nagpur. He acted as a key note speaker at the National Seminar on "Ecology Vs Economic Development with Special Reference to the Ganga Basin" (NEED-2023) held at the Dept. of Zoology, Nehru Gram Bharati University, Prayagraj, Uttar Pradesh during 25-26th February, 2023. He was felicitated at the National Conference on Changing Course in Global Environment: Challenges and Solutions organized by the Dept. of Environmental Science, University of Kashmir, Srinagar.
- **Dr. B. K. Das**, Director got the Best Researcher Award for the new science inventions in 2023. He also bagged the Congress Zoology Medal by the Zoological Society of India. Dr. Das also awarded by the Lifetime Achievement Award by the International Academy of Science and Research in 2023. He received the appreciation award for ICAR-CIFRI at the International Conference on Agriculture and Rural Development by the Society for Agricultural Research and Management (SARM).
- **Dr. Archana Sinha** received the recognition award from Zoological Society of India, Gaya (Bihar) on 05 June 2023. Dr. Sinha was invited by ASRB, New Delhi as expert for confidential work- related to ARS examination during 09-11 October 2023. She was invited as an expert in the consultation meeting to strengthen and promotion of ornamental fisheries through PMMSY under the Chairmanship of Secretary, Department of Fisheries, GOI on 24 August 2023.
- **Dr. Archana Sinha** delivered an invited lecture in 108th Indian Science Congress held in R.T.M. Nagpur University, Nagpur, Maharashtra, 03-05 January 2023. She Chaired a technical session in 108th Indian Science Congress session of Animal, Veterinary and Fisheries Sciences Section, held at R.T.M. Nagpur University, Nagpur from 03 to 07 January, 2023. She chaired a special conclave on women scientist oration during National Conference on "Transforming rural poverty to prosperity through sustainable fisheries (TRPSF-2023) organized by College of Fisheries, Kishanganj during 19-21 July 2023. Dr. Sinha acted as Reviewer of the journal Acta Ecologica Sinica and Aquaculture Report.
- **Dr. B. K. Bhattacharjya** was recognized as an External expert for Ph.D. research in Zoology by the University of Science & Technology, Meghalaya. He also acted as an External Expert for a Ph.D. Synopsis presentation by Ms. Wewa U. of Zoology department under University of Science and Technology of Meghalaya (USTM), Baridua, Ri-Bhoi District. He was recognized as an Expert for Phone-in-Live programme by Door Darshan Kendra, Guwahati. In the International training cum Workshop on "Sustainable fisheries and Dairying" organized by ICAR-CIFRI, Barrackpore on 13 December 2023, he delivered invited lecture on "Wetland fisheries management: Case studies from North-eastern states of India". He has delivered another invited lecture on "Principles, potential and factors affecting culture-based fisheries (CBF) with case studies/ success stories" organized by ICAR-CIFRI, Barrackpore on 13/12/2023.
- **Dr. S. K. Nag** was a member of the judging committee for evaluation of papers presented in the 10th Annual Convention and National Webinar on 'Next-gen Management of Agro-chemicals for Achieving Sustainable Development Goals' organized by the Society for Fertilizers and Environment during 24-25 March 2023. He was an External Screening and Evaluation Committee Member for short listing of ideas received under MSME idea Hackathon 3.0 at ICAR-CRIJAF, Barrackpore on 22 August 2023. Dr. Nag was a Member (Expert) for the Assessment Committee constituted for a ARS Scientist for consideration of promotion under the Career Advancement Scheme at ICAR-NRRI, Cuttack.
- **Dr. M. Naskar** delivered an invited lecture on "Some statistical techniques for inland fisheries assessment-data cruising to model-based inferences" at Indian Statistical Institute, Baranagar, Kolkata dated 15 July 2023. He also delivered an invited lecture on "Some data-driven Techniques for Inland fisheries assessment." in Online Workshop on "Techniques in Freshwater Fish Stock Assessment" organized by BOBP on12 July, 2023.
- **Dr. Preetha Panikkar** was the Member of the High power Committee constituted by Directorate of Fisheries, Govt. of Karnataka for cage culture programs in the State. She was also the Member of Tilapia steering Committee for Govt. of Karnataka. Dr. Panikkar was nominated by the Ministry of Science and Technology for the Project evaluation and monitoring of project proposal submitted to Technology Development Board, New Delhi.

- **Dr. Preetha Panikkar** acted as External Examiner for evaluation of Ph.D. thesis of ICAR-CIFE, Mumbai and Cochin University of Science and Technology, Kochi. She also served as Subject expert to set question papers on Trophodynamic modeling in aquatic ecosystems for Kerala University of Fisheries and Ocean Sciences, Kerala. She was also nominated by the Marine Biological Association of India to evaluate the journal papers for the Dr. S. Z. Qasim Memorial Best Paper Award.
- **Dr. S. K. Manna** acted as Editor-in-Chief of the Journal of the Inland Fisheries Society of India. He also acted as an Editor of the journal Exploratory Animal and Medical Research.
- **Dr. S. Samanta** served as an External Member of a Selection Committee for recruitment of SRF of ICAR-CIFE, Kolkata. He also acted as an External Member of a Selection Committee for recruitment of YP II at ICAR-CRIJAF, Barrackpore and Project Fellow in the Department of Ecological Studies, University of Kalyani.
- As a Resource Person, **Dr. S. Samanta** attended the Stakeholders Workshop on 13.01.2023 of the East Kolkata Wetlands. He served as panellist in the Seminar on Sustainable agriculture in Sundarban organized by Impact 360 Foundation on 08 June 2023 at Saltlake, Kolkata. He also served as the Co-Chairperson and invited Speaker in the International Conference on Aquatic resources and sustainable management during 30-31 August 2023, held at ICAR-CIFRI, Barrackpore. Dr. Samanta attended Stakeholders consultation cum consultative workshop on Hilsa fisheries improvement for sustainable fisheries and conservation in river Ganga ICAR-CIFRI, Barrackpore on 27 September 2023 as a Resource Person. He is serving as a Member of the Institute Management Committee of ICAR-ATARI, Kolkata. He participated in the Advisory Committee Meeting of Ramkrishna Ashram KVK, Nimpith on 15 December 2023 as a resource person. As a Member of the State Wetland Authority, he time to time gives input to the Environment Division and especially to the East Kolkata Wetland Management Authority.
- **Dr. S. K. Majhi** was the Keynote Speaker at the College of Fisheries, Rangailunda, Odisha, in the workshop on "Scope for Overseas Education in Fisheries Science." He was also the keynote speaker at the Department of Fisheries, Assam, on World Fisheries Day 2023. He also delivered an invited lecture on "Stem Cell Based Technologies for Fisheries Resources Management" during a National Symposium on Crosstalk between Animal Research & Alternatives held at CSIR-NEIST, Jorhat, Assam on 09 September 2023.
- **Dr. Arun Pandit** was recognized as ICAR-IARI research guide for PG programmes in Agricultural Economics. He reviewed thesis and conducted viva voce of Ms. Dave Chandani Prakash Bhai and Shri Liton Paul, M.F.Sc. scholars of ICAR-Central Institute of Fisheries Education, Mumbai and conducted viva voce. He also reviewed Ph.D. thesis and conducted viva voce of Shri Dhande Kranthi Kumar, Ph.D. scholar of ICAR-Central Institute of Fisheries Education, Mumbai. Dr. Pandit also reviewed thesis of Shri Khemraj Bunker, Ph.D. scholar of ICAR-Central Institute of Fisheries Education, Mumbai. He conducted comprehensive Ph.D. viva voce of Shri Abhilasa Thapa of ICAR-Central Institute of Fisheries Education, Mumbai. He served as Subject Expert (Fisheries Economics) for selection of faculty positions for the discipline of Fisheries Economics for the Central Agricultural University, Imphal on 05 October 23.
- **Dr. Arun Pandit** acted as reviewer for the Journal of the Inland Fisheries Society of India, J of Indian Society of Coastal Agricultural Research, Agriculture research journal. He also served as a panellist for the discussion on 'Hilsa fisheries improvement in the middle stretches from Prayagraj to Farakka, dolphin conservation and socio-economics of the fishers of river Ganga' as a part of the stakeholders consultation cum consultative workshop on 'Hilsa fisheries improvement in the middle stretches (Prayagraj to Farakka) of river Ganga through broodstock release and captive broodstock development under the NMCG project on 27 September 2023 at ICAR-CIFRI, Barrackpore.
- **Dr. Md. Aftabuddin** was recognised as Member of Screening Committee for evaluating Bio-data of applicants for Hiralal Chowdhury award of IFSI for 13 IFAF-2024. Dr. Aftabuddin also acted as Member of IAEC of ICAR-CIFRI
- **Dr. B. K. Bhattacharjya, Dr. Pronob Das,** and **Dr. B. K. Das** were the recipients of the "Award of Appreciation" at the "Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference" during 18-20 April



Dr. B. K. Das, Dr. B. K. Bhattacharya & Dr. P. Das receiving the "Award of Appreciation" at the "Northeast Livestock-Aqua-Poultry Expo, 2023 & Conference"

2023, at the Maniram Dewan Trade Centre, Guwahati, for their contribution to the development of fisheries and aquaculture in Northeast India.

- **Dr. Absar Alam**, served as the member of district level committee, Prayagraj district, Uttar Pradesh for Pradhan Mantri Matsya Sampada Yojna. He received the Best Oral Presentation in the National Seminar on Ecology Vs Economic Development with special reference to the Ganga Basin (NEED-2023) during 25-26 February 2023.

- **Dr. A. K. Sahoo** was conferred the Best Scientist Award 2023 by the ICAR-CIFRI, Barrackpore. He also received the Best Ichthyologist Award 2023 by the Council of International Academy of Science and Research during the International Conference on "Aquatic Resources and Sustainable Management". He bagged the Best Oral Presentation Award for his presentation 'Histopathological manifestation of Tilapia Parvovirus" in VIROCON 2023-Advances in Global Virus Research Towards One Health held at Trichirappalli, Tamil Nadu from 01 to 03 December 2023. He (as a team member) also received the Best Oral Presentation award in the International Conference on "Aquatic Resources and Sustainable Management" for the presentation "Amino Acids profile of anadromous Hilsa, *Tenualosa ilisha* (Hamilton, 1822) is related to age and sex" by Hena C. et al., in International Academy of Science and Research (IASR) during the International Conference on "Aquatic Resources and Sustainable Management."

- **Dr. A. K. Sahoo** acted as Member of the Technical Committee of BIS Standardization ecosystem in the country: SSD 20. Provided inputs for Biodiversity-Guidance for the characterization of products based on native species under ISO TC 331 ISO TC 331/WG 4. Dr. Sahoo acted as Member of the Technical Expert Appraisal Committee for River Valley Projects of Ministry of Environment, Forest and Climate Change, New Delhi. He also Sahoo as Member, Review Committee Meeting on Environmental Flows in river Naramada, Narmada Controlling Authority, NCA, M.P.

- **Dr. A. K. Sahoo** acted as Guest Associate Editor, Frontiers in Marine Science. He also acted as Editor in Chief, Journal of Inland Fisheries Society of India, ICAR-CIFRI, Barrackpore. Dr. Sahoo acted as Editor, Journal of Wildlife Science, Ministry of Environment, Forest and Climate Change. Dr. Sahoo acted as member in Expert

Committee in pursuance of the order dated 22 December 2022 passed by the Hon'ble National Green Tribunal (Southern Zone) at Chennai in the matter OA No. 148 of 2021 titled as D. Chandramouleswara Reddy Vs Union of India 8s Ors. - reg.

- **Dr. A. K. Sahoo** acted as Invited expert by WorldFish for participation in Aqua data gaps stakeholder consultation. He also acted as Invited Expert for the Indo-EU Water platform workshop on Fourth Ramganga E-Flows Stakeholders Consultation 20th November at New Delhi. He acted as Subject Expert as Evaluation of MFSc students Examination 2023 from ICAR-CIFE, Mumbai Dr. Sahoo supervised Ms. Payel Malik from SRM Institute of Science & Technolgy, Chennai in her M.Sc. dissertation work.

- **Dr. A. K. Yadav** received the 'Excellence in Research Award 2023' by the Kalash Research and Welfare Society for his contribution to science and research.

- **Dr. Dhruba Jyoti Sarkar** received the Young Researcher Award for the year 2022 for his contribution to environmental chemistry and pollution research by the Indian Society of Analytical Scientists, Delhi Chapter (ISAS-DC) on 26 October 2023, at Faridabad, Haryana. He chaired a Session at 15th IUPAC International Congress of Crop Protection Chemistry: Futuristic Approaches Towards Seed to Market Strategies held at New Delhi from 14 to 17 March 2023. Dr. Sarkar also gave invited lecture in the Congress. Dr. Sarkar acted as Guest Speaker in Workshop on Alternatives to Single-Use Plastics at Prof. Nilay Chaudhuri Conference Hall, CPCB Regional Directorate, Kolkata on 23 March 2023.

- **Dr. Dhruba Jyoti Sarkar** acted as External Examiner for Evaluation of the M.Sc. (Ag) dissertation of students of Agricultural Chemicals Division, BCKV, Mohanpur & conducted the Viva-voce Examination on 09 August 2023.

- **Dr. Dhruba Jyoti Sarkar** acted as reviewer of peer reviewed journals *viz*. Journal of Hazardous Materials, Environmental Pollution, Journal of Cleaner Production, Urban Water Journal, Environmental Advances, Frontiers in Microbiology, Journal of Sea Research, Journal of Applied Polymer Science, Carbohydrate Polymer, Ecohydrology and Hydrobiology, Journal of the Marine Biological Association of India, Current Chinese Science, International Journal of Microbiology Research, Journal of Water Process Engineering, HELIYON, Macromolecular Materials and Engineering, and Current Opinion in Environmental Science & Health.

- **Dr. Dibakar Bhakta** received the best 'Senior Scientist Award' at the National Seminar on "Ecology Vs. Economic Development with Special



Dr. Dhruba Jyoti Sarkar (at the middle) receiving the Young Researcher Award



Dr. Dibakar Bhakta (2nd from left) received the 'Best Senior Scientist' Award

Reference to the Ganga Basin (NEED-2023), held at Nehru Gram Bharati and ICAR-CIFRI, Prayagraj, during 25-26 February 2023. He also received the best oral presentation award for paper on "Ichthyofaunal abundance, juvenile distribution with special reference to hilsa juvenile fishery at Hooghly-Matlah estuarine system along the Gangetic delta, India" in the same seminar.

- **Dr. Dibakar Bhakta** supervised a M.F.Sc. student, Ms. Anwesha Mondal, of the Department of Fisheries Resource Management, Faculty of Fishery Sciences, WBUAFS, for her M.F.Sc. thesis, "Diet variation and food and feeding habit of Scaly hair fin anchovy *Setipinna taty* (Valenciennes, 1848), in Hooghly-Matlah estuary, West Bengal, India, in March 2023.Dr. Bhakta supervised a Ph.D. student, Dr. Susmita Jana, of WBUAFS, in her Ph.D. thesis "Spatio-temporal distribution and stock assessment of *Chrysochira urea* (Richardson, 1846) along the West Bengal coast" in December 2023.

- **Dr. Dibakar Bhakta** acted as Co-convener of the Global and Regional Alumni Meet (GRAM) 2.0 at CoF, CAU, on 09 December 2023. Dr. Bhakta, scientist, acted as a reviewer for the journals Thalassas: An International Journal of Marine Sciences, National Academy Science Letters, Proceedings of the National Academy of Sciences, Biological Sciences (NASB), Journal of the Indian Society of Coastal Agricultural Research, Heliyon, Marine Biological Association of India, and Journal of the Inland Fisheries Society of India.

- **Shri Ganesh Chandra** acted as Expert member of Committee Meeting of Infringement of IPR protected technology of ICAR-CRIJAF, Barrackpore in May 2023. Shri Chandra reviewed thesis and conducted viva voce of Shri Dinesh R. and Shri Rujan J., M.F.Sc. Scholars of ICAR-Central Institute of Fisheries Education, Mumbai, in September 2023.

- **Dr. D. K. Meena** edited a book on Organic farming (Second Edition): Global Perspectives and Methods. Dr Meena was the Lead Guest Editor of ESPR Special issue, Biotica journal. He also worked as Topical Advisory Panel member of Fishes, water and life MDPI journals. He was appointed as Academic Editor PLOSONE and Advances in Agriculture. He also acted as Guest editor in Frontiers in aquaculture and nominated as an editor Journal of Inland Fisheries Society of India (JIFSI).

- **Dr. D. K. Meena** joined as EBM in Aquaculture International Journal, BMC Environmental Science, Blue Biotechnology,

Discover Biotechnology, NPJ sustainable Agriculture and International Aquatic Research, Discover Foods and Natural Product Communications. Dr. Meena conferred with the Fellow of Society of Biotic and Environmental Research.

- **Dr. D. K. Meena** acted as an external examiner for evaluation of PG thesis of COF, CAU, Agartala, Tripura. Dr. Meena acted as Principal Member of FAD12 technical Committee of BIS, New Delhi. He acted as an Expert on Screening Cum Evaluation Committee for promotion of Assistant Professor in the discipline of Fisheries Resource Management under Career Advancement Scheme (VI & VII Pay Commission nominated by Hon'ble Vice Chancellor, MAFSU, Nagpur.

- **Dr. Deepa Sudheesan** acted as as an external examiner for the thesis evaluation of B.Sc.-M.Sc. (Int.) Climate Change Adaptation student Ms. Subadra K.M., College ofClimate Change and Environmental Science, Kerala Agricultural University. She acted as reviewer for Fishery Technology, Journal of Marine Biological Association of India, Journal of Inland Fisheries Society of India and PLOS-One

- **Dr. Kavita Kumari** received Best presentation award in International Conference on "Aquatic Resources and Sustainable Management" held on 30 to 31 August 2023 at ICAR-Central inland Fisheries Research Institute (CIFRI), Barrackpore, West Bengal. She delivered an invited talk on the topic, "Potential of Metagenomics and Applications", on 21 December 2023 under the training "Advances in Molecular Tools for Aquatic Genetic Resource (AqGR) Management" held during 12 to 21 December 2023, in online mode at ICAR-NBFGR. She also delivered an invited talk on "16s metagenomics for microbial identification" in a training program titled "Emerging Tools and Methodologies in Conservation Biology of Fishes" on 27 September 2023 in the training held between 20 to 29 September 2023 at ICAR-NBFGR, Lucknow. Dr. Kumari reviewed manuscripts for the journal PLOS ONE: PONE-D-23-19907'.

- **Dr. Pronob Das** acted as Academic Editor of the journal 'Journal of Applied Ichthyology' published by Hindawi in collaboration with Wiley-Blackwell. He also acted as Review Editor on the Editorial Board of Production Biology (specialty section of Frontiers in Aquaculture) published by Frontiers. He also acted as Review Editor on the Editorial Board of Freshwater Science (specialty section of Frontiers in Environmental Science) published by Frontiers. Dr. Das acted as Paper setter for recruitment of professional fisheries graduates for AAU, Jorhat on 06 July 2023.

- **Dr. Santhana Kumar V.** received ZSK special research award from the Zoological Society Kolkata during 13 December 2023. He delivered a lecture for the B.F.Sc students of Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Tamil Nadu on 17 October 2023.

- **Dr. Soma Das Sarkar** received the *Best Oral Presentation Award* in the International Conference on "Aquatic Resources and Sustainable Management" on 30-31 August 2023, at ICAR-CIFRI Barrackpore, Kolkata, for the paper "Ecofriendly viable solution to aquatic weed management in the Indira Gandhi drinking water treatment plant".

- **Dr. Sona Yengkokpam** acted as External Examiner for evaluation of Ph.D. thesis of Aquaculture Department of College of Fisheries (CAU), Lembucherra, Tripura.

- **Dr. S. C. S. Das** received the 'Best Ph.D. thesis Award 2023' by Kalash Research and Welfare Society for his contribution to science and research. He also received the best oral presentation award for his paper on "Ecology and reproductive strategies of *Cyprinus carpio* L. in the River Ganga at Prayagraj, India" at the National Seminar on "Ecology vs. Economic Development with Special Reference to the Ganga Basin (NEED-2023), held at Nehru Gram Bharati and ICAR-CIFRI, Prayagraj, from 25-26 February 2023.

- **Dr. S. Borah** received the *Young Scientist Award 2023* by Kalash Research and Welfare Society for his contribution to science and research.Dr. Borah acted as the *Keynote Speaker* at KVK, Dhemaji, Assam, in the Workshop on "Strategic Approach for the Development of Agriculture and the Allied Sector of Dhemaji District." Dr. Borah also acted as Key Speaker in a workshop on "Strategic approach for the development of agriculture and allied sector of Dhemaji district" at KVK, AAU, Dhemaji, Assam.

- **Dr. S. Borah** acted as an *editorial board member* for the journal 'BMC Environmental Science'. He was also recognized by Elsevier for publishing an article linked to

United Nations Sustainable Development Goals. He acted as resource person in a training programme on "Prospects of Breeding & Culture of Indigenous Fish Species of Assam" at College of Fisheries, AAU, Raha. Dr. Borahacted as Observer in randomization process for posting of candidates recruited as per selection of SLRC for Grade III & IV in Fishery Department, Govt. of Assam. He acted as Member of District Level Committee, Nalbari, Assam for approval of beneficiaries and review of progress under PMMSY. He alsoacted as Course Coordinator of an awareness cum training program on "Genetically Improved Fish Stocks for Aquaculture" organized by ICAR-CIFE, Mumbai in collaboration with DoF, Assam at Kolong-Kopili, Kamrup, Assam.

- **Shri Mishal P.** was awarded Netaji Subhas ICAR International Fellowship 2022-23.
- **Dr. Suvra Roy** received the *Young Scientist Award* at the International Conference on 'Aquatic Resources and Sustainable Management' on 30-31 August 2023, organized by the International Academy of Science and Research (IASR), Kolkata. She also received the *Best Presentation Award* at the International Conference on 'Aquatic Resources and Sustainable Management' on 30-31 August 2023, organized by the International Academy of Science and Research (IASR), Kolkata. Dr. Roy served as Guest editor for a special issue Biotechnological Tools in fish health management published by Life Journal.
- **Dr. Vikash Kumar** received the *Young Scientist Award* (Dr. V. G. Jhingran Gold Medal) at the National Conference on "Transforming Rural Poverty to Prosperity through Sustainable Fisheries (TRPSF-2023), held on 19-21 July 2023, organized by the College of Fisheries, Kishanganj, Bihar, India. He also received the *Best Presentation Award* at the same National Conference. He received the *Best Presentation Award* (2nd) at the VIROCON International Conference 2023 Advancements in Global Virus Research Towards One Health on 01-03 December 2023, organized by the ICAR-National Research Centre for Banana, Tiruchirappalli, and the Indian Virological Society, New Delhi. Dr. Kumar Serves as Associate Editor of Frontiers in Marine Sciences and Frontiers in Physiology. He also served as Guest editor for a special issue Biotechnological Tools in fish health management published by Life Journal.



Dr. Suvra Roy (3rd from right) Receiving 'Young Scientist Award 2023'

- **Dr. Suman Kumari** delivered a lecture on " Best management practices for ornamental fisheries and aquarium maintenance"as Resource person in workshop cum training on titled "Potential of ornamental fish resources and their sustainable utilization for the livelihood and income generation" from 25 to 27 July 2023 at ICAR-NBGFR, Lucknow, UP. She also delivered a talk as Resource person in one-day workshop on "Wetland fisheries management" held on 19 July 2023 at BAMETI, Patna. She becomes member of IUCN Commission on Ecosystem Management (CEM), for the period of 2021-2025.
- **Dr. Lianthuamluaia and Mishal P.** served as delegates for the International Workshop on 'Mainstreaming Climate Change in International Fisheries Governance' organized by FAO, BoBP-IGO and DoF, GoI at Chennai during 16-19 October 2023.
- **Dr. Thankam Theresa Paul** acted as external examiner for the evaluation of thesis of BSc-MSc (Int) Climate Change Adaptation student Ms. Vaishnavi V. J. of College of Climate Change and Environmental Science, Kerala Agricultural University.
- **Dr. Aparna Roy** was conferred with the ISEE Young Scientist Award, 2023 at College of Agriculture, UAS, GKVK, Bengaluru during 22-24 June 2023.



Dr. Aparna Roy (4th from left) was conferred with the ISEE Young Scientist Award

ICAR zonal sports Tournament (Eastern Zone)

- The institute sports contingent participated in the ICAR zonal sports Tournament (Eastern Zone)-2022 at ICAR-IVRI, Izatnagar, during 24-27 April 2023 and won several medals. Dr. Suman Kumari won a gold medal in discus throw (women) and a silver medal in javelin throw (women). Dr. Sajina A. M. won gold medals in badminton singles and doubles. Ms. Anjana Ekka won a gold medal in badminton doubles.
- In the ICAR Zonal Sports Meet 2023 at the ICAR-National Rice Research Institute, Cuttack, Odisha, during 13–16 December 2023 the institute team comprising Drs. Deepa Sudhessan, Sajina A.M., Anjana Ekka, Sangeetha M. Nair, and Canciyal Johnson bagged silver medal in women relay race.







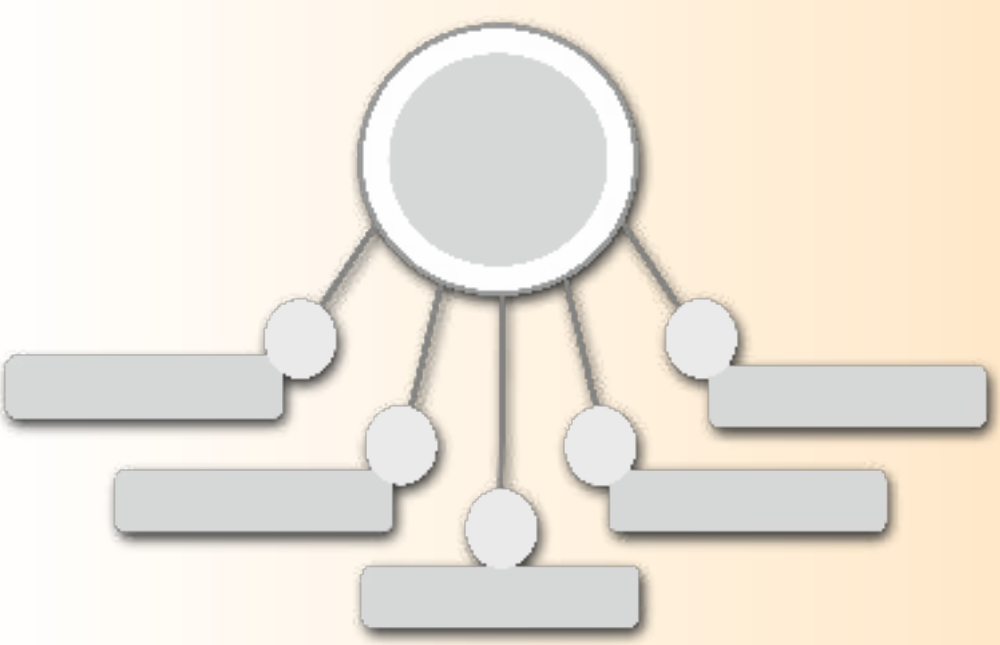


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Linkages Developed

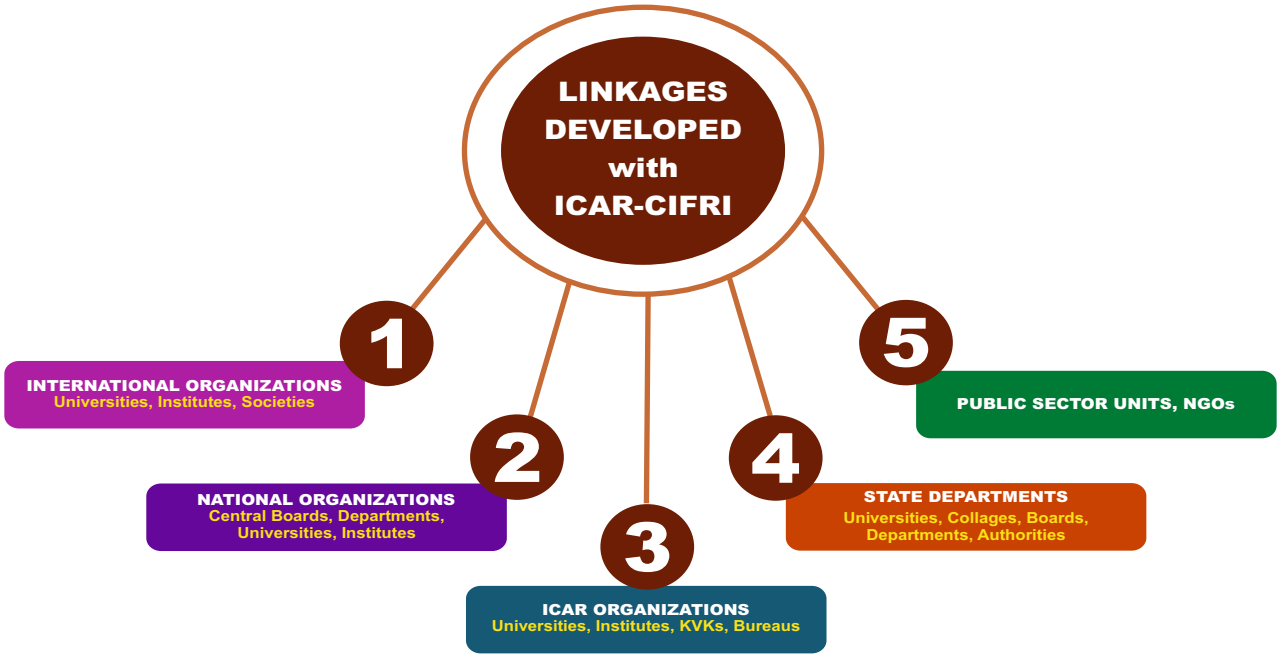


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Linkages Developed



The institute has been maintaining close linkage with the stakeholders involved in fisheries research and development in India and abroad. Linkages help to transmit knowledge and skills between the linked organizations. The purposes of such linkages are 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 2023 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

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 Fishworkers
- 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 Bio-technology, New Delhi
- Farakka Barrage Authority, Murshidabad, West Bengal
- Indian Council of Social Science Research
- 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 Thermal Power Co-corporation (NTPC)
- National Mission for Clean Ganga, Department of River Development & 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 Ind, Kolkata
- Central Silk Board- CSRTI, Mysore and CTR&TI, Ranchi, Ministry of Textiles
- Govt. of IndiaCentral Pollution Control Board
- Centre for Development of Advanced Computing, Kolkata

National Central Universities & Institutes

- Assam Agricultural University, Jorhat
- Benares Hindu University, Varanasi
- Bihar Animal Science University, Patna
- 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
- BKC College, West Bengal
- D.M. College, Imphal
- Dr. Rajendra Prasad Central Agricultural University, Dholi, Bihar
- College of Fisheries, Udgir, Maharashtra
- TamilNadu Dr. J. Jayalalithaa Fisheries University, TamilNadu

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/ NGO

- 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

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ICAR-CIFRI at Media



Radio Programme

Akashvani Kolkata : *Khabarer Aynay*

- Topic : CIFRI's initiative to enhance fish Production in Sundarban
  Duration : 16 Minutes
  Date of Broadcast : 12th June, 2023 (08:15 hrs) (22:15 hrs)
  Speaker : Dr. Basanta Kumar Das, Director, ICAR-CIFRI & Dr. Aparna Roy, Senior Scientist, ICAR-CIFRI

- Topic : National Fish Farmers Day (in Bengali)
  Duration : 12 Minutes
  Date of Broadcast : 11th July, 2023(08:15 hrs) & 18th July, 2023 (18:20 hrs)
  Speaker : Dr. Basanta Kumar Das, Director, ICAR-CIFRI & Dr. Aparna Roy, Senior Scientist, ICAR-CIFRI

Akashvani Maitri Channel : *Khet Khamarer Katha*

- Topic : Activities of ICAR-CIFRI in Fish Farming (in Bengali)
  Duration : 30 Minutes
  Date of Broadcast : 10th October, 2023 (18:20 hrs)
  Speaker : Dr. Basanta Kumar Das, Director, ICAR-CIFRI & Dr. Archan Kanti Das, Principal Scientist, ICAR-CIFRI

Radio Kolkata : *Chasbas*

- Topic : Fish Production Enhancement through Cage Culture (In Bengali)
  Duration : 20 Minutes
  Date of Broadcast : 29th November, 2023 (21:00 hrs)
  Speaker : Dr. Basanta Kumar Das, Director, ICAR-CIFRI & Dr. M. A. Hassan, Principal Scientist, ICAR-CIFRI

Documentary Film Developed by ICAR-CIFRI (2023)

- Sarana – A lucrative species in pen based model in wetland for auto recruitment (English Version)
- Transforming poverty of Sundarban to prosperity through sustainable small scale aquaculture (English Version)
- ICAR-CIFRI empowered fisher community of Chamardaha beel, West Bengal through culture based fisheries (English Version)
- Eco restoration of Duma fisheries – CIFRI intervention (English Version)
- Sundarbaner khudra matsya chasider daridrata durikaraner mahat prayas (Bengali Version)

Training and Capacity Building of ICAR-CIFRI Employees



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Training and Capacity Building of ICAR-CIFRI Employees

The Annual Training Plan (ATP) of all categories of employees of the Institute for the year 2023-2024 was prepared based on the training need assessment and submitted through TMIS. There was 58% realization of trainings planned during the year. Category wise, as per the target 56% scientists and 67% technical and administrative persons attended training. But due to non availability of suitable trainings,thewhole target could not be achieved for them. Four training programmes *viz*., "Recent advances in conservation aquaculture of indigenous riverine fishes towards sustainable development goals","Advances in Aquatic Health Management", "Advances in Heavy Metals and Microplastics Analysis (ICP-MS & µFTIR)"and "Fish disease and health management in open water fisheries" were also organised at the institute.

Annual Physical and Financial Targets and Achievements

A. Physical Targets and Achievements

Sl. No.	Category	Total no. of employees	No. of trainings planned for each category during 2023-2024 as per ATP	Total no. of employees undergone training during the year
1	Scientist	75	18	10
2	Technical	41	3	2
3	Administrative & Finance	33	3	2
4	SSS	20	Nil	Nil
	Total	171	24	14

B. Financial Targets and Achievements (April -December 2023)

BE 2023-24 for HRD (Rs in lakhs)	Actual Expenditure (up to 31st December 2023)(Rs in lakhs)	% Utilization of allotted budget
6.68	1.06	15.87



Sh. Mitesh Ramteke (2nd from left)



Mrs. Poushali Mukherjee (2nd from left)



Sh. Praveen Maurye (at the middle)

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Meetings, Workshops, Seminars Attended



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Meetings/conference/seminar/workshop attended during January to December 2023

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
1.	108thIndian Science Congress 2023	RTM University, Nagpur	3-8 January	B. K.Das A. K. Das
2.	Brainstorming on 'Water Quality Issues and Policy guidelines in Agriculture and Aquaculture' at ICAR-IIWM, Bhubaneswar	On-line	13 January	S. K. Nag
3.	Transfer to Technology (ToT) ceremony of Biosensing device, developed by ICAR-CIFRI	C-DAC, Kolkata	17 January	B. K. Das
4.	International seminar and workshop on 'CRISPR/Cas based plant functional genomics and computational modelling' (ISWCPC – 2023)	CSIR-North East Institute of Science and Technology, Jorhat, Assam	17-21 January	S. Roy
5.	Workshop on IPR Issues in Fisheries Science	Online	18 January	B. K. Das and all the scientists
6.	First Technical Advisory Committee Meeting of ICAR-NePPA Project	Barrackpore	10-11 January	A. K. Das
7.	EAC meeting on River Valley Projects as Fisheries Expert conducted by MoEFCC, New Delhi	On-line	25 January, 15 February, 07 March, 26 June, 18 July, 31 August, 12 September, 17 October	A. K. Sahoo
8.	National Consultative Meet on "Roadmap for Dissemination of Genetically Improved Varieties of Fish and Shellfish"	ICAR-CIFA Bhubaneswar	27-28 January	B. K. Das
9.	Project monitoring meeting of Technology Development Board, Ministry of Science and Technology	Mudhol, Karnataka	31 January - 01 February	P. Panikkar
10.	Awareness programme on Alternative Livelihood Development of Fisher Folks in Wetland Areas at KVK of Sasya Shyamala KrishiVigyan Kendra, Sonarpur	Sasya Shyamala KrishiVigyan Kendra, Sonarpur	02 February	B. K. Das
11.	Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries by ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB23)	Online	13-17 February	B. K. Das
12.	International Workshop on "Innovative Technologies in Support of a Safe and Sustainable Aquatic Food Supply" organized by Cefas, U.K. and ICAR-CMFRI	Kochi	20-22 February	B. K. Das A. K. Sahoo

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
13.	Conference on "Fisheries and Aquaculture-An Ecological Perspective" (IESFAC-2023)	GADVASU, Ludhiana	22-24 February	B. K. Das
14.	International Conference on "Technological Innovations in Animal Science Research and Social Transformation"	Bhubaneswar	24-26 February	B. K. Das
15.	National Seminar on "Ecology Vs. Economic Development with Special Reference to the Ganga Basin (NEED-2023)"jointly organized by ICAR-CIFRI and Nehru Gram University, Prayagraj, Uttar Pradesh	Prayagraj, UP	25-26 February	B. K. Das D. Bhakta A. K. Das
16.	Annual Review Meeting with the CG Centres to discuss their ongoing projects/ activities taken up during 2022 as per the approved Work Plan and future plan/activity to be taken	ICAR, New Delhi	27 February	B. K. Das Arun Pandit
17.	4th Scientific Advisory Committee (SAC) Meeting of ICAR-CRIJAF-KVK, North 24 Parganas	ICAR-CRIJAF, Barrackpore	28 February	B. K. Das
18.	51th IMC 2023	ICAR-CIFRI, Barrackpore	28 February	B. K. Das A. K. Das All HoD's CAO FAO AAO
19.	Attended the concluding workshop and presented the final report of the 'Input cost and farm gate price in inland fisheries of India' project'	MoSPI office, Govt of India, New Delhi	01 March	Arun Pandit
20.	Research Advisory Committee meeting of ICAR-CIFRI	ICAR-CIFRI, Barrackpore	02-03 March	All the scientists of Hqs and centre Incharges
21.	Workshop on 'Genome editing in farm animals for improved productivity and health' conducted by ICAR-NDRI, Karnal	Online	03 March	S. Roy
22.	Annual Conference of Vice-Chancellors (VCs) of Agricultural Universities and Directors Conference of ICAR	NASC Complex, New Delhi	4-5 March	B. K. Das
23.	Workshop under the project "Production Systems, Agribusiness and Institutions - Component 1: Impact of Agricultural Technology"	Online	06 March	Arun Pandit
24.	ICAR Industry interface stakeholders meet	NASC complex, New Delhi	06 March	B. K. Das G. Chandra

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
25.	Tuna Stock Assessment Good Practices Workshop	CAPAM, NIWA and ISSF, New Zealand (online)	07-10 March	S. Kumari
26.	DigitALL:Innovation and Technology for Gender Equality	ICAR-CIFRI, Barrackpore	08 March	S. Kumari
27.	Karnataka Fisheries State level approval and monitoring committee meeting to review implementation of PMMSY	Vikas Soudha, Bangalore	9 March	P. Panikkar
28.	Town Official Language Implementation Committee meeting	ICAR-IIHR, Bangalore	10 March	P. Panikkar
29.	Thematic Review Workshop of the fisheries research institutes under NICRA Project	ICAR-CMFRI, Kochi	11 March	S. K. Nag T. T. Paul
30.	National conference on the theme "Science and Technology for Sustainable World" organised by ISCA BBSR Chapter in association with KIIT-DU & KISS-DU	Bhubaneswar	14-15 March	B. K. Das
31.	Fish Farmers, Fishers and Scientist Meet	ICAR-CIFRI, Barrackpore	17 March	B. K. Das R. K. Manna A. K. Das H. Chaudhury Sajina A M S. Kumari Lianthuamluaia Mishal P S. K. Koushlesh P. Majhi
32.	Workshop on “Alternatives to Single-Use Plastics”	CPCB Regional Directorate, Kolkata	23 March	D. J. Sarkar
33.	10th Annual Convention and National Webinar on ‘Next-gen Management of Agro-chemicals for Achieving Sustainable Development Goals’	Kolkata	24-25 March	S. K. Nag
34.	Meeting of e-HRMS under the Chairmanship of Secretary, DARE and DG, ICAR	New Delhi	31 March	B. K. Das
35.	Stress Management: Managing stress at present time of chaos	ICAR- CIFRI, Barrackpore	31 March	All Staff
36.	World fish W3 review meeting	ICAR-CIFRI Headquarters	13 April, 19 June, 20 June	B. K. Das Arun Pandit A. Roy G. Karnatak A. K. Das

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
37.	Business to business (B2B) meeting with Happy Feeds Ltd. Rajasthan	ICAR-CIFRI, Barrackpore	15 April	B. K. Das G. Chandra M. A. Hassan
38.	ITMC meeting of ICAR-CRIJAF	ICAR-CRIJAF, Barrackpore	25 April	G. Chandra
39.	Midterm review meeting of ICAR Regional Committee VIII	On-line	25 April	P. Panikkar Arun Pandit
40.	Webinar on the occasion of World Intellectual Property Day with the theme of "Women and IP: Accelerating Innovation and Creativity" organized by NBFGR, Lucknow (Hybrid mode)	On-line	26 April	S. K. Majhi, B. K. Bhattacharjya S. Yengkokpam D. Debnath, A. K. Yadav P. Das S. Borah N. Sharma R. K. Manna A. K. Das H. Chaudhury Sajina A M Lianthuamluaia Mishal P S. Kumari S. K. Koushlesh P. Majhi
41.	Governing Body Meeting of Nijasharana Sri AmbigaraChowdiah N. Karnataka inland fisheries development under RKVY and Blue revolution schemes	Directorate of Fisheries Govt. of Karnataka	27 April	P. Panikkar
42.	FPO meet	ICAR-CIFRI Headquarters, Barrackpore	29 April	B. K. Das A. K. Das Arun Pandit
43.	IRC 2023 Meeting	ICAR-CIFRI Headquarters, Barrackpore	02-05 May	All scientists
44.	Inland Fisheries Society of India GB meeting	ICAR-CIFRI Headquarters, Barrackpore	04 May	All IFSI members
45.	Workshop on Implementable Technologies for Chhotnagpur Plateau of Eastern India	Purulia	22 May	A. K. Das
46.	Meeting with DoF, Jharkhand	Ranchi	23 May	A.K. Das
47.	Review Meeting of ITMUs/ABIs/ZTMC of Fisheries and Engineering Division	On-line	24 May	G. Chandra
48.	B2B meeting with GlaucusAgrochem India and Baishata Farmers Producers Company	ICAR-CIFRI, Barrackpore	25 May	B. K. Das G. Chandra M. A. Hasan

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
49.	Interactive workshop on "Management of Openwater Fisheries in Sikkim". The workshop is organized by ICAR-CIFRI, Guwahati in association with Directorate of Fisheries, Govt. of Sikkim, Gangtok at Gangtok	Gangtok, Sikkim	29-30 May	B. K. Das Scientists of Guwahati centre
50.	Committee meeting of 'Infringement of IPR protected technology of ICAR-CRIJAF'	ICAR-CRIJAF, Barrackpore	30 May	G. Chandra
51.	Webinar on 'linking FPOs to alternative marketing system' conducted by MANAGE	On-line	30 May	Arun Pandit
52.	Webinar on 'Wealth awareness program'	On-line	30 May	Arun Pandit H. Chaudhury
53.	Meeting on consultation on technologies available for precision farming under RCM Zone VIII	Online	31 May	P. Panikkar
54.	Project evaluation meeting by Technology Development Board, Ministry of Science and Technology	Mudhol, Karnataka	01-02 June	P. Panikkar
55.	ITMC meeting of ICAR-NBFGR	ICAR-NBFGR, Lucknow	05 June	G. Chandra
56.	National Conference on "Changing Course in Global Environment: Challenges and Solutions"	University of Kashmir, Srinagar	05-07 June	B. K. Das A. K. Das
57.	4th Indian Workshop on Applied Deep Learning	BITS Pilani, KK Birla Goa Campus	12-16 June	C. Jana
58.	Meeting on NMCG project	NMCG Office, New Delhi	13 June	B. K. Das
59.	Webinar on Web presentation	ICAR-CIFRI, Barrackpore	14 June	H. Chaudhury
60.	Review meeting of Fisheries institutes by Officer on Special Duty, Department of Fisheries, Government of India	ICAR, New Delhi	14 June	B. K. Das
61.	B2B Meeting with M/s Bansal feed	ICAR-CIFRI, Barrackpore	19 June	B. K. Das G. Chandra M. A. Hassan
62.	Role of Yoga in health and well being	ICAR CIFRI, Barrackpore	21 June	All Staff
63.	Meeting on Scaling up of fish production in Shallow tanks and ponds under the Chairmanship of Joint Secretary(Inland Fisheries)	ICAR-CIFRI, Barrackpore	21 June	Mishal P.
64.	Discussion on cage culture at Krishnarajasagar reservoir	Department of Fisheries, Karnataka,	22 June	Jesna P. K.

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
65.	ISEE National Seminar on Evolving extension science towards secondary agriculture for sustainable development	University of Agricultural Sciences, Bangalore	22 June	P. Panikkar
66.	5th Meeting of Biodiversity Sectional Committee, SSD 20 conducted by BIS, New Delhi	On-line	23 June and 01 August	A. K. Sahoo
67.	NFDB meeting	NFDB, Hyderabad	26 June	S. Samanta
68.	Zonal level workshop on "Exit policy under APART" organized by Directorate of Fisheries, Govt of Assam and WorldFish, Malaysia	Conference hall of Directorate of Extension Education, AAU, Khanapara, Assam	28 June	P. Das
69.	Launching workshop of the "Report Fish Disease App" organized by Department of Fisheries, Govt. of India	On-line	28 June	S. Samanta S. K. Majhi B. K. Bhattacharjya S. Yengkokpam, D. Debnath, A. K. Yadav P. Das S. C. S. Das S. Borah N. Sharma
70.	Attended workshop with the project on Formulation of area development schemes and development of area specific sift-ware template for model integrated farming across six-agro-climatic regions of West Bengal	West Bengal	30 June	A. K. Das
71.	National Fish Farmers Day	ICAR- CIFRI, Barrackpore, West Bengal.	10 July	All Staff
72.	1st Fish Farmers' Science Congress" (FFSC) –cum- 23rd National Fish Farmers Day, jointly organized by College of Fisheries, CAU (I), National Bank for Agriculture & Rural Development (NABARD) and Northeast Society for Fisheries and Aquaculture (NESFA)	Tripura	10-11 July	B. K. Das
73.	Meeting on price fixation of CIFRI Fish Tanavhari	ICAR CIFRI, Barrackpore	11 July	H. Chaudhury Arun Pandit
74.	Meeting with Secretary, Govt. of West Bengal	Kolkata, West Bengal	13th July	B. K. Das
75.	Web telecast of 95th ICAR Foundation Day	ICAR New Delhi	16 July	All Scientists
76.	95th Foundation Day cum Technology Day of ICAR	New Delhi	16-18 July	B. K. Das

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
77.	Transforming Rural Poverty to Prosperity through Sustainable Fisheries (TRPSF-2023), organized by College of Fisheries, Kishanganj, Bihar, India	Kishanganj, Bihar	19-21 July	B. K. Das A. K. Das A. Sinha V. Kumar
78.	Global food regulators Summit by FSSAI	New Delhi	20-21 July	B. K. Das
79.	Workshop on Wetland Fisheries Management in Bihar	BAMETI, Patna	19 July	G. Chandra S. Kumari
80.	National Conference on "Transforming Rural Poverty to Prosperity through Sustainable Fisheries"	College of Fisheries, Kishanganj, Bihar	19-21 July	D. Bhakta
81.	Wiley Training Webinar for CeRA Consortium	ICAR-CIFRI Barrackpore	03 August	S. Das Sarkar
82.	Webinar on "Wiley Online Library: How Can It Help Researchers? - CeRA Consortium" organized by Wiley	On-line	03 August	P. Das
83.	Institute Joint Staff Council Meeting	On-line	03 August	P. Panikkar
84.	Town Official Language Implementation Committee Meeting	Department of Atomic Energy, Bangalore	04 August	P. Panikkar Jesna P. K.
85.	One day seminar on Reservoir Fisheries and their Management	BAMETI, Patna	07 August	Lianthuamluaia
86.	SPARROW sensitization workshop	On-line	09 August	Arun Pandit
87.	Workshop on "Adoption of state fish of Assam" organized by the Directorate of Fisheries, MeenBhawan, Ulubari, Guwahati.	Directorate of Fisheries, MeenBhawan, Ulubari, Guwahati	10 August	S. K. Majhi B. K. Bhattacharjya D. Debnath P. Das
88.	Techno Commercial Assessment and Expert Committee Meeting with Agrinnovate India Ltd for commercialization of CIFRI Technologies	Agrinnovate India	10 August	B. K. Das G. Chandra
89.	Online launch of the program Matsya Sampada Jagruti Abhijan	On line	11 August	S. Samanta
90.	Workshop on "Livelihood Development addressing SDG through inland open water fisheries (under SCSP)"	ICAR-CIFRI, Barrackpore	18 August	B. K. Das A. K. Das T. N. Chanu
91.	Regional Advisory Group Meeting on Furthering Animal Husbandry and Fisheries Sectors for Boosting Rural Income through Farmers' Collectives	NABARD, Kolkata	25 August	A. K. Das

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
92.	Town Official Language Implementation Committee - I Half-yearly meeting	O/o the Principal Chief Commissioner of Income Tax, NE Region, Guwahati	29 August	S. K. Majhi A. K. Yadav
93.	ITMC meeting of ICAR-CRIJAF	ICAR-CRIJAF, Barrackpore	29 August	G. Chandra
94.	International Conference on "Aquatic Resources and Sustainable Management"	ICAR-CIFRI Barrackpore	30-31 August	S. Das Sarkar P. Gogoi D. J. Sarkar K. Kumari V. Kumar S. Roy M. S. Devi S. K. Nag Arun Pandit S. Das Sarkar
95.	Workshop on DaakSevaem	General Post Office, Bangalore	04 September	P. Panikkar Jesna P. K.
96.	Orientation programme of the ICAR-IARI mega university hub	ICAR-CRIJAF, Barrackpore	05 September	Arun Pandit Anjana Ekka
97.	Orientation Programme for IARI Faculty	ICAR-CRIJAF, Nilgunj	07 September	H. Chaudhury
98.	Review meeting on NASF funded project on "Captive breeding of hilsa, *Tenualosai lisha*:Phase II with ADG NASF and all advisory members	ICAR-CIFRI, Barrackpore	8 September	A. K. Sahoo
99.	Workshop on 'Writing Winning Proposals for Securing International Grants' organized by the Aquatic Environment & Health Management Division of ICAR-CIFE, Mumbai	On-line	12 September	S. K. Majhi B. K. Bhattacharjya S. Yengkokpam D. Debnath, A. K. Yadav Pronob Das S. C. S. Das S. Borah N. Sharma
100.	Hindi Saptah	ICAR- CIFRI, Barrackpore, West Bengal	14- 20 September	All Staff
101.	Stakeholder consultation for 'Scoping and scenario setting of TEEB AgriFood application in Assam', organized by ICAR-CAFRI, Jhansi and SAFE and sponsored by UNEP	Guwahati, Assam	15 September	S. K. Majhi D. Debnath
102.	Hindi Workshop on "*DeshKeVikas Me Rajbhasha Ki Bhoomika*"	ICAR-CIFRI Regional Centre, Bangalore	15 September	All scientists of the Guwahati Centre

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
103.	Third anniversary celebration of PMMSY	Brillian Convention Center, Indore	15 September	R. K. Manna S. K. Koushlesh
104.	Seminar on "Enhancing Aquaculture sustainability by improving aquatic animal health" conducted by the Aquaculture Pathology Laboratory, University of Arizona, USA	On-line	20 September	Jesna P. K., SibinaMol S V. L. Ramya H. Chaudhury
105.	Hindi workshop on "*Samakaleen Sthree Kavithā*"	ICAR-CIFRI Regional Centre, Bangalore	20 September	All scientists of the Bangalore centre
106.	Participated and presented on Estimation of e-flows below SSD on river Narmada in First Review Meeting on Eflows organized by Narmada Controlling Authority (NCA), Indore	Narmada Controlling Authority (NCA), Indore	21 September	A. K. Sahoo
107.	Concluding Workshop of NICRA Project on Vulnerability of Inland Fisheries to Climate Change. Dr. Nag presented aninvited talk on 'Carbon stock assessment, sequestration and GHG emission in wetlands'	ICAR-CIFRI Barrackpore	25 September	S. K. Nag A. K. Das S. Das Sarkar H. Chaudhury Lianthuamluaia Mishal P. S. Kumari Arun Pandit
108.	Workshop on "Vulnerability of Inland Fisheries to Climate Change" (Concluding workshop of NICRA Project)	ICAR- CIFRI, Barrackpore, West Bengal	25 September	Arun Pandit K. Kumari Mishal P Lianthuamluaia S. Kumari T. T. Paul
109.	Mid-term review meeting of ICAR Regional Committee 3	On-line	26 September	B. K. Bhattacharjya Arun Pandit
110.	"Stakeholders consultation cum consultative workshop on fish conservation and ranching in River Ganga" (Concluding workshop on NMCG component I & II)	ICAR-CIFRI, Barrackpore	26 September	B. K. Das Arun Pandit T. N. Chanu R. Baitha
111.	Stakeholders consultation cum consultative workshop on Hilsa fisheries improvement for sustainable fisheries and conservation in river Ganga	ICAR-CIFRI, Barrackpore	27 September	T. N. Chanu
112.	Interactive workshop cum review meeting on IP management, technology licensing and commercialisation	ICAR-NBFGR, Lucknow	05 October	G. Chandra
113.	Awareness lecture on "Importance of reporting corruption and protection of PIDPI complainant"	ICAR-CIFRI Regional Centre, Bangalore	05 October	All scientists of the Bangalore centre

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
114.	Webinar: Women, Wetlands and Climate Resilience in Asia: Policy and other elements for an empowerment roadmap. Jointly organized by SCOPE, DISHA and Women for Water Partnership	On-line	05 October	S. Samanta
115.	Stakeholders meeting with the Vembanad Kayal Samrakshana Samithi	Edakochi, Kerala	05 October	D. Sudheesan T. T. Paul T. Abdulla
116.	Awareness lecture on "Systems and procedures of the Organization"	ICAR-CIFRI, RC Bangalore	09 October	All scientists of the Bangalore centre
117.	XVI Agricultural Science Congress organized by National Academy of Agricultural Sciences	Kochi	10-13 October	P. Panikkar D. Sudheesan T. T. Paul
118.	NMCG meeting for final approval of Phase III of the project	New Delhi	12 October	B. K. Das
119.	Institute Management Committee and Institute Research Committee Meeting of ATARI, Kolkata	ICAR-ATARI, Kolkata	13 October	S. Samanta
120.	Conference on "Monitoring Biodiversity for Action" organized by Earth Observations Biodiversity Observation Network (GEO BON), in partnership with the UN Convention on Biological Diversity (CBD)	On-line	10- 13 October	K. Kumari
121.	16th Agricultural Science Congress organized by ICAR-CMFRI, Kochi	Kochi	10-13 October	B. K. Das Santhana Kumar V.
122.	Mainstreaming Climate Change into International Fisheries Governance and Strengthening of Fisheries Management Measures in the Indo-Pacific region	Chennai	16-19 October	Lianthuamluaia Mishal P.
123.	International Conclave on "Mainstream Climate Change into International Fisheries Governance and Strengthening of Fisheries Management Measures in the Indo-Pacific Region"	Online	16-18 October	B. K. Das
124.	Online Training programme on 'Next generation sequencing and data analysis'	ICAR-NAARM, Hyderabad	16-20 October	S. Roy T. Abdulla
125.	Meeting on Awareness o n Audit Process and Functioning	ICAR-CIFRI, Barrackpore	18 October	All Scientists
126.	6th CSD Annual Conference on Sustainable Development 2023: Unpacking Sustainability, Resilience and Equity in Dhaka, Bangladesh	Dhaka, Bangladesh	26- 30 October	B. K. Das Arun Pandit
127.	International workshop on "Genetic Improvement of Performance Traits: A Genome-Wide Selection Perspective"	ICAR-CIFA	28 October	Jesna P. K. V. L. Ramya

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
128.	ICAR-WorldFish collaborative workshop	WorldFish, Egypt	30 October – 06 November	B. K. Das S. Borah
129.	Webinar on 'precision farming' conducted under the ICAR regional committee 8	On-line	31 October	Arun Pandit
130.	Lecture on"Work ethics and Governance"	ICAR-CIFRI, RC Bangalore	01 November	All scientists of the centre
131.	26th meeting of ICAR Regional Committee 6	On-line	03 November	B. K. Das Arun Pandit D. Jha
132.	Meeting on DPR for establishing a public aquarium at Guwahati Assam	Directorate of Fisheries, Meen Bhawan, Guwahati	06 November	S. K. Majhi S. Yengkokpam N. Sharma B. C. Ray
133.	Regional Training-cum-Awareness Workshop for EasternRegion on J-Gate@CeRA	OUAT, Bhubaneswar	10 November	S. K. Das
134.	Awareness on women empowerment and harassment at workplace	On-line	14 November	All scientists of the ICAR CIFRI Barrackpore
135.	Review meeting on SCoPIF project	Directorate of Fisheries, Guwahati, Assam	16 November	S. K. Majhi, S. Borah
136.	Launching programme of cage culture at Dumbur reservoir	Narkelkunja, Dhalai district, Tripura	17 November	S. C. S. Das
137.	Meeting on ICAR- Network Program on Precision Agriculture (NePPA) project	Mumbai	17 November	B. K. Das
138.	Interactive meeting with Director General, ICAR	Online	17 November	All scientists
139.	Stakeholder consultative workshop on Ramganga E-flows estimation organized by GIZ, India and NMCG	New Delhi	20 November	A. K. Sahoo
140.	CRISPR Cas genome editing: Workflow, Tools and Techniques	Nano Science and Technology Consortium (NSTC)	20-30 November	S. Roy
141.	Global Fisheries Conference 2023 (GFC- 2023)	Ahmedabad, Gujarat	21 - 22 November	B. K. Das
142.	Start-up meeting of SWIFT project to be implemented by Department of Fisheries, Govt. of Assam	Directorate of Fisheries, Meen Bhawan, Guwahati	23 November	S. K. Majhi S. Yengkokpam S. Borah
143.	3rd International Conference on Aquatic Animal Epidemiology (AquaEpi III)	ICAR-NBFGR, Lucknow	29 November – 01 December	B. K. Das S. K. Manna A. K. Sahoo R. Baitha
144.	1st Technical Advisory Committee Meeting on Fisheries Census 2023	Online	30 November	S. Samanta

Sr. no.	Meetings/ Seminar	Venue	Date	Participants
145.	26th meeting of ICAR Regional Committee 3	On-line	01 December	B. K. Das S. K. Majhi Arun Pandit
146.	Techno Commercial Assessment and Expert Committee Meeting of ICAR-DCFR	ICAR-DCFR, Agrinnovate India	01 December	G. Chandra
147.	Participated and presented in the conference VIROCON 2023-Advances in Global virus Research towards One Health	ICAR-NRCB, Tiruchirappalli	01-03 December	B. K. Das A. K. Sahoo
148.	Technical Review Committee (TRC) meeting for the Fisheries Domain under network project on "Agricultural Bioinformatics and Computational Biology"	Virtual Mode	04 December	B. K. Das
149.	Interaction meeting of the DG, ICAR with the faculty member of IARI hubs	On-line	07 December	Arun Pandit
150.	'Metagenomics Data Analysis' under ICAR-CRP Genomics Project	ICAR-IASRI, New Delhi	11-13 December	S. Roy
151.	International Conference on Responsible Aquaculture and Sustainable Fisheries Interact (RASHI-2022) conducted by the College of Fisheries Central Agricultural University (Imphal) Agartala Tripura	On-line	13-16 December	S. Das Sarkar
152.	ITMC meeting of ICAR-NBFGR	ICAR-NBFGR, Lucknow	14 December	G. Chandra
153.	Meeting on proposed ICAR-CIFRI's Brood Bank project	Directorate of Fisheries, Meen Bhawan	18 December	S. K. Majhi, D. Debnath
154.	TOLIC meeting for the planning of the upcoming दक्षिण क्षेत्रीय राजभाषा सम्मेलन	GPO Bangalore	18 December	Jesna P. K.
155.	Institute review meeting by the DG, ICAR	On-line	21 December	B. K. Das S. Samanta Arun Pandit



Distinguished Visitors



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Distinguished visitors



Dr. Sailesh Kulkarni, Base Hospital, Barrackpore and team visited the Institute headquarters on 05 January 2023



Dr. Dhriti Banerjee, Director, Zoological Survey of India on 17 March, 2023



Shri Avanindra Singh, IAS (2nd from right), Secretary, Department of Fisheries, Govt. of West Bengal on 17 March, 2023



Dr. M.V. Rao, IAS, Chairperson, West Bengal Electricity Regulatory Commission on 29 April, 2023



Prof. Kuldeep Krishna Sharma (in the middle), Vice Chancellor, Himalayan University, Itanagar on 10 July 2023



Dr. Gopal Krishna, Former VC, ICAR-CIFE, Mumbai (at the left) on 24 August 2023



Sadhvi Niranjan Jyoti Sahni, Union Minister for State (Rural Development) (at the middle) on 05 September 2023



Shri Sandesh Kumar Nagotia, Sr. AO, DGGI, Kolkata (at the right) on 18 October 2023



Dr. B. Meena Kumari, Former DDG (Fy. Sc.) ICAR & Former Chairperson, NBA (at the left) on 19 December, 2023



Shri Rajesh Sahay, Director, Finance, ICAR, New Delhi (4th from left) on 21 December 2023

Distinguished visitors visited ICAR-CIFRI headquarters

1. Dr. Pranjib Kumar Chakrabarty, Former Member, ASRB on 12 January, 2023
2. Prof. J. Adinarayana, IIT Bombay on 12 January, 2023
3. Dr. Kanchan Singh, Former ADG (Engg), ICAR on 12 January, 2023
4. Prof. Abdul Samad, Former Dean and Director of Instructions MAFCU, Nagpur on 12 January, 2023
5. Shri Ashok Kumar, Director (F.S.), ICAR, New Delhi on 28 February, 2023
6. Dr. Madan Mohan, Former ADG (Marine Fisheries), ICAR on 03 March, 2023
7. Dr. (Prof.) Subhashisa Dutta, Professor, IIT, Guwahati on 03 March, 2023
8. Dr. A. K. Singh,, Former Director, DCFR on 03 March, 2023
9. Dr. V. P. Saini, Dean, CoF, Kishanganj, Bihar on 03 March, 2023
10. Dr. K. Satyanarana, Director, CSB-CTRTI, Ranchi on 15 March, 2023
11. Shri Avanindra Singh, IAS, Secretary, Department of Fisheries, Govt. of West Bengal on 17 March, 2023
12. Dr. Dhriti Banerjee, Director, Zoological Survey of India on 17 March, 2023
13. Dr. D. B. Shakyawar, Director, ICAR-NINFET on 17 March, 2023
14. Dr. Gouranga Kar, Director, ICAR-CRIJAF on 17 March, 2023
15. Dr. U. K. Sarkar, Director, ICAR-National Bureau of Fish Genetic Resources, Lucknow on 25 April, 2023
16. Dr. B. K Chand, Joint Director Research, WBUAFS on 29 April, 2023
17. Dr. M.V. Rao, IAS, Chairperson, West Bengal Electricity Regulatory Commission on 29 April, 2023
18. Dr. Himanshu Pathak, Secretary DARE &Director Genearal, ICAR, New Delhi on 19 May, 2023 at Kultali
19. Prof. (Dr.) Jayanta K Biswas, University of Kalyani on 05 June, 2023
20. Prof. Kuldeep Krishna Sharma, Vice Chancellor, Himalayan University, Itanagar on 10 July 2023
21. Prof. B. B. Jana, Kalyani University, West Bengal on 10 July 2023
22. Dr. Gopal Krishna, former VC, CIFE, Mumbai on 24 August 2023
23. Madam Niranjan Jyoti Sahni, Minister for state, Ministry of Rural Development, Union on 05 September 2023
24. Dr. Jeetendra Kumar, ADG, NASF, ICAR on 08 September 2023
25. Dr. Satya Prakash Tiwari, Head, Department of Hindi, Shibpur Dinbandhu College, Howrah on 20 September 2023
26. Shri Yatindra Pratap Singh, Assistant Statistical Officer, Department of Fisheries, Govt. of Chhattisgarh on 20September 2023
27. Dr. Pradip Dey, Director, ICAR-ATARI, Kolkata on 25 September, 2023
28. Shri Sandesh Kumar Nagotia, Sr. Audit Officer, Indian Audit & Accounts Dept. on 18 October, 2023
29. Shri Rajneesh Meena, DD, DGGI, Kolkata on 06 November 2023
30. Dr. Niharendu Saha, Professor, Dept. of Agrl. Chemistry &Soil Science, BCKV, West Bengal on 05 December, 2023
31. Dr. P. Krishnan, Director, BOBP-IGO on 19 December, 2023
32. Dr. B. Meena Kumari, Former DDG(Fy. Sc) ICAR & Former Chairperson, NBA on 19 December, 2023
33. Shri Rajesh Sahay, Director, Finance, ICAR on 21 December 2023
34. Dr. K. K. Vass, Former Director, ICAR-CIFRI, Barrackpore on 28 December, 2023

Dignitaries visited ICAR-CIFRI, Prayagraj



Dr. Dilip Kumar (3rd from right), Ex-Director/VC ICAR-CIFE Mumbai and Former UN (FAO) advisor visited the ICAR-CIFRI, Prayagraj Centre on 25 February 2023



Prof. R. S. Verma (2nd from left), Director, MNIT & IIIT, Prayagraj visited the ICAR-CIFRI, Prayagraj Centre on 26 February 2023

Dignitaries visited ICAR-CIFRI, Bengaluru and Kochi



Dr. B. Meenakumari, Former DDG visited Bengaluru Centre (3rd from left)



Dr. U. K. Sarkar, Director, ICAR-NBFGR (in the middle) visited Kochi Centre

Dignitaries visited ICAR-CIFRI, Vadodara



Dr. Pravin Kumar, Director, ICAR-CCARI, Goa (3rd from left) visited CIFRI Vadodara centre

Dignitaries visited ICAR-CIFRI, Guwahati



Dr. R. Murugesan (in the middle)



Dr. B. C. Deka (3rd from left)

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Staff Position as on 31 December 2023

Category	Sanctioned Strength	Filled up	Vacant
R.M.P	1	1	-
Scientist	88	76	12
Technical	86	41	45
Administrative	66	33	33
Skilled Support Staff	65	20	45
TOTAL	**306**	**171**	**135**

New Joining

Name & Designation	Place of Posting	With effect from
Shri Kumar Vivek, Chief Administrative Officer	ICAR-CIFRI, Barrackpore	30.01.2023
Dr. S. Samanta, HoD, FRAI Division	ICAR-CIFRI, Barrackpore	04.07.2023
Dr. R. K. Manna, HoD, RWF Division	ICAR-CIFRI, Barrackpore	06.07.2023
Dr. S. K. Manna, HoD, REF Division	ICAR-CIFRI, Barrackpore	10.07.2023
Dr. Sullip Kumar Majhi, HoRC, Guwahati	Regional Research Centre, ICAR-CIFRI, Guwahati	14.07.2023
Shri Rakesh Kumar, Scientist	Regional Research Centre, ICAR-CIFRI, Guwahati	20.07.2023
Dr. (Mrs.) Archana Sinha, HoD, AEB	ICAR-CIFRI, Barrackpore	10.11.2023

Transfer

(i) Inter-Institutional transfer

Sl. No.	Name & Designation of the Staff	From	To
1.	Shri Biswajit Barua, Administrative Officer	ICAR-CIFRI, Barrackpore	ICAR-NBSSLUP, Kolkata Centre
2.	Dr. Vaisakh G., Scientist	Research Station, ICAR-CIFRI, Vadodara	ICAR-CMFRI, RS, Kozhikode
3.	Shri S. Manoharan, Chief Technical Officer	Research Station, ICAR-CIFRI, Kochi	ICAR-SBI, Coimbatore

(ii) Intra-Institutional transfer

Sl. No.	Name & Designation of the Staff	From	To
1.	Shri Rajdip Dutta, Assistant	Regional Centre, ICAR-CIFRI, Guwahati	ICAR-CIFRI, Barrackpore
2.	Ms. Tanuja Abdulla, Scientist	ICAR-CIFRI, Barrackpore	Research Station, ICAR-CIFRI, Kochi

Superannation

Sl. No.	Name	Designation	Date of Birth	Date of Retirement	Place of Posting
1.	Mr. Mohan Lal Sarkar	Skilled Support Staff	22. 01. 1963	31. 01. 2023	Barrackpore
2.	Mr. M. Karthikeyan	Scientist	17. 03. 1961	31. 03. 2023	Bengaluru
3.	Mr. M. Feroz Khan	Scientist	31. 07. 1961	31. 07. 2023	Bengaluru
4.	Ms. Keya Saha	Chief Technical Officer	04. 08. 1963	31. 08. 2023	Barrackpore
5.	Dr. M. A. Hassan	Principal Scientist	13. 12. 1961	31. 12. 2023	Barrackpore

Promotion

Scientist

Sl. No.	Name & Designation	Next higher RGP & Pay Scale in the promotional post of	Date from which promotion approved
1.	Dr. Pranaya Kumar Parida, Scientist	Scientist with RGP ₹ 7000 (₹15600-39100/-) Revised Pay Level -11 as VII CPC	19. 04. 2017
2.	Dr. Piyashi Debroy, Scientist	Scientist with RGP ₹ 7000 (₹15600-39100/-) Revised Pay Level -11 as VII CPC	21. 01. 2019
3.	Dr. Thankam Theresa Paul, Scientist	Senior Scientist with RGP ₹ 8000 (₹15600-39100/-) Revised Pay Level -12 as VII CPC	15. 12. 2021
4.	Dr. Pritijyoti Majhi, Scientist	Scientist with RGP ₹ 7000 (₹15600-39100/-) Revised Pay Level -11 as VII CPC	01. 01. 2022
5.	Mrs. Tanushree Banerjee, Scientist	Scientist with RGP ₹ 7000 (₹15600-39100/-) Revised Pay Level -11 as VII CPC	05. 07. 2022
6.	Dr. J. Canciyal, Scientist	Scientist with RGP ₹ 7000 (₹15600-39100/-) Revised Pay Level -11 as VII CPC	05. 07. 2022
7.	Dr. Dharmendra Kumar Meena, Senior Scientist	Senior Scientist with RGP ₹ 9000 (₹37400-67000/-) Revised Pay Level -13 A as VII CPC	15. 12. 2022

Supporting Staff

Sl. No.	Name & Designation	Promoted to	With effect from
1.	Shri Sukhen Das, SSS	Promoted to the post of LDC	12. 05. 2023
2.	Shri Jayanta Pramanik, SSS	Promoted to the post of LDC	12. 05. 2023

Foreign Visit

Dr. B. K. Das and Dr. Arun Pandit visited Bangladesh during 26.10.23 to 30.10.23 for attending the 6th CSD Annual Conference on "Sustainable Development 2023: Unpacking Sustainability, Resilience and Equity" in Dhaka, Bangladesh at the University of Liberal Arts Bangladesh (ULAB), Dhaka. Dr. Pandit presented a paper 'Exploring livelihood strategies of small-scale riverine fisheries: A study of fishers of eight rivers of India'. Dr. Das was the panellist in the discussion entitled 'Transitions and pathways in small-scale fisheries vulnerability to viability' focusing on V2V country-specific case studies.

Dr. B. K. Das and Dr. Simanku Borah visited WorldFish, Abbassa Egypt during 31.10.23 to 06.11.23 for attending the technical workshop and presented the activities of ICAR-CIFRI carried out under "Small-scale fisheries" project implemented during 2019-2023. They developed the workplan for next phase of collaboration between ICAR-CIFRI and WorldFish for the improvement of openwater fisheries sector of the country for the period 2024-28.



LIST OF STAFF AS ON 31 DECEMBER 2023

Head Quarter, Barrackpore

Director

Dr. B. K. Das

Head of Division

Dr. Srikanta Samanta
Dr. Sanjib Kumar Manna
Dr. Ranjan Kumar Manna
Dr. Archana Sinha

Principal Scientist

Dr. Malay Naskar
Dr. Subir Kumar Nag
Dr. ArchanKanti Das
Dr. Md. Abul Hassan
Dr. Md. Aftabuddin
Dr. Sanjay Kumar Das
Dr. Bijay Kumar Behera
Dr. Arun Pandit
Dr. Hemanta Chowdhury
Dr. Asit Kumar Bera

Senior Scientist

Dr. A. K. Sahoo
Dr. Aparna Roy
Dr. Sajina A.M.
Dr. Soma Das Sarkar
Dr. D. K. Meena
Dr. D. J. Sarkar
Dr. AjoySaha

Administrative Staff

Mr. Kumar Vivek
Mr. Subhankar Dey
Mr. Shyam Sunder Ghosh
Ms. Pausali Mukherjee
Mr. Subir Das
Mr. Chandan Chakraborty
Mr. Ganesh Chandra Barman
Mr. Raushan Kumar
Mr. Santosh Sarkar
Ms. Mousumi Banerjee Nan
Ms. Jolly Saha
Ms. Ruma Ghosh
Mr. Pradipta Sen
Mr. Suranjan Kumar Singh
Mr. Rajdip Dutta
Mr. Fazal Khan
Mr. Bhola Lal Dhanuk
Mr. Ganesh Bhanja
Mr. Somenath Banerjee
Ms. SreemantiSaha
Mr. Syed AbolKabi
Mr. Debasish Acharya
Mr. Aritra Datta
Mr. Debasis Singha
Mr. P. C. Pramanick
Mr. P. R. Mahata
Ms. Shibani Bhattacharya
Mr. Sukhen Das
Mr. Jayanta Pramanick

Scientist

Mr. Praveen Maurye
Mr. Ganesh Chandra
Dr. Debabrata Das
Mr. Sanjeev Kumar Sahu
Dr. P. K. Parida
Ms. PrajnaRitambhara Swain
Mr. Roshith C.M.
Dr. Raju Baitha
Ms. Suvra Roy
Dr. Kavita Kumari
Mr. Satish Kumar Koushlesh
Mr. Mitesh H Ramteke
Ms. T. N. Chanu
Dr. Suman Kumari
Dr. Vikash Kumar
Dr. Lianthuamluaia
Dr. Gunjan Karnatak
Mr. Mishal P.
Ms. Pritijyoti Majhi
Ms. Anjana Ekka
Ms. Tanushree Banerjee
Dr. J Canciyal
Dr. PiyashiDebroy
Mr. Rahul Das
Dr. Dibakar Bhakta
Mr. PronobGogoi
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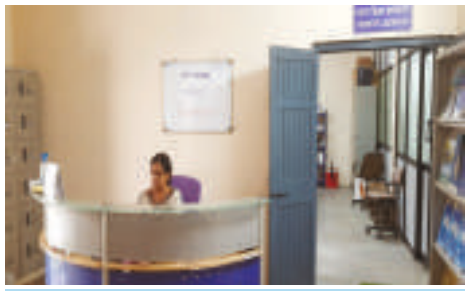
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Acronyms

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

Acronyms

Abbreviation	Expanded form
NT	Near Threatened
NTU	Nephelometric Turbidity Unit
OC	Organic carbon
P	Phosphorous
$P_2 O_5$	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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Annual Report

2023



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Guwahati RRC



Kochi RS



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Vadodara RRC

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