वार्षिक प्रतिवेदन
Annual Report
2018-19

भाकृअनुप
ICAR

ICAR- Central Inland Fisheries Research Institute
(Indian Council of Agricultural Research)
Barrackpore, Kolkata-700120, West Bengal


NAMAMI GANGE

ANNUAL 2018-19 REPORT

भा.कृ.अनु.प.-केन्द्रीय अंतर्स्थलीय मात्स्यिकी अनुसंधान संस्थान
बैरकपुर, कोलकाता–700120, पश्चिम बंगाल

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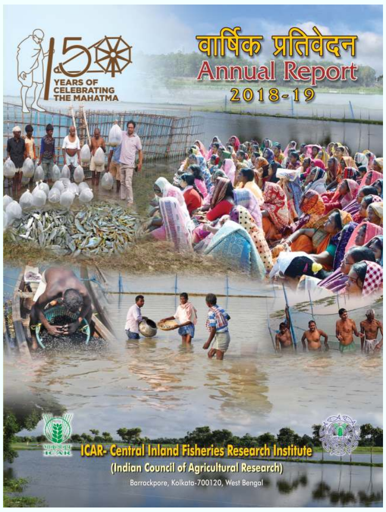

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Preface

Fishery in inland open water sector occupies a unique status in the national economy and provides livelihood, food and nutritional security and ecosystem services to the growing population in the country. The country is blessed with vast inland open water resources in terms of 45,000 km of rivers, 0.3 million ha of estuaries, 0.19 million ha of backwaters and lagoons, 3.51 million ha of reservoirs, 0.354 million ha of floodplain wetlands and 0.72 million ha of upland lakes. The estimated demand of fish by 2025 in the Indian domestic market would be around 16 million tonnes (MT) against the present production of 12.60 MT coming from inland (65%) and marine (35%) sectors. These resources provide employment and livelihood support to 1.24 million inland fishers. In this scenario, the projected second blue revolution of the country demands fish production from inland open water bodies as a promising option for providing high quality protein food, livelihood to the rural populace and doubling the fisher's income. However, over-exploitation of natural fish stocks, ecosystem degradation, man-made modifications for water diversion, pollution, etc. are the major threats for these aquatic resources. Further, with increasing pressure and perceptible climatic changes, it becomes necessary to protect these resources for sustained inland fisheries and harness their untapped production potentials. In this backdrop, ICAR-CIFRI has considerably accomplished significant scientific and technological milestones towards generating knowledge base through interdisciplinary research for enabling sustainability of their ecosystem services and fisheries.

The Institute executed a number of programmes and activities resulting in significant scientific and technical achievements in the year 2018-19. The TiLV Rapid Diagnostic Kit was developed for the pathogenic Tilapia Lake Virus (TiLV) reported by the Institute. The Institute has also got trademarks on CAGE GROW®, CIFRI GI CAGE®, CIFRI PEN HDPE® and CIFLIN®. The Institute extended its cage culture programme to the states of Odisha, Telengana, Bihar and Assam. The modified cages were also installed in wetlands, addressing the diversified climate resilient species and *in-situ* raising of fingerlings. *Puntius gonionotus* was introduced in cages to clean up the periphytic substrates grown in the cage nets. HDPE PEN® which was commercialised last year has been popularised through various schemes namely TSP, SCSP, NICRA, NEH component and NHMPS programmes to the States of West Bengal, Odisha, Bihar, Assam, Kerala, Gujarat, Manipur and Arunachal Pradesh.

To strengthen the livelihood of the fishers of the Vembanad Lake, clam culture in pen was successfully demonstrated. The Institute is involved in the projects initiated on various aspects of riverine, reservoir, wetlands and environmental management contributing towards sustainable fishery, ecological alterations, multiple habitat changes of these water bodies and developing a road map for its productivity enhancement. Livelihood is also a complex phenomenon in the natural water bodies giving an opportunity to about 1.2 million fishers across India. The Scientists of this Institute are striving to suggest the inter-governmental bodies, national institutes and fishers for sustaining production from inland open waters without altering ecological integrity and pollution.

Climate change is the biggest challenge to this sector for which the Institute is working continuously to provide an alternative species from the rich biodiversity of India that could restore and feed the growing more than billion population. E-flow after the construction of large number of dams and barrages is another challenge in the riverine system and CIFRI is in a quest to provide effective solution. The Institute in association with Central Water Commission (CWC) provides solution for the fish migrations in the riverine system. To cater to the cutting edge researches in the open water system, the Institute works on disease surveillance, fish genetics stock characterisation, metagenomics in river, nano-remediation, pre-biotics from natural habitat etc.

In the last two years, the Institute has worked on ecological status, habitat fingerprinting, fish diversity, pollution abatement, e-flow and emerging contaminants of ten rivers viz. Ganga, Yamuna, Cauvery, Narmada, Kathajodi, Tapti, Siang, Chaliyar, Teesta, and Godavari. Continued efforts have been made to study the wetland productivity, especially six wetlands have been taken for integrated development of fisheries by adopting CIFRI technologies. With the funding support of Government of Odisha, CIFRI has installed 110 GI cages and a circular cage in reservoirs of Odisha. The Institute has also contributed effectively for the development of the Sunderban community by providing exposure training, canal fisheries and products on derelict water bodies involving various stakeholders and NGOs. In collaboration with GIZ and World Fish, basin approach of Mahanadi and wetland productivity enhancement has been initiated. During the year, the Institute conducted about sixty seven training programmes benefitting more than 1750 fishers and fish farmers and 181 officials from various states.

The Institute organised a number of workshops on fish proteomics, hilsa fisheries, metagenomics, biosensor technology and open water fisheries management of Tripura, Manipur and North Eastern States. A massive drive of Swachha Bharat Abhiyan and coverage under Mera Gaon Mera Gaurav received wide appreciations.

New initiatives on Hilsa and Indian Major Carps ranching in the River Ganga have been carried out aiming to help the declining fish stocks in River Ganga. With a view to provide a strategic planning of fisheries enhancement and livelihood options for the poor fishers, studies have been conducted on Narmada, Godavari and Sardar Sarovar Nigam Reservoirs. CIFRI has also executed multiple activities under Tribal Sub Plan, NEH component, Scheduled Caste Sub Plan benefitting the fishers community through canal fisheries development, ornamental fish culture, integrated farming, distribution of inputs for fish culture, fishing implements, pen culture and wetland fisheries development. The Staff of the Institute have attended a number of capacity building programmes, overseas trainings, workshops, brainstorming sessions, international and national seminars, symposia and meetings, etc.

To add on, CIFRI has initiated the smart door system, installed sensor based lights at campus, developed the Complaint Management System, pensioners' database and unified code file numbering system for the smooth functioning of the office. Online Database on reservoir, mobile apps on fish disease and Nutri Fish App are some of the fisher-friendly digital systems which have been developed.

During the current year new records of fishes like *Awaousgramme pomus* (Bleeker 1849), *Parambassis lala* (Hamilton 1822), *Plotosus canius* (Hamilton 1822), *Takifugu oblongus* (Bloch 1786), *Thryssasteno soma* (Wongratana 1983) have been documented from certain parts of Indian rivers.

I am confident that our endeavours and persistent research activities will continue and would yield significant output and decision making tools for developing effective strategies for sustainable management of inland open water resources.

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

Dated: 1 July, 2019
Barrackpore

(B. K. Das)
Director

प्रस्तावना

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xr nk o"kk e lLFkku u ufn;k d ifjr= dh fLFkfr] mudk gchVV ÇQxjÇçÇVx] eRL; fofoèkrk] çn"k.k l funku mik;] i;koj.kh; çokg rFkk n'k dh cMh ufn;k] xxk] ;euk] dkojh] uenk] dkB tkMh] rkIrh] fl;kx] pkfy;kj] rhLrk vkj xknkojh e çn"k.k d Lrj ij vè;;u fd;k tk jgk gA

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xxk unh e fgylk vkj Hkkjrh; e[; dki çtkfr;k d loèku l xxk unh e eNyh d lp;u e of) gÃ gA xjhc eNvkjk d fy, eRL; loèku vkj vkthfodk fodYi dh ,d ;ktuk çnku dju d mí'; l uenk] xknkojh vkj ljnkj ljkoj fuxe tyk'k; ij vè;;u fd, x, gA lLFkku u vkfnokl h mi ;ktuk] iokÙkj {k= ;ktuk] vulfpr tkfr mi ;ktuk d rgr dÃ xfrfofèk;k dk lpkyu fd;k g& ugj ekfRL;dh fodkl] vydkjh eNyh ikyu] ,dh–r ikyu] eNyh ikyu d fy, lkekuk dk forj.k] eNyh idMu dh dyk] iu e eNyh ikyu vkj vkæ{k= eRL; fodkl d ekè;e l eNvkjk lenk; dk ykHkkfUor dju okyh vulfpr tkfr mi ;ktuk vkfnA lLFkku d depkfj;k u ekuo lLkèku fodkl d vrxr l{kerk fuek.k dk;Øe] fon'kh çf'k{k.k] dk;'kkykvk] fopkj eFku l=] vrjk"Vh; vkj jk"Vh; lfeukjk] lxkf"B;k vkj cBdk vkfn e Hkkx fy;k gA

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e> ;g i.k foÜokl g fd ge vFkd ç;kl vkj yxkrkj vulèkkuk l vrLFkyh; [kyk ty llkèku ekfRL;dh fodkl d fy, çHkkoh mik;k dk fodflr dj ldx vkj egRoi.k miyfC/k;k dk vèt r dju e lQy gkxA

e lLFkku d dk;k ,o miyfCèk;k d fy; Mk- Vh- egkik=] lfpo] M;j o egkfun'kd] Hkkjrh; –f"k vulèkku ifj"kn d çfr –rK gA e Mk- t- d- tuk] mi&egkfun'kd ¼ekfRL;dh foKku½] Mk- çoh.k i=] lgk;d egkfun'kd ¼vrLFkyh; ,o leæh ekfRL;dh½ d ekxn'ku ,o çkRlkgu rFkk ifj"kn d ekfRL;dh foKku lHkkx d vfèkdkfj;k d lg;kx d fy, vkHkkj çdV djrk gA çLrr okf"kd çfronu e m)r leLr dk;dykik e lLFkku d oKkfudk vkj lg;kxh dfe;k dh yxkrkj egur g vr% e bld fy, leLr flQjh ifjokj dk vkHkkjh gA lkFk gh] bl çfronu d lEiknu e.My dk mud vFkd ç;kl] fu"Bki.k lg;kx rFkk çfrc)rk d fy; gkfnd èkU;okn nrk gA

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Director's Desk

It gives me immense pleasure and satisfaction that during the last one year, trademarks of four technologies of the Institute, namely, CAGEGROW®, CIFRI GI CAGE®, CIFRI PEN HDPE® and CIFLIN® were successfully registered. Among them the CIFRI GI CAGE, CIFRI PEN HDPE and CAGEGROW have already been commercialized. Eight MoUs have been signed for conducting collaborative research and development works. The Institute has been awarded and initiated projects on Antimicrobial resistance (AMR) in fisheries, Ornamental fish seed production, Ranching of Hilsa above Farakka Barrage and Fisheries development on Kothia Maun of Bihar. CIFRI has also been provided with Quarantine facility for aquatic animals in Eastern Region sanctioned by NFDB, Hyderabad. A total number of 1,25,500 nos. of fish seeds have been ranched in twelve ranching programmes towards restoration of depleting IMC stock in the Ganga River. Hon'ble Union Minister of Agriculture & Farmers' Welfare Shri Radha Mohan Singh Ji visited ICAR-CIFRI, Barrackpore and lauded efforts of the Institute in research and development in the inland fisheries sector. The Institute conducted research and development programmes under fifteen Institution projects, one outreach programme, fourteen externally funded projects and ten consultancy projects. Interesting studies have been conducted on fishing gears, fish biology, fish migration, ecology and fisheries of reservoirs, rivers, post flood assessment of riverine fisheries of Kerala etc during this period. He also inaugurated four NFDB funded projects in wetlands of Bihar. I would also like to mention here that in the last year, our Institute has imparted training to 1,752 farmers from different states, 204 students from various universities, and 181 Officials of Departments of Fisheries from various states apart from providing exposure visit to 973 visitors including students, farmer trainees and State Department officials. In this context, I am delighted to mention that the Institute has adopted smart office management systems such as smart door, sensor-based light for energy saving, and systematic inventorization of institute file movement. The newly created reservoir fisheries database, fish disease mobile app and on-line pensioner database are a step forward towards digitization of existing scientific knowledge-base and its application.

The Institute successfully organized different workshops such as Inception workshop of NMHS project, 1st Barrackpore proteomics workshop and Biosensor technology in inland fisheries. Workshops on open water fisheries management of Tripura, Manipur and for the whole North-Eastern region were also organized. The Institute organized important events like Vigilance Awareness Week, World

Fishery Day, Agriculture Education Day, Women in Agriculture Day, World Soil Day, International Women Day etc. with active participation of all stakeholders. World Yoga Day, Independence Day, World Biodiversity Day, World Environment Day, National Fish Farmers Day etc. were also celebrated at the Institute with great fanfare and enthusiasm.

The Institute carried out the *Swachha Bharat Abhiyaan* and *Mera Gaon Mera Gaurav* activities religiously throughout the year, involving local community and village farmers. The 24^{th} meeting of the ICAR Regional Committee II comprising members from the states of West Bengal, Odisha, Andhra Pradesh, Telangana and UT of Andaman and Nicobar Islands was successfully organized at Bhubaneswar on 22 - 23rd June 2018. It is a matter of pride that the Institute's Hindi magazine Nilanjali bagged the first prize Ganesh Shankar Vidyarthi Purashkar of ICAR. This is the second time in seven years Nilanjali received the coveted prize. The 73^{rd} Foundation Day of the Institute was celebrated in a commendable manner on 17^{th} March, 2019 with successful organization of *Matsya Samriddhi Mela* on the occasion. A confluence of over 2,500 fishers/fish farmers interacted with researchers, university teachers, students, representatives of Industry, officials of NABARD and members of Indian Science Congress. The QRT team and the Parliamentary Committee on Rajbhasha visited the Institute, assessed the progress and appreciated the work being done by the Institute.

The Institute was further strengthened with joining of three new scientists, nine technical, six administrative and eight Skilled Support Staffs during this year. I welcome all of them to the CIFRI family and hope that they will contribute whole-heartedly for the cause of the Institute and the fisheries sector. I also congratulate the staff who got promotions and awards/ recognitions during last year.

Dated: 1 July, 2019
Barrackpore

(B. K. Das)
Director

निदेशक की कलम से

Hkk—vui&dæh; vrLFkyh; eRL; dh vuq lèkku lLFkku dh vkj l vki lHkh dk gkfnd vfHkunuA

lLFkku dk o"k 2018&19 fiNy o"k dh Hkkfr cgr gh mRlkgoèkd vkj fofHkUu dk;Øek l lfTtr jgk gA fjikV vofèk d nkjku lLFkku e pkj çk|kfxfd;k d VMekd dk i thdj.k fd;k x;k g & ^flQjh d txk* ¼CAGEGROW®½] ^flQjh thvkÃ d t* ¼CIFRI GI CAGE®½] ^flQjh ,pMhihÃ iu* ¼CIFRI PEN HDPE®½ vkj flQfyu ¼CIFLIN® & eNfy;k e Qkjefyu feykoV d ijh{k.k grq½A bue l ^flQjh e,My thvkÃ d t*] ^flQjh ,pMhihÃ iu* vkj flQjh d txk* dk okf.kT;dj.k dj fy;k x;k gA bl o"k lLFkku }kjk vk;kftr dk;Øek d vrxr vU; lxBuk vkj jkT; ljdkjk d lkFk vuqlèkku vkj fodkl dk;k d fy, vkB le>kr Kkiu gLrk{kfjr g;s gA lLFkku dk eRL;dh vuqlèkku vkj fodkl l tM egRoi.k igyvk ij ifj;kstukvk d }kjk dk;s dju dk lvolj feyk gA ; ifj;ktuk,¡ g & eRL;dh e l{ethojkèkh fujkèkdrk] vydkjh eNfy;k dk cht mRiknu] Qjôk cjkt e fgylk eNyh dk loèku] fcgkj d dkfB;k eu e eRL;dh fodkl] vkfnA lLFkku dk jk"Vh; eRL;dh fodkl ckM] gnjkcn }kjk çk;kftr ifj;ktuk; vkj ioÊ{k= d tyh; thok d fy, lxjkèkd lfoèkk tlh fofHkUu ifj;ktukvk dk çnku fd;k x;k gA xxk unh e ?kV jgh eNfy;k dh l[;k vkj eRL;dh iu#RFkku d fy, loèku }kjk Hkkjrh; e[; dki çtkfr;k d yxHkx 20 yk[k eRL; cht vkj vxfydkvk dk xxk unh d fofHkUu LFkyk e çokfgr fd;k x;k gA

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;fn çf'k{k.k dh ckr dh tk; rk lLFkku u fjikV vofèk d nkjku fofHkUu jkT;k d 1752 eRL; ikydk] fofHkUu foÜofo|ky;k d 204 Nk=@Nk=k,¡ rFkk eRL;dh foHkkxk d 181 vfèkdkfj;k dk vrLFkyh; eRL;dh d fofHkUu igyvk ij çf'k{k.k fn;k gA ;gh ugÈ] yxHkx 973 eRL; ikydk] foÜofo|ky;k Nk=@Nk=kvk rFkk eRL;dh foHkkxk d vfèkdkfj;k d le{k lLFkku d dk;dyki vkj fodflr çk|kfxfd;k dk çn'kr fd;k x;kA bl lnHk e] e> vkidk ;g crkr g, [k'kh gk jgh g fd lLFkku u LekV v,fQl vkj vuqlèkku çcèku d d'ky vkj lQy dk;kUo;u d fy, dÃ lkjh lfoèkkvk dk ltu fd;k g tl& LekVMkj] Åtk cpr gr llj okyh cfUk;k] lfu;kftr Qkby lpyu çfØ;k vkfnA uo fu£er tyk'k; ekfRL;dh vkdMk dk"k] eRL; jkx lcèkh ,i vkj v,uykbu iÙluj vkdMk dk'k miyCèk oKkfud vkj vU; lpukvk d lp;u vkj mi;kx d Mh thVkÃt'ku dh fn'kk e ,d egRoi.k vkj vU;re dne gA

lLFkku u bl o"k dN dk;'kkykvk dk lQy lpkyu fd;k ftle çe[k g & ,u,e,p,l ifj;ktuk(çFke cjdij çkVh;kfeDl(vrLFkyh; ekfRL;dh e tolpdk dh Hkfedk(f=ijk] ef.kij vkj mÙkj ioÊ jkT;k e [kykty ekfRL;dh çcèku vkfnA lLFkku u egRoi.k fnolk – foÜo ekfRL;dh fnol] lrdrk tkx:drk fnol] –f"k f'k{kk fnol] foÜo enk fnol] foÜo tofofoèkrk fnol] foÜo i;koj.k fnol] jk"Vh; eNvkjk fnol] –f"kjr efgyk fnol] foÜo ;kx fnol] LorU=rk fnol] x.kr= fnol] vrjk"Vh; efgyk fnol] vkfn dk lQy :i l euk;kA ejk xko vkj ejk xkjo rFkk LoPN Hkkjr vfHk;ku d vrxr lLFkku vkj bld {k=h; dUæk e o"k Hkj fofHkUu dk;dykik dk vk;ktu fd;k x;k ftle LFkkuh; xkeh.k vkj eNvkjk lenk;k dk Hkh lfEefyr fd;k x;k FkkA

bl o"k lLFkku u HkouÜoj e fnukd 22&23 tu dk Hkkjrh; –f"k vulèkku ifj"kn dh {k=h; lfefr–II dh cBd vk;kftr dhA bl {k=h; lfefr d vrxr if'pe cxky] vkMh'kk] vkèk çn'k] ryxkuk rFkk vMeku vkj fudkckj }hi leg 'kkfey gA bl cBd d lQyQrkiod vk;ktu e lLFkkudeÊ cèkkÃ d ik= gA bld lkFk lLFkku d fy, vkj Hkh xkjoi.k jgkA bldh xg if=dk Þuhyk tfyß dk nljh ckj Hkkjrh; –f"k vulèkku ifj"kn d x.k'k 'kdj fo|kFkÊ ijLdkj ;ktuk d vrxr çFke ijLdkj l lEekfur fd;k x;kA o"k 2010 e 'kHkkjHk dh xÃ bl if=dk dk doy 7 o"kk d vrjky e nk ckj ijL–r fd;k x;k g vkj nkuk gh ckj] çFke ijLdkj lA ;g lEeku bl ckr dk |krd g fd bldh xfjek vkj bldk mPp Lrj vHkh Hkh cjdjkj gA e bld fy, bl if=dk l tM lLFkku dæ;k dk èkU;okn nrk g rFkk bld lykgdkj e.My d lnL;k vkj ifj"kn d egkuHkkvk d ekxn'ku d çfr vkHkkj çdV djrk g ftud vFkd ç;kl vkj mfpr ekxn'ku l ;g if=dk vkt bl LFkku ij igph gA e leLr dæ;k dk bld fy, èkU;okn nrk g vkj ;g vk'kk djrk g fd vku oky o"kk e lLFkku dk vkj Hkh miyfCèk;k gkfly gkxhA

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lLFkku dh ipo"kÊ; leh{kk ny ¼2013&2018½ dh cBd lLFkku e[;ky; vkj bld {k=h; dUæk e vk;kftr gÃA jktHkk"kk lcèkh llnh; ny dk lLFkku d bykgkckn dæ e fgUnh dk;k dh leh{kk d fy, vkxeu gvkA

bl o"k 3 oKkfud] 9 rduhdh depkjh] 3 dfu"B J.kh fyfid] 1 LVuksxkQj rFkk 8 d'ky lgk;d dæ;k dh fu;fä gÃ gA e lHkh dk vfHkunu djrk g rFkk ;g vk'kk djrk g fd o viu mÙkjnkf;Ro dk ikyu djx vkj lLFkku dk uà Åpkb;k rd igpk,xA e inkUufr] ijLdkj vkj lEekfur gku oky dæ;k dk cèkkÃ nrk gA

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Salient Achievements

- Four trademarks, namely, CAGEGROW®, CIFRI GI CAGE®, CIFRI HDPE PEN®, and CIFLIN® have been registered.
- Fish catch was estimated to be 1.2-1.4 tonnes/km/year in River Cauvery and 1.0-1.1 tonnes/km/year in River Tapti considering the actively fished length of the rivers.
- *Oreochromis niloticus* has replaced native fish fauna and contributes 92 % to the fish catch in middle stretch of River Cauvery. In River Tapti *Clupisoma garua* and *Labeo fimbriatus* fishery have drastically declined.
- To maintain the pristine condition of River Kathajodi during lean season minimum discharge of 4456 cusec at Naraj and to maintain the river in Class A, B, and C category discharge of 4053, 3798 and 3654 cusecs respectively are required.
- Preliminary estimation based on the FDC using Global Environmental Flow Calculator indicated that to maintain river Tamas/Tons in slightly modified class of EMC 27.8 % of MAR (1607 MCM) discharge should be released from the Bakia barrage.
- A total of 190 fish species, including 7 exotics have been recorded from River Ganga, with higher fish diversity at Bijnor, Narora, Farraka, and Fraserganj.
- Fish landing from Allahabad stretch of the river Ganga was 158.6 tonnes in 2018 with dominance of miscellaneous group of fishes (43%), followed by exotics (34%). There is about 11% decline in fish landing as compared to the previous year.
- Better water quality, higher primary productivity, biodiversity and fish catch were observed in seasonally open Samaguri wetland than in closed Sibasthan-Potakolong wetland, highlighting importance of river connectivity on wetland fisheries.
- Bishnupur wetland of West Bengal, receiving municipal sewage, has less indigenous fish diversity and richness and also suffered from fish mortality due to *Aeromonas* infection.
- Patratu, Derjang, Harangi, Mettur, Krishnagiri, Mangalam and Jargo reservoirs have rich fish species diversity with dominance of IMC in Jargo, Derjang and Patratu reservoirs, small indigenous fish *Amblypharyngodon mola* in Harangi, *Puntius vittatus* in Krishnagiri and *Pethia conchonius* in Mettur reservoir.

- Fish production (kg/ha/yr) in Patratu, Derjang, Mangalam and Jargo reservoirs were 147, 200, 54, and 51.3 respectively and below their production potentials. Scientific stocking has enhanced fish production (kg/ha/yr) from 1.1 in 2004-05 to 43.46 in 2017-18 in Indirasagar and from 12.1 in 2004-05 to 80.8 in 2013-14 in Gandhisagar reservoir.
- A cost effective protein-rich fish feed has been prepared incorporating pre-pupae of Black soldier fly (BSF). The BSF pupae meal can replace up to 70% of fish meal in diet without hampering fish growth and survival.
- *Labeo bata* at stocking density of 50 nos./m³ yielded optimum growth in cages. The species grew well when cultured with *Ompok bimaculatus* indicating feasibility of polyculture. Polyculture of herbivorous fish *Barbonymus gonionotus* with catfish *Pangasianodon hypophthalmus* resulted in higher fish yield, reduced periphyton growth and biofouling of cages.
- Freshwater sponge *Spongilla lacustris* has been identified as a biofouling agent in cages in reservoirs.
- Water availability in upper stretch of the River Godavari, from Nasik to Ramagundam, was limited. This, along with effluent discharge, had severely compromised river continuity and ecosystem health. The river health moderately improved in Telegana and Andhra Pradesh stretch, and the lower estuarine zone was the most productive.
- Heavy metal contamination was non-alarming in water and fish of River Godavari. Organochlorine, organophosphate and synthetic pyrethroid pesticide residues were detected in some of the water and fish samples of River Godavari and River Torsa. The detected residue levels in fish were below the tolerance limit set by FSSAI.
- Severe restriction in water discharge has limited the River Kathajodi to pockets and deep pools during lean period. Effluent discharge from Cuttack city has further deteriorated the river health.
- Arsenic level in ponds and floodplain wetlands in the arsenic affected villages of Nadia district, West Bengal exceeded the permissible limit for human (10 ppb) and aquatic life (5 ppb). Arsenic contamination in different concentrations was detected in different biotic matrices also.
- Curcumin enhanced survival rate, restored fatty acids levels and expression of lens crystalline genes, TLR-4, IL 1 β and IL-10 altered by arsenic exposure in fish.
- Bacterial and parasitic diseases were common in inland open water fisheries. Pathogenic *Acinetobacter* sp., *Aeromonas* sp., *Edwarsiella* sp. have been isolated from diseased fish from wetlands and cage culture.
- One Step Tilapia Lake Virus detection kit has been developed.

- ORF encoded functional genes of Tilapia Lake Virus has been characterized. A novel *E. tarda* transcriptome sequence data has been generated which will allow identifying biologically significant genes for therapeutic targets.
- Through metagenomic applications, 142 antibiotic resistant genes were identified from sediments of the river Yamuna, mangrove and non-mangrove soil of Sunderbans.
- Essential oils of plant origin exhibited dose dependant antibacterial activity showing their potential. Polysaccharides of plant source also showed immunostimulation and fish growth promotion properties.
- Meso- and micro-plastic contents in sediment of the River Ganga at seven sites were estimated for their risk assessment.
- Two spatial databases were generated with data comprising (a) water quality, site characteristics, species richness of fish, phytoplankton, zooplankton, and benthos of Himalayan river system, and (b) fish species richness, geo-physical parameters of Arunachal river network system.
- A model-based approach has identified temperature, specific conductivity, nitrate and dissolved oxygen as key determinants of abundance of *Chanda nama* in Krishna River.
- In reservoirs of Jharkhand monthly income (Rs. 11,093 - 17,548) was higher for fishers/fish farmers practicing cage culture which contributed 30% of their livelihood.
- Stocking of advanced fingerlings, produced by *in-situ* pen culture has increased wetland production from 492 kg/ha/yr in 2012-13 to 1011 kg/ha/yr during 2016-17. In Takmu Pat of Manipur there was a significant ($p<0.001$) difference in the monthly income before (Rs. 6183 ± 2711) and after (Rs. 9250 ± 3318) pen culture demonstrations.
- Impact assessment of training given to 3261 fishers/fish farmers from Bihar during 2012-13 to 2018-19 indicated higher average annual income from Rs. 17,000 to Rs. 36,000 of trainee fishers/fish farmers from fisheries. “Model Training Course” has been rated as 'excellent' by 50% of the trainee officers.
- Administration of the oxytetracycline and emamectin benzoate through feed was found to be safe in *Pangasianodon hypophthalmus* without significant clinical outcome. Further, withdrawal period of the oxytetracycline was determined to be 2 weeks in the catfish.
- Survey in aquaculture farms of Assam estimated that for one tonne of fish production an average of 6 kg lime, 4.63 kg potassium permanganate, 4.05 L CIFAX were used.

- To enhance wetland fish production in Bihar more than 16 tonnes of fish seed were stocked in Sirsa, Rulhi, Kararia and Majharia wetlands. Pens have been erected and stocked with fish seed. Nursery ponds have been excavated in Majharia and Kararia mauns. For income generation of fishers *Pangasianodon hypophthalmus* was stocked in cages in Sirsa wetland which gave a harvest of 2210 kg table size fish.

- With objective to reduce detrital load and restoration of carp fishery more than 12.85 lakhs wild bred fingerlings of IMC were ranched in the River Ganga.

- A Hilsa ranching station has been established at Farakka, West Bengal. A total of 151 Hilsa fish has been ranched in River Ganga above Farakka during December 2018 to March 2019.

- Climate resilient pen system with superior net-pen enclosure was demonstrated in selected floodplains wetlands of West-Bengal, Assam and Kerala. In Vembanad Lake black clam was stocked giving production of 2 tonnes benefitting 50 fishers.

- Surveillance study identified prevalence of Microsporidian *Enterocytozoon hepatopenaei* infection in 84.9% of cultured *Litopenaeus vennamei* in three districts of West Bengal.

- Metagenomic analysis of sediment samples from 10 sites of river Ganga and Yamuna identified a rich microbial diversity in these rivers. Proteobacteria were the most dominant bacterial flora, followed by Acnitobacteria, Firmicutes and Deinococcus–Thermus.

- To enhance reservoir fish production of Telangana state, cage culture has been initiated. Jayanti Rohu and freshwater prawn showed best growth and can be used as potential candidates for cage culture in the state.

- Cent-percent of fishers of Takmu Pat, Manipur were in below poverty line with average annual income of Rs. 1.0 Lakh. Only 9.8% of fishers had savings, that too in non-formal entity.

- Investigation carried out in Teesta River estimated that a discharge of 15-19 cumec from Teesta - IV hydroelectric dam will fulfill the average depth requirement of 1.2 m and velocity of 1.2m/s in the stretch between dam and powerhouse during non-monsoon months.

- Tagging experiments were carried out to understand the efficacy of fish pass/ ladders in Teesta Low Dam - III and Teesta low Dam - IV. Overall recovery of tagged fishes was 6.25% within a month of tagging.

- In Gujarat part of Sardar Sarovar Reservoir, study sites were categorized either as mesotrophic or eutrophic.

- In Halali reservoir *O. niloticus* contribute >90% to the daily catch. Introduction of tilapia has steadily enhanced total landing but catch of commercially important indigenous species have been significantly reduced.

- Accidental leakage of fly ash during transportation through the waterways was observed to have little or no impact on fish fauna of river Hooghly.
- Complete mitochondrial genomic data of *Osteobrama belangeri* from Loktak Lake, Manipur indicated that the species is close to the cluster of *Systomus sarana*, *S. orphoides*, *Barbuse burneensis* and *Enteromius guirali* than other related Cypriniformes species.
- The Institute has created/implemented smart office and research management systems such as SmartDoor, Censor-based light for energy savings, Systematic file movement system, Online Pensioner Database, Fish Disease App and Reservoir Fisheries Database.
- The Institute organized 67 training programmes imparting training to 1752 fishers and fish farmers, 204 students and 181 officials during the year.

मुख्य उपलब्धियाँ

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- xxk unh l dy 190 eRL; çtkfr;k dk nt fd;k x;k g ftl e 7 fon'kh çtkfr;k 'kkfey gA budh to fofoèkrk lcl vfèkd fctukj] ujkjk] Qjôk vkj Ýtjxt e n[kh x;h gA

- o"k 2018 e bykgkckn dh xxk unh l eNyh dh idM 158-6 Vu vkdh x;h g ftl e lcl vfèkd fofoèk çtkfr;k dh eNfy;k 43 çfr'kr nt dh x;hA blds ckn fon'kh çtkfr;k 34 çfr'kr vkj Hkkjrh; etj dki çtkfr;k 9 çfr'kr n[kh xbA ;g n[kk x;k g fd fiNy o"k dh ryuk e vkSlru eNfy;k dh yfMx 11 çfr'kr de gÃ gA

- vle d lexfjFku e lhclFkku&ikVdkykx vkæ {k= e ty dh x.koÙkk cgrj n[kh x;h ftlld dkj.k blds ey mRikndrk] to fofoèkrk vkj eNyh dh idM e of) gÃ gA vè;;u e ;g n[kk x;k fd bl vkæ{k= dk l;ktu ufn;k l cgr vPNk g blfy, mRikndrk] to fofoèkrk vkfn mUur gÃ gA

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- irjkr] nkjtx] ghjxh] eÙkj] –".kkfxjh] exye vkj tkjxk tyk'k;k dh to fofoèkrk çpj vkj mÙke ik;h xÃ gA tkjxk] nkjtx vkj irjkr Hkkjrh; e[; dki çtkfr] ghjxh e NkVh nlh çtkfr] *,cyhQjEXkMku ekyk*] –".kkfxjh e iuVh;l fofVVl vkj eÙkj e *ifB;k dkudkfu;l* dh çpjrk vfèkd ik;h x;h gA

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eNfy;k dk fn, tku oky Hkkstu e çkVhu le) Cyd lkYtj ¶ykÃ ½fç&l;ik voLFkk½ dk fefJr fd;k x;kA bl Hkkstu dk vej dki çtkfr] *lkbfçul dkfiZ;k vkj ixl hvkukMku gkbikFkye l* dk fn;k x;kA ble ;g n[kk x;k g d bu çtkfr;k dk fodkl ryukRed :i l vfèkd vPNk gkrk gA bl Hkkstu dh ykxr eY; de gkrh g rFkk bll eNfy;k dk fodkl vkj vfr thfork Hkh vPNh gkrh gA

eNyh mRiknu vfèkd c<ku d fy, Çitjk e *ychvk ckVk* dk 50 eNyh çfr ox ehVj dh nj l lpf;r fd;k x;kA ,l lp;u ?kuRo oky Çitjk e *ychvk ckVk* dk fodkl mÙke n[kk x;kA *ychvk ckVk* vkj *vkeid chekdyVl* d ,d lkFk ikyu dju ij *ychvk ckVk* dk fodkl vfèkd n[kk x;k gA ijh{k.k e ;g n[kk x;k g fd *ckckuhe l xkfuvkukVl* d lkFk dVfQ'k *ixl hvkukMku gkbikFkye l* dk ikyu fd;k tk; rk Çitjk e ifjikni vfèkd ugÈ iuir g] Çitjk e ck;kQkÅÇyx ugÈ gk ikrh g vkj nkuk gh çtkfr;k dk fodkl vPNk gkrk gA

vyo.kh; ty Lik¥t çtkfr] *Likthykyk dkfLVl* d mifLFkfr d dkj.k Çitjk e ck;kQkÅÇyx gkrh gA

xknkojh unh d Åijh Hkkx] ukfld l jkeiune rd ty dh miyCèkrk lhfer ik;h x;h gA lkFk gh] bl ty {k= e dMk&ddV d çokfgr gku d dkj.k bld ty dh x.koÙkk ?kV x;h gA ij ryxkuk vkj vkèk çn'k dh ufn;k dh ifjfLFkfrdh mUur ik;h x;h g vkj fuEu Tokjune[k Hkkx dh mRikndrk vfèkd ik;h x;hA

xknkojh unh e d,ij dk NkMdj vU; Hkkjh èkkrvk dk teko bld ty] ryNV dh enk vkj eNfy;k e ik;k x;k g ij ;g [kk| lj{kk vkj ekud vfèkdj.k }kjk fuèkkfjr ekud vkj fu£n"V Lrj l cgr de gA bld ty vkj eNyh d ueuk e vkjxukQ,LQV vkj ÇlFkfVd ik;jFkk,M dhVuk'kdk d vo'k"k ik; x, gA

dkBtkMh unh e xh"e dky e ty dk çokg de gk tkrk g ftll ;g unh ,d ik[kj d leku utj vkrh gA lkFk gh] ble dVd 'kgj d ?kjy vof'k"Vk d çokfgr gku d dkj.k bld ty dh ikjfLFkfrdh dk cgr udlku igpk gA

if'pe cxky d ufn;k ftyk e fLFkr ik[kjk vkj vkæ{k=k e vklfud çn"k.k ik;k x;k gA lrgh ty e vklfud dh Loh—r ek=k 10 ihihch vkj tyh; thok d fy, 5 ihihch fu;r dh x;h gA bu ty{k=k d iknilyod] tUrlyod] ifjiknik] xLVki,M] eØkQkbV rFkk eNfy;k e vklfud dk teko nt fd;k x;k gA ;g teko lcl vfèkd *,y- dryk] ,y- jkfgrk] iVh;l lkQkj] flJghu l exyk* vkj *,y- ckVk* e n[kk x;kA

ddehu vFkkr çpfyr uke] gYnh d jkx mipkjkRed x.kk ij vè;;u fd;k x;kA ;g n[kk x;k fd bll eNyh dh vfr thfork c<rh g rFkk ;g vklfud lØfer eNfy;k d yl fØlVfy;k tÈl] TLR&4] IL 1ß and IL&10 d ,Dlç'ku dk cuk, j[krk gA

vrLFkyh; [kyk ty llkèkuk e thok.k vkj ijthoh lØe.k cgr gh lkekU; lh ckr gkrh gA bld fy, vkæ{k=k vkj Çitjk ikyu {k= dh lØfer eNfy;k e ljkxtud ijthoh] vlhuVkcDVj çtkfr] ,jkekuk l çtkfr] ,Mokjfl ,yk çtkfr dk vyx fd;k x;kA

lLFkku e fryfi;k yd okbjl dh igpku dju d fy, ^ou LVi fryfi;k yd okbjl fMVDlu fdV* dk fodflr fd;k x;k gA

fryfi;k yd okbjl ¼TiLV½ d vkvkj,Q Qd'kuy tÈl d ljpukRed fo'k"krk dh igpku dh x;h gA Ã- *VkjMk* dh ,d uÃ VkU lfØlVke lhDol MVk çkIr fd;k x;k g thlI eNfy;k e gku okyh chekfj;k vkj mipkj e egRoi.k tfod thu vkj mudh fØ;kRed lEcUèkk dh igpku dh tk ldxhA

lnjcu d exko vkj vU; Hkkxk rFkk ;euk unh d ryNV d 142 ,Vhck;kfVd çfrjkèkd thu dh igpku eVkthukfed ,lyhdlu }kjk dh x;h gA

ikèkk lfudky x, ryh; inkFk e thok.k lØe.k dk [kre dju dh {kerk gkrh gA eNfy;k d c<u d fy, ikèkk e ik; tku oky ikyhldjkbM cgr çHkkoh gkr gA bld fy, ijthoh vkxyl çtkfr vkj bld fujkèk çfrjkèkh] ,jkekuk l çtkfr d fy, uuk mRiknk dh to çHkkokRiknd rk dh tkp dh x;h gA

xxk unh d lkr LFkyk d ryNV enk e mifLFkr NkV vkj l{e lykfLVd d vof'k"Vk dk vkdyu bul gku oky [krjuk d çHkkok d fy; fd;k x;k gA

lLFkku u nk LFkku fo'k"k vkdMk dk"k cuk;k g – ¼1½ fgeky;h unhr= dh ty x.koÙkk] LFky fo'k"krk] eRL; çtkfr;k dh çpjrk] ikni lyod] tUr lyod vkj cFkkl(¼2½ v#.kkpy unhr= dh eRL; çtkfr;k dh çpjrk vkj bldh Hkkxkfyd& Hkkfrd çkpyrkA ; vkdMk dk"k 'kkèkdÙkkvk vkj ;ktudkjk d fy, cgr gh mi;kxh lkfcr gkxA

–".kk unh e NkVh nlh çtkfr] *pnk ukek* dh çpjrk dk irk yxku d fy, ,d e,My ,çkp dk ç;kx fd;k x;k g ftlls pkj ekunM dh igpku dh x;h – rkieku] fof'k"V pkydrk] ukbVV vkj ?kfyr v,DlhtuA

>kj[kM d pkj tyk'k;k e ?kj e eNyh ikyu l eNvkjk d lkekftd&vkfFkd thou vkj mudh vkthfodk ij çHkkok dk vè;;u fd;k x;kA ;g n[kk x;k fd mudh ekfld vk; #- 11093 l #- 17548 gA ;g vk; Çitj e eNyh ikyu dju oky fdlkuk l ryukRed rkj ij vfèkd gA ;g jkf'k mud dy vk; dh 30 çfr'kr vkdh x;h gA

vkæ{k=k e cMh eNfy;k dk lp;u rFkk ?kj e ikyu }kjk mud ey LFkku ij mRiknu l eRL; mitu e cgr of) n[kh x;h gA bu ty llkèkuk dk vkSlr mRiknu 492 fdyxke çfr gDV;j çfr o"k ¼2012&13½ l c<dj 1011 fdyxke çfr gDV;j çfr o"k ¼2016&17½ gk x;kA ef.kij d rkde ikV e ?kj e eNyh ikyu dju l eNvkjk dk vfrfjä vk; mitu Hkh gvk gA

o"k 2012&13 l 2018&19 d chp fcgkj d 3261 eRL; ikydk@eNvkjk dk vrLFkyh; ekfRL;dh çcèku ij çf'k{k.k fn;k x;kA bl çf'k{k.k l bu eNvkjk d e[; 0;olk;] vfèk–r Hkfe] lxBuk dh lnL;rk ij ldkjkRed vkj egRoi.k çHkko iMk g ¼lpdkd – 87-86 çfr'kr½A budh vklr vk; #- 17000 l c< dj #- 36000 gk x;k gA vfèkdkfj;k dk nh x;h ,d e,My çf'k{k.k ikBîØe dk eY;kdu fd;k x;k tk ;g crkrk g fd 50 çfr'kr çf'k{k.kkFkÊvk d vulkj çf'k{k.k dk;Øe ^mR–"B* FkkA *ix lhvkukMku gkbiklFkkyel* dh lof) d fy, budk ,Vhck;kfVd] v,DlhVVklkbdfyu dk bud Hkk tu e feyk dj fn;k x;kA ij blds vfèkd ek=k ¼fu;r ek=k dk 10 xuk½ eNfy;k d ;—r vkj xnk dk udlku igpk ldrh gA blds fu;r ek=k bl çtkfr d fy, ljf{kr gA dVfQ'k çtkfr;k dk ;g 2 lIrkg rd fn;k tk ldrk gA

vle d 132 ty—f"k Qkek e fd, x, lo{k.k ;g crkr g fd bu Qkek e fjikV vofèk d nkjku vkIru çfr Vu eNyh mRiknu d fy, 6 fdykxke puk] 4-63 fdykxke ikVkf'k;e ijexuV rFkk 4-05 ,y fIQkDl dk ç;kx fd;k x;kA

fcgkj d vkæHkfe e eNfy;k dh mRiknu of) dju d fy, bld fofHkUu euk tl fljlk] #ygh] djfj;k vkj e>fj;k e 16 Vu eRL; chtk dk lp;u fd;k x;kA bu euk e eNyh ikyu d fy, iu yxk, x, gA e>fj;k vkj djfj;k euk e uljh rykck dh [knkÃ dh x;h g rFkk bue eRL; chtk dk lpf;r dj mUg cM vkæ{k=k e Mkyk x;kA fljlk eu e *ix lhvkukMku gkbiklFkkyel* d lp;u l 2210 fdykxke eRL; mi t çkIr gÃ gA

xxk unh e vijn teko dk de dju d fy, okbYM eRL; çtkfr;k dk loèku d }kjk çokfgr fd;k x;kA bld fy, xxk unh d lxg dh x;h 0;Ld uj eNfy;k dk fudVorÊ ik[kj e cMk fd;k x;kA bl çdkj l o"k 2018&19 e Hkkjrh; e[; dki dh yxHkx 12-85 yk[k uljh ikfyr vxfydkvk dk xxk unh e çokfgr fd;k x;k gA

if'pe cxky d Qjôk cjkt e ,d loèku LV'ku dk LFkkfir fd;k x;k g ftll cgeY; çtkfr] fgylk eNyh dk mRiknu c<k;k tk ldA bl fn'kk e fnlcj 2018 l ekp 2019 rd 151 fgylk eNfy;k dk xxk unh e çokfgr fd;k x;k g vkj fgylk lj{k.k d fy, tu tkx:drk dk;Øe Hkh vk;kftr fd, x, gA

tyok; ifjoru d gkfudkjd çHkkok l fucVu d fy, if'pe cxky] vle vkj djy d dN vkæ{k=k e ?kj e eNyh ikyu vkjHk fd;k x;k gA djy d ocukn >hy e dkyh lhih (Cykd Dyke) dk lpf;r fd;kxÃ g] ftll 2 Vu mRiknu gvk g vkj 50 eNvkj ykHkkfUor g; gA

if'pe cxky d rhu ftyk d ty llkèkuk e ikfyr *yhVkihfu;l ouke<Ã* e ekbØkikjhfM;u ,VjklkÃVk tu gikVkihuh lØe.k 84-9 çfr'kr nt fd;k x;k gA

xxk vkj ;euk ufn;k d 10 LFkyk l çkIr ryNV dh enk d ueuk dk eVk thukfed vFkkr mRifÙk fo"k;d fo'y"k.k fd;k x;k gA ifj.kke ;g fn[kkr g fd bu ufn;k e l{e thok dh fofoèkrk çpj gA iknik e 0;kIr thok.kvk e lcl vfèkd çkVhvkcdVhfj;k ik; x,A bld ckn ,fDVuk cdVhfj;k] QeÊdVl vkj Mhukdkdl&Fke l n[k x,A

ryxkuk jkT; d tyk'k;k e eNyh mRiknu d fy, Çitj e eNyh ikyu vkjHk fd;k x;k gA ikfyr eRL; çtkfr;k e t;rh jkg vkj ehBk ty >Ãxk dk fodkl lcl mÙke n[kk x;kA bl jkT; e Çitj e eNyh ikyu d fy, bUg lcl vfèkd mi;ä tyh; thoekuk x;k gA

ef.kij d rkde ikV ij fuHkj vfèkdrj eNvkjk dh vkl vk; 1-0 yk[k çfr o"k vkdh xÃ g rFkk budk vkÊFkd Lrj xjhch j[kk l uhp gA doy 9-8 çfr'kr eNvkjk d ikl FkkMh cgr cpr n[kh xb gA

- rhLrk unh e vè; ;u e ;g n[kk x;k g fd blds vklikl ty çokg 15&19 D;sed g tks rhLrk& ıv ty fo|qr ckèk ls çHkkfor gksrk gA eku lu jfgr eghuks e vkSlr xgjkÃ 1-2 ehVj g rFkk ty dk ox 1-2 ehVj çfr ldM gA

- rhLrk yks Me&ııı vkSj rhLrk yks Me&ıv e fQ'k ikl vkSj fQ'k yMj ds çHkko dk tkuus dh fy, VSªxx dh x;h gA Vx dh x;h eNfy;ks ,d eghus ds Hkhrj gh okil vkÃ vkSj budk çfr'kr 6-25 rd FkkA

- xtjkr ds ljnkj ljkoj tyk'k; e v/;;u LFkyks dk oxhdj.k fd;k x;k g & vYi VkfQd vkSj ik"kd rRoks ls i.k :i ls HkjkS gvkA

- gykyh tyk'k; e vk- ukbykfVdl dh fu;fer idM yxHkx 90 çfr'kr rd ik;h x;h gA bl tyk'k; e fryfi;k çtkfr;ks ds Mkyus ls eNfy;ks dh vkod e c<r gÃ g ij egRoi.k nlh çtkfr;k dh l[;k ?kV jgh gA

- eNfy;ks ds ,d txg ls nljh txg rd yk tkus ij ¶ykÃ ,'k dk vpkud fjlko gksus ls eNfy;k ij dkÃ çHkko ugÈ iMrk gA

- ef.kiqj ds yksdrd >hy e *v,fLV;kckek cykfxjh* ds ekbVkdkMfj;y thukfed vkdM ;g crkr g fd bl çtkfr dk thukfeDl *fLVkek ljkuk], l- vkQkÃM] ckjcl ckjfuufll* ds leku gkrk g tcfd bl dk le{k çtkfr lkbfçukQ,El lh bldh dkÃ lkE;rk ugÈ n[kh x;hA

- lLFkku us LekVZ v,fQl vkSj vuqlèkku çcèku ds d'ky vkSj lQy dk;kUo;u ds fy, dÃ lkjh lfoèkkvk dk lt fd;k g tl& LekVZ Mkj] Åtk cpr gr lkSj okyh cfÙk;k] lfu;kftr Qkby lpyu çfØ;k] v,uykbu iLrqr vkdMk dk'k] eRL; jkx lcèkh ,i vkSj tyk'k; ekfRL;dh vkdMk dk'kA

- fjiksVZ vofèk ds nkjku lLFkku e 67 çf'k{k.k dk;Øe vk;kftr g, g ftue 1752 eNvkjs vkSj eRL; ikyd] 204 Nk=@Nk=k, rFkk fofHkUu jkT;ks vkSj lxBuks ds 181 vfèkdkfj;ks us Hkkx fy;k gA

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

Introduction

History

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

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

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

Organizational Structure

To address the mandate, the Institute is organized in the following manner: the Headquarters of the Institute is located at Barrackpore, West Bengal;

the Regional Research Centers are located at Allahabad, Guwahati, Bangalore and Vadodara, with Research stations at Kochi and Kolkata. In XI Plan, the research set up of the Institute has been re-structured in to three Research Divisions, viz.,

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

Besides these, Socio-economic research, Extension and Training activities are carried out through the 'Agricultural Economics Section' and 'Extension and Training Cell', respectively. The research activities under each of these divisions are led by Heads of Divisions appointed by ICAR. While the Regional Centers at Allahabad and Guwahati are administered by Heads of Regional Centers appointed by ICAR, other research centres are administered by Officers-in-Charges. The Institute has cadre strength of 95 Scientists, 85 Technical Officers, 67 Administrative and 130 Supporting personnel.

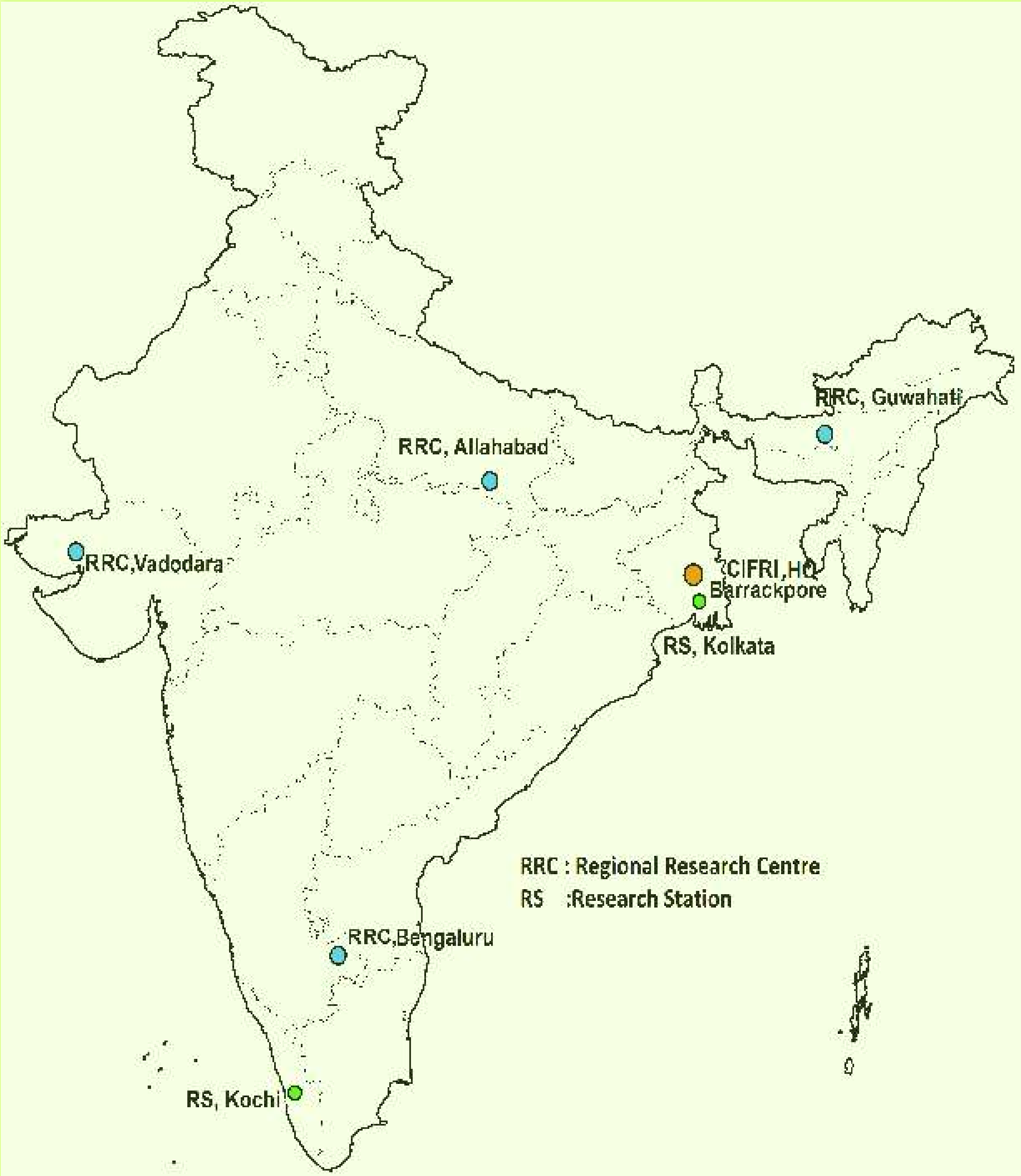
Head Quarter of the Institute has a number of support services, viz. Administration Section, Audit and Accounts Section, PME Cell, Hindi Cell, AKM Unit, Library and Informatics Section, Institute Technology Management Unit, Hindi Cell, Stores Section, Vehicle Section, and Nodal Officers for MGMG programme,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

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

Organogram of ICAR-CIFRI

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

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



Budget Details

Budget Details for the Year 2018-19 : (` in lakh)

Head of Account	Budget (RE)	Expenditure
	Institute	Institute
Pay and Allowance including OTA *	8339.88	8339.88
TA	95.00	95.00
Other Charges including Equipment, Library Books, IT and HRD	1078.33	1078.33
Works	278.39	278.39
Grand Total	**9791.60**	**9791.59**

*includes Pension also

The Budget & Expenditure for the Financial Year 2018-19 (` in lakh)

Budget Head	Institute	
	Budget	Expenditure
Revenue		
Estt. Charges	3089.77	3089.77
OTA	0.11	0.11
TA	95.00	95.00
Other Charges	612.68	612.67
Office Buildings	142.78	142.78
Residential Buildings	11.28	11.28
Minor Works	3.85	3.85
Misc expenses including HRD	12.57	12.57
TSP general	25.65	25.65
NEH General	22.00	22.00
Capital		
Equipment*	87.75	87.75
Information Technology	17.47	17.47
Library Books	4.93	4.93
Vessel/Vehicles	5.79	5.79
Furniture & Fixture	20.78	20.78
Works	272.23	272.23
Minor Works	6.16	6.16
TSP Capital	12.00	12.00
NEH Capital	2.00	2.00
SCSP Capital	19.96	19.96
SCSP General	76.84	76.84
Total	**4541.60**	**4541.59**
Pension	5250.00	5250.00
Total	**9791.60**	**9791.59**
Loans & Advances	36.00	36.00

*Plan Equipment includes 'Other Equipment' of 9.23 lakh

Contd......

Other projects (` in lakh)

Budget Head	Budget		Expenditure	Refund
	Receipts (including opening balance)			
NICRA	63.20	63.20	60.30	-
CABIN	18.00	18.00	17.64	-
NASF	-	-	-	-
ITMU	10.00	9.84	9.78	-
SIF-EXMU	0	0	0	0
Fish Health	17.00	13.21	13.00	0.21
Deposit Schemes (Externally Funded)	0	582.43	398.20	-
Consultancies	0	243.28	86.33	-

Revenue Receipts (2018-19) (` in lakh)

Head	ICAR	Institute	Target	Achievement
Income from Sales / Services	14.50	59.95	14.50	14.50
Fee / Subscription	0	0		
Income from Royalty, Publication etc.	0	0		
Other Income	4.04			
STD Interest	60.89			
Sale of Assets	0.08			
Recoveries on Loans and Advances	9.14			
CPWD / Grants Refund	1.99			

Certificate of Registration

This certificate has been awarded to

ICAR- Central Inland Fisheries Research Institute

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

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

ISO 9001:2015

The scope of activities covered by this certificate is defined below

Basic and Strategic Research in Inland Open Water Fisheries

Certificate Number:	Date of Issue: (Original)	Date of Issue:
96370/A/0001/NB/En	30 May 2018	30 May 2018
Issue No:	Expiry Date:	
1	29 May 2021	

Issued by: *On behalf of the Schemes Manager*

NABCB

QM016

Page 1 of 1

Riverine Ecology and Fisheries

Project Title	:	**Habitat characterization, fisheries and socioeconomics of rivers cauvery, Tapti, Siang and Chaliyar**
Project Code	:	**REF/17-20/07**
Project Personnel	:	V. R. Suresh, B. K. Bhattacharya, S. K. Das, Feroz Khan, R. K. Manna, C. M. Roshith, T. T. Paul, Deepa Sudeeshan, Kavita Kumari, Raju Baitha, D. Bhakta, Kamble Suhas Prakash, T. N. Chanu, W. Anand Meetei, Sibina Mol, S., Vaishak, G., Ajoy Saha, Satish K. Kouhlesh, Simanku Borah, N. Samarendra Singh, Shravan K. Sharma,Pranab Gogoi, S. K. Sahu, Aparna Roy,Chayna Jana and Lohith Kumar
Associates	:	R. C. Mandi, C. N. Mukherjee, A. Sengupta, D. Saha, A. R. Chowdhury, S. Mandal, K. K. Sharma, A. Kakati, M. E. Vijaykumar, S. Manoharan. U. Unnithan, R. K. Sah and J. K. Solanki

Fig. 1 Rapid habitat along river Cauvery during monsoon below Mettur dam

River Cauvery

The upper stretch of the river (Bhagamandala to Kudige) represents typical hill stream habitats with narrow channel (9.5 to 55 m width), high canopy cover on stream (>60%), medium thalweg depth, high riparian vegetation (>80%) and greater flow velocity. The river channel in middle stretch (Bhavani and Mayannur) has an average width of 315 m and average thalweg depth of 4.5 m. The lower estuarine stretch of Cauvery at Kollidam, Poompuhar and Pazhaiyar represented typical run habitats. Water depth was low (less than 2.0 m) at most of the sampling stations during non-monsoon months except at Valnur (deep pool), Hogenakkal (rocky gorge) and Mayannur (barrage).

High transparency (up to 3.2 m) and low turbidity (<2.0 NTU) were recorded at T. Narasipura and Shivanasamudram during non-monsoon months, which may be attributed to the dense infestation of submerged macrophytes.

Lower water pH at Bhavani as compared to other stations indicated polluted environment. Higher pH at Shivanasamudram and Hogenakkal during post-monsoon due to higher photosynthesis of dense submerged macrophyte infestation in this stretch. At Mayannur, higher pH was observed in pre-monsoon due to the photosynthetic activity of the dense phytoplankton assemblages that thrive in lentic conditions above the barrage.

Very low dissolved oxygen (2.59 mg/L) and high biological oxygen demand (BOD) during pre-monsoon at Bhavani indicated impact of severe anthropogenic pollution load. Very high BOD (30 mg/L) was also recorded in the same stretch during post-monsoon. Hence, stretch of river Cauvery at Bhavani needs immediate attention especially during non-monsoon months.

The bottom soil was alkaline in most of the stations, except in the upper reaches at Bhagamandala and Valnur where it remained acidic. Higher soil organic carbon at T. Narasipura, as compared to neighbouring stations, may be due to high detritus load from

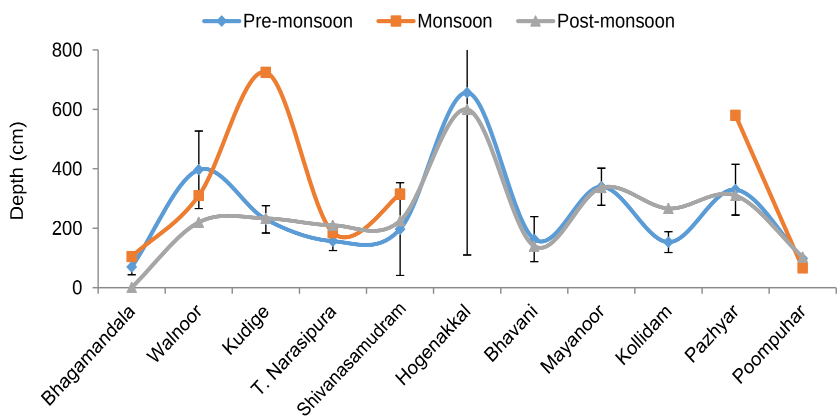


Fig. 2 Station-wise average water depth (cm) of river Cauvery

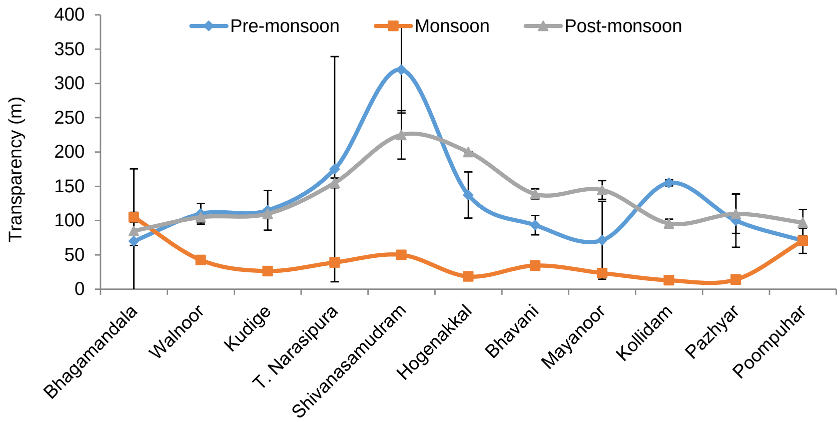


Fig. 3 Station-wise average transparency (cm) of river Cauvery

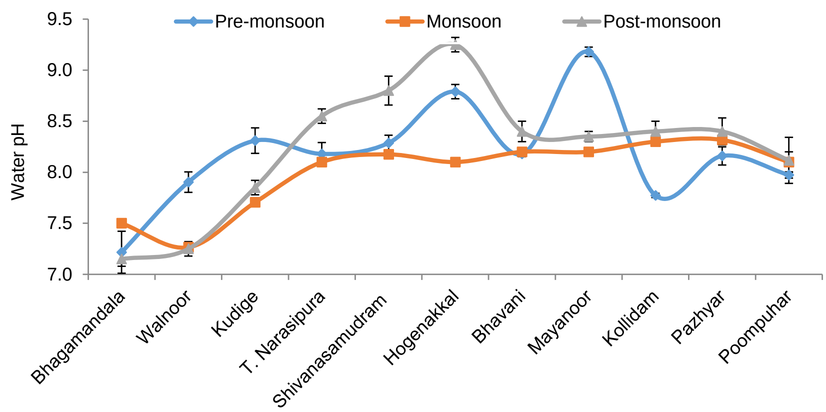


Fig. 4 Station-wise average water pH of river Cauvery

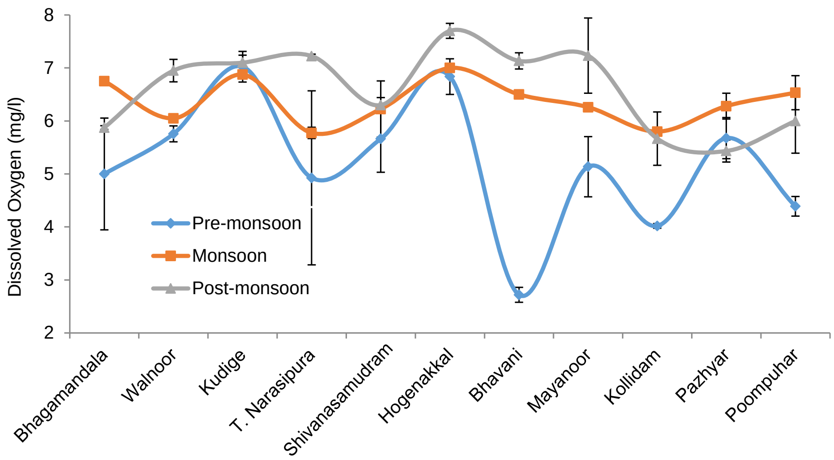


Fig. 5 Station-wise average dissolved oxygen (mg/l) in river Cauvery

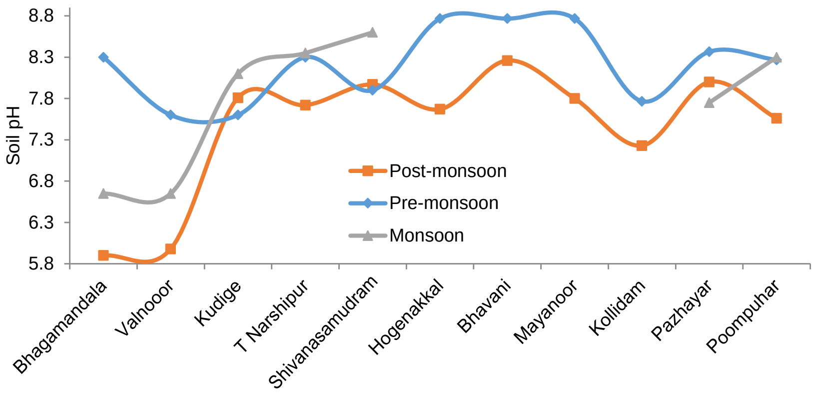


Fig. 6 Station-wise Soil pH of river Cauvery

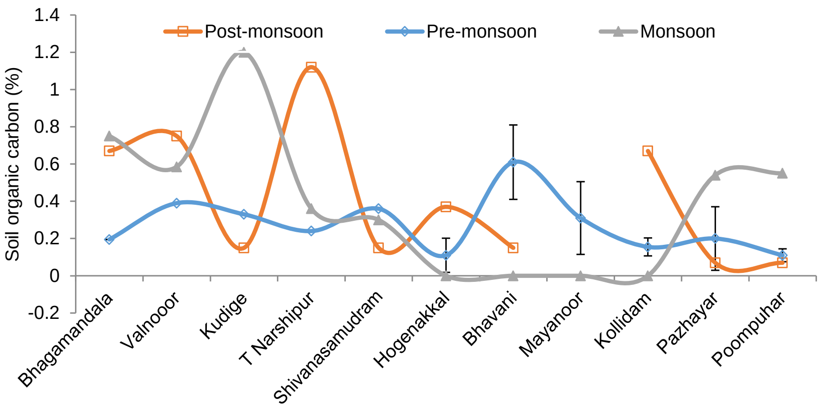


Fig. 7 Station-wise Soil organic carbon of river Cauvery

submerged macrophytes, whereas, higher soil organic carbon at Bhavani is an indication of severe anthropogenic sewage loading and lack of adequate flushing.

The total plankton density varied from 500-1273 units/l across the stations. 52 genera of phytoplankton were recorded. Phytoplankton density at various stations ranged from 360-1087 units/l. Canonical Correspondence Analysis (CCA) revealed that, transparency, nitrate and total phosphorus highly influenced the density of phytoplankton. Zooplankton community comprised of four groups, *viz*., Copepoda, Cladocera, Rotifera and Protozoa were recorded (127-213 nos./l) at different stations. Protozoans (34 %) dominated the zooplankton population, followed by Copepods (29 %).

A total of 55 species of macro-benthic fauna comprising of gastropods (16 species), bivalves (13 species), insects (9 species), Polychaetes (3 species), Oligochaetes (4 species) and crustaceans (10 species) were recorded during 2017-19. Viviparidae, a gastropod family, was most abundant (146.2 nos./m^2) in monsoon, while the clam family Corbiculidae dominated in pre-monsoon (104.3 no./m^2). Chironomidae (547.2 nos./m^2) was the most abundant group in post monsoon season. Larger soil grain size resulted in lower meio-benthic abundance at Bhagamandala and Valnur. The river at Kudige, T. Narasipura and Shivanasamudram were in better health as their ASPT (Average Score per Taxon) and

EPT (Ephemeroptera, Plecoptera and Trichoptera) scores were higher compared to those at Hogennekal, Bhavani and Mayannur. The low scores at Hogennekal, Bhavani and Mayannur might be due to decline in water and soil quality. The low scores at Valnur can be attributed to rocky and boulder dominated substratum where population of benthos are naturally low.

With the addition of 29 species to our fish diversity records from Cauvery in 2018-19, the overall documented fish fauna during the project comprises of 115 species belonging to 42 families. The highest diversity was observed at Pazhaiyar (42 species) which can be attributed to the habitat heterogeneity due to the moderately dense mangrove vegetation in the region that serves as nursery ground for the juveniles of marine fishes. Lowest diversity has been observed at Mayannur (13 species) as this site represented a highly stressed habitat in the middle stretch where the fisheries is totally dependent on the amount of water released from the Mettur Dam and series of small barrages downstream of Mettur. The average number of species recorded per station was also highest in the lower estuarine zone (36 species) due to the dominance of marine migrants.

The red cornet fish (*Fistularia petimba*) has been recorded from Cauvery estuarine mouth at Poompuhar. This is the first record of this species from Indian inland waters.

Gradual replacement of native fish fauna by the exotic fish species was evident in the middle stretch

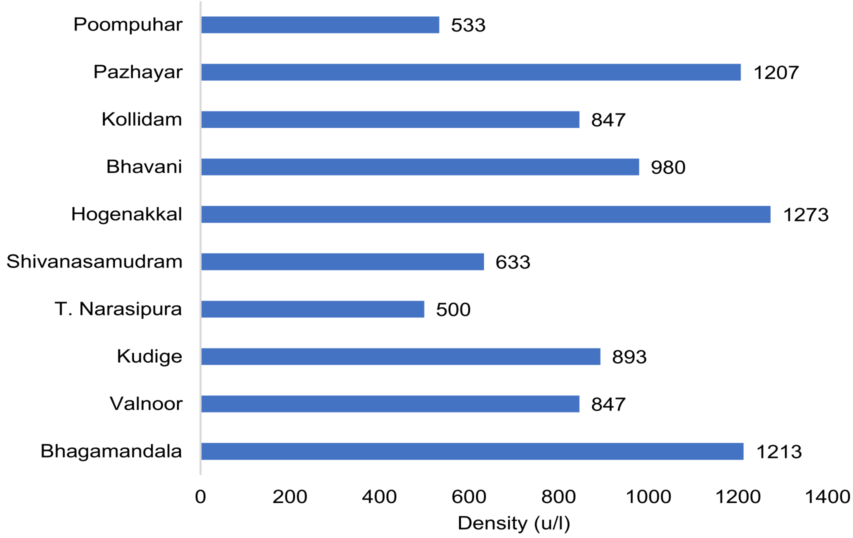


Fig. 8 Station-wise abundance of total plankton in river Cauvery

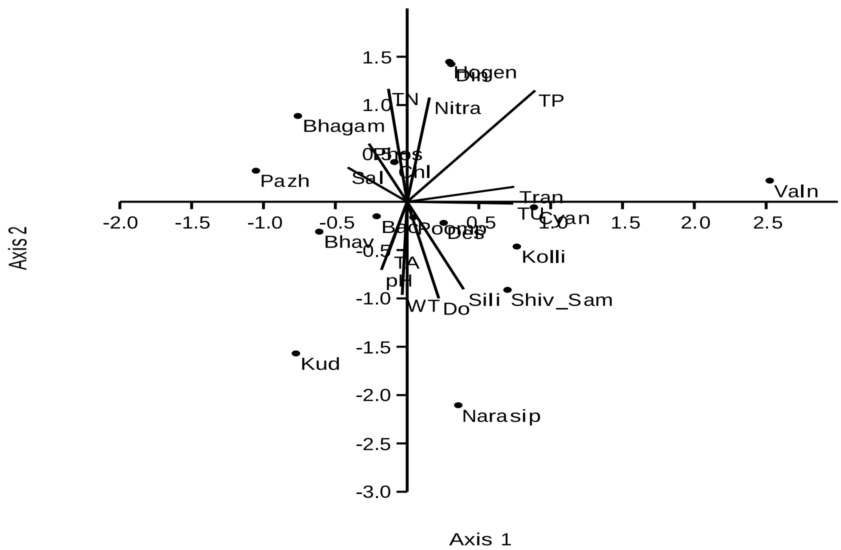


Fig. 9 The canonical correspondence analysis biplot: phytoplankton with water quality parameters in river Cauvery

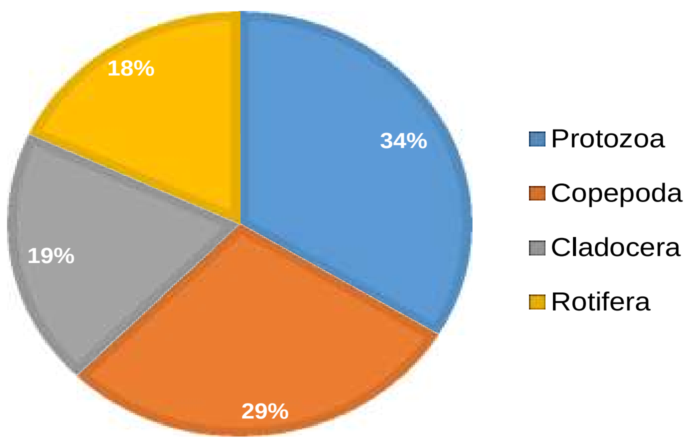


Fig. 10 Zooplankton composition in river Cauvery

Fig. 11 *Oreochromis mossambicus* catch from a deep pool at Mayannur

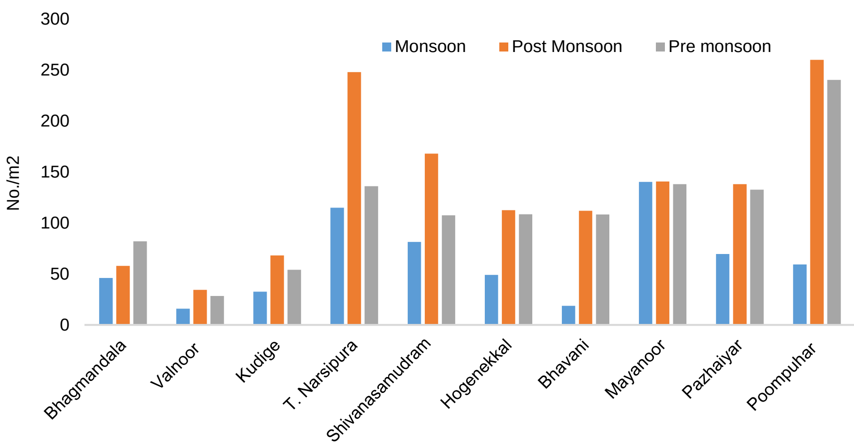


Fig. 12 Spatio-temporal variations in total abundance of macro benthic communities in river Cauvery

(Mayannur) where the landings were dominated by tilapia (*Oreochromis mossambicus*) which comprised about 92 % of total fish catch (in terms of weight). The South American sailfin catfish (*Pterygoplichthys disjunctivus*) was recorded in reasonably good numbers in the gill net catches (2.5 % of the gill net landings) at Mayannur. Observations on the fish landings at middle stretch of Cauvery (at Bhavani and Mayannur) revealed that the native fish fauna presently contributed to only 4 – 15 % of the total fish landings.

Fish catch data from Indian rivers are seriously lacking due to inherent difficulties in data collection and estimations. The methodologies available are not directly usable due to various constraints. Hence, attempts were made to customize the Stratified Multistage Random Sampling to estimate fish catch of a river.

River Cauvery has a length of 798km, of which 56% is actively fished (488 km). Considering the actively fished length of the river the catch was estimated to be 1.2-1.4 tonnes/km/year. The year-wise total catch from the river for 2017-18 and 2018-19. The average riverine fish landings at the various sampling sites ranged from lowest value of 70 kg/day at upper stretch (Kudige) to about 550 kg/day at the estuarine mouth region in Pazhaiyar. The fish yield was also reported to be higher in the estuarine mouth region at Pazhaiyar (60.2 kg/km/day).

A unique crab fishery (mainly represented by *Barytelphusa cunicularis*) exists at the upper reaches of the river at Kudige during pre-monsoon where traditional migratory fishers (migrate from other parts of Karnataka) capture the freshwater crabs (size 4.6-8.0 cm, weight 20-150 g) using monofilament gill nets.

Socio-economic survey of fishers along the river revealed an average monthly income, from riverine fisheries, of Rs. 10,500/month with average eight man months in fisheries, followed by three man months in animal husbandry and other works highlighting importance of river fisheries.

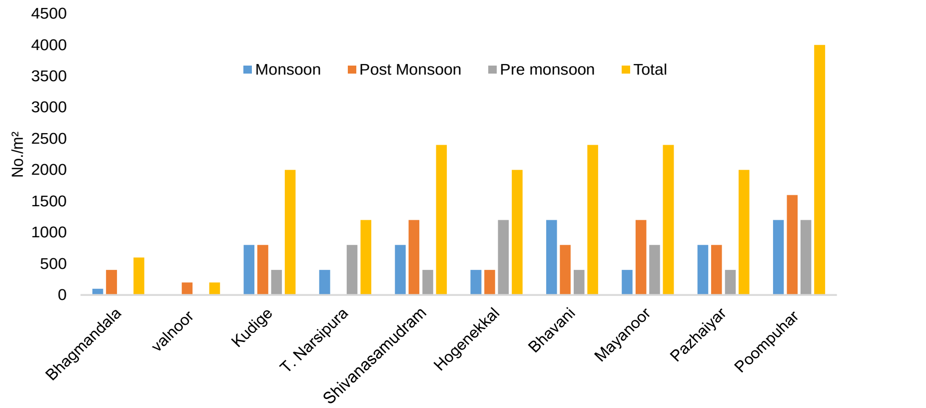


Fig. 13 Spatial and temporal variations in meiobenthos abundance in river Cauvery

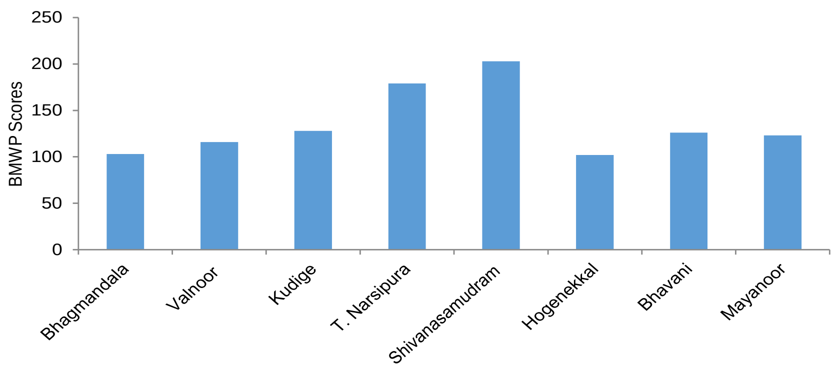


Fig. 14 Station-wise BMWP index Score along river Cauvery

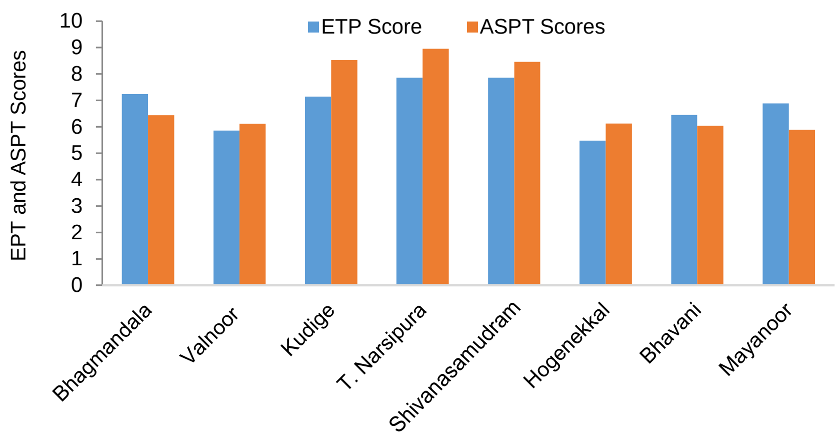


Fig. 15 Station-wise ASPT and EPT scores of river Cauvery

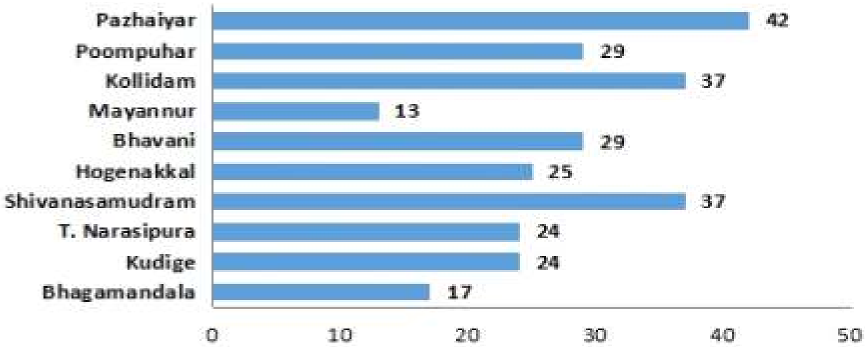


Fig. 16 Number of fish species recorded at selected stations along river Cauvery

Fig. 17 *Fistularia petimba,* a new record from Poompuhar, river Cauvery

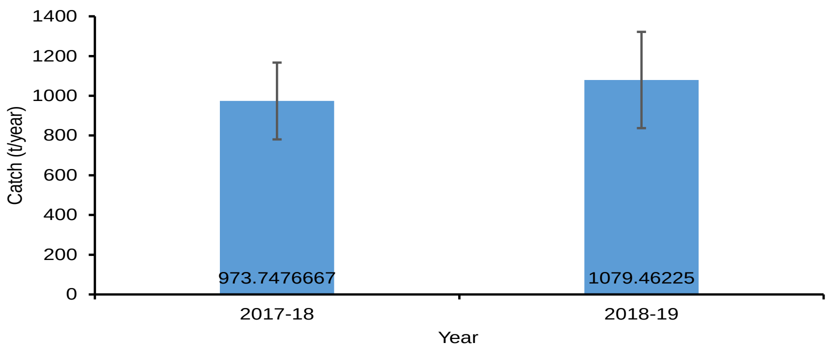


Fig. 18 Annual fish catch from river Cauvery (tonne/year)

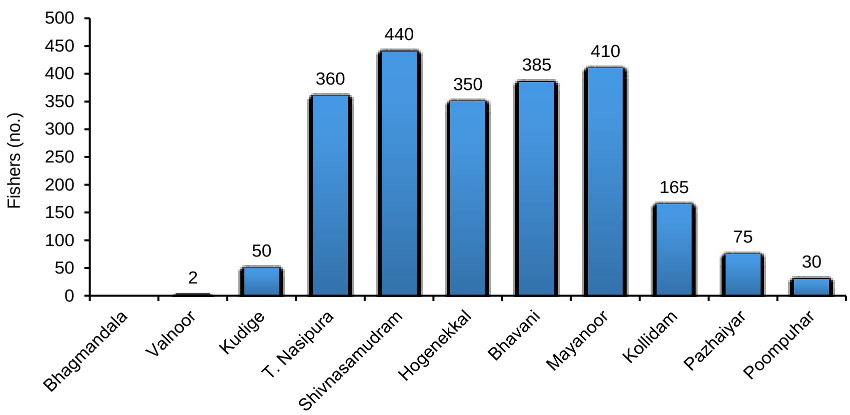


Fig. 19 Station-wise number of active fishers in river Cauvery

Tapti River

The macro-habitat structure, *viz*., pool, run/glide, rapid/riffle varied seasonally along all the stations of the river. The most dominant macro-habitat recorded along all the stations was pool, which comprised 100% of the instream macro-habitat in Betul, Dedtalai and in Burhanpur during pre-monsoon. Along the middle and lower stretches, the dominant habitat structure was pool (80 %) followed by glide (20 %). Multai was dry stretch, while at Changdev and Bhusawal 10 % of macro-habitat were run/glide. During monsoon, more than 80 % of observed wetted width were run type along Changdev, Burhanpur, Dedtalai, Sarangkheda, Singalkanch and Surat while pool and riffle formed entire macro-habitat composition at Multai stretch. In Betul, rapids formed 70-80 % of the observed macro-habitat, while pool comprised entirely at Betul and Dedtalai stretch during post-monsoon season. Glide constituted 10 to 15% of macro-habitat in Nepanagar and pool formed 85-90% of the macro-habitats. Pool (90%), followed by run (10%), formed the majority of habitat at Burhanpur and Changdev, while at

Fig. 20 Rapid habitat along river Tapti at Betul

Fig. 21 Pool habitat of river Tapti at Burhanpur

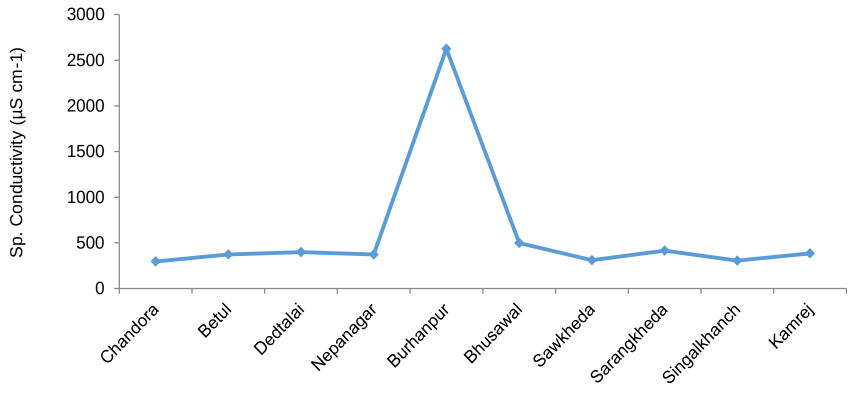


Fig. 22 Station-wise specific conductivity of water recorded during pre-monsoon along river Tapti

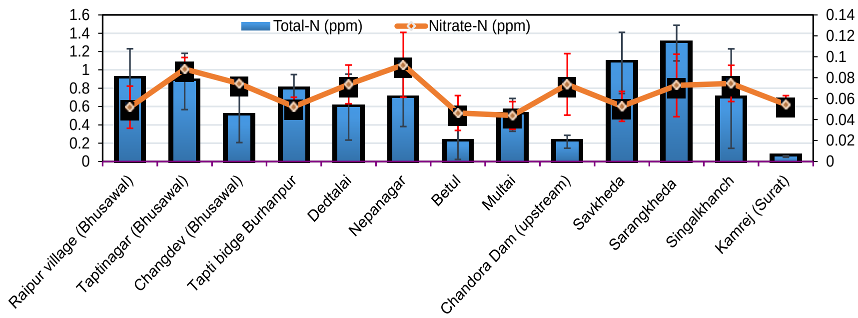


Fig. 23 Station-wise total nitrogen and nitrate content of water along selected stations of river Tapti

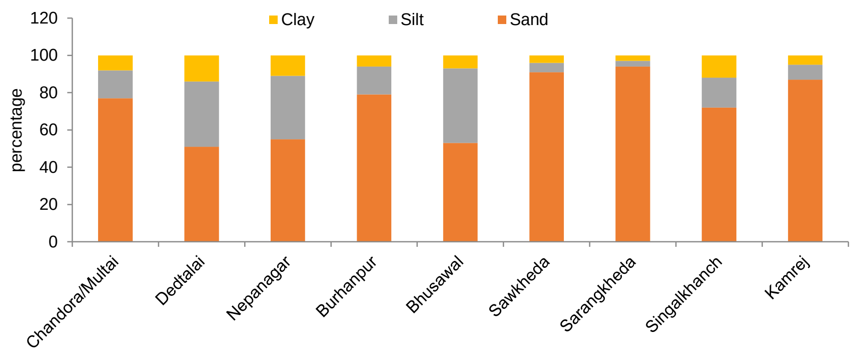


Fig. 24 Variations in sediment texture in selected stations of river Tapti

Bhusawal, dominance of pool (70%), followed by riffle (10%) and glide (10%) were recorded during post monsoon.

Most of the important water quality parameters were within congenial limit for supporting aquatic life. Prime limitation of this river was low flow rates during post and pre-monsoon seasons as the river channel gets fragmented into a series of deep pools. Burhanpur in middle stretch showed high total nitrogen (5.69±1.18 mg/L) and phosphorus (1.11±0.27 mg/L), sulphate (0.0208±0.0072 mg/L) and magnesium (92.55 ±3.40 mg/L), and also recorded much higher specific conductance (2625±35.36 µS cm^{-1}) as compared to other stations due to high organic load. Eutrophication was seen at this place affecting water quality. Primary Productivity (GPP) and Community Respiration (CR) were significantly higher (375 and 300 mg C/m^{-3}/h respectively) at Burhanpur due to increased nitrogen and especially phosphorus contents at that station.

Nitrate contents ranged between 0.4-0.5 mg/L, except at few stations, viz., Taptinagar, Changdev, Nepanagar, Chandora Dam where the values were low (~0.1 mg/L). Frequent human activities such as dropping of garlands into the river during religious rituals at Changdev might be a cause behind increased total N content in water. Total hardness at Nepanagar station was found exceptionally low (~80 mg/L), which was due to low Mg++ content in water. Overall, good primary productivity was obtained throughout the stretch (min NPP 10.4mg C/m^{-3} /h). High NPP values were estimated at Dedtalai and Betul (31.2 and 41.7 mg C/m^{-3}/h respectively) indicating productive ecosystems. Heavy metal contents of the river water were below detectable levels. The uppermost and lower middle-stretch riverbeds were sandy and thus accumulation of organic carbon were low to very low at those places. Sediment pH remained neutral to moderately alkaline (7.7-8.8) throughout the river. Specific Conductivity values were <1 mS/ cm; mostly in the range of 0.1-0.2 mS/cm, except at Burhanpur (0.9 mS/cm) due to higher pollution.

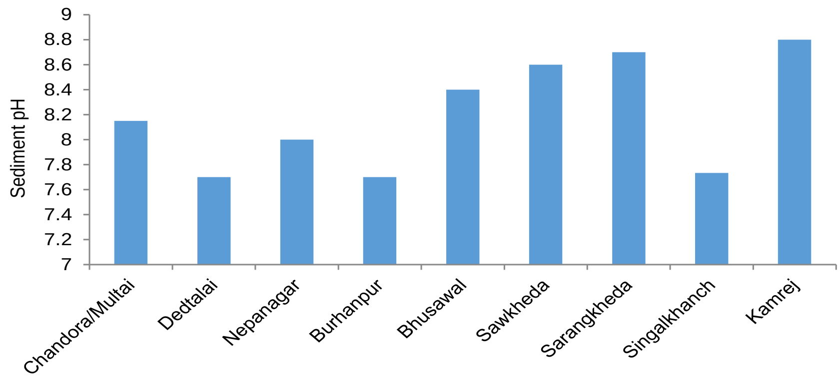


Fig. 25 Variations in sediment pH in selected stations of river Tapti

A total of 120 species of phytoplankton were recorded. Species diversity was higher (116 species) during lean period (pre-monsoon and post-monsoon) in comparison to monsoon (75 species), which may be due to low water velocity coupled with rich nutrients favouring growth of phytoplankton in this river during low water phase. Mean seasonal abundance peaked in post-monsoon (11.33 x 10^3 units/L) and lowest in monsoon season (5.89 x 10^3 units/L). Among zooplankton, crustacean naupli (27.19%) recorded highest dominance, followed by rotifers (27.14%) and cladocerans (14%). The quantitative abundance of zooplankton ranged from 71 to 3,533 nos./L.

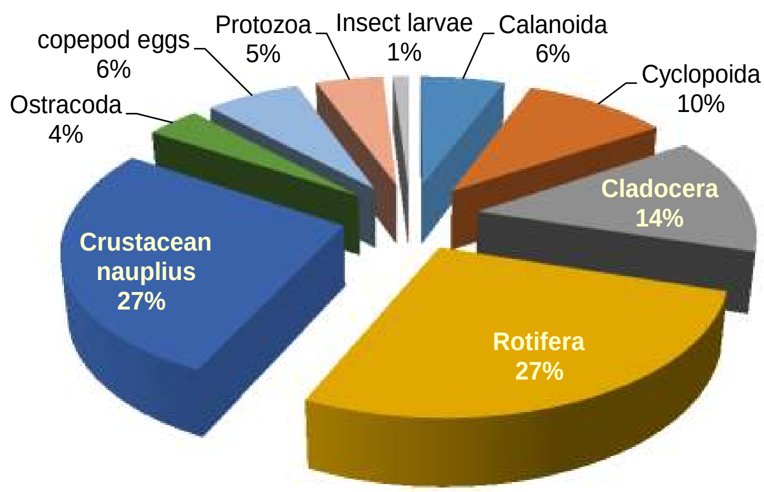


Fig. 26 Composition of zooplankton community in river Tapti

The benthic macro-invertebrate community in the river composed of 51 species from 5 classes with density ranging from 9 to 1320 nos./m^2. Qualitatively, the lower stretch of the river was richer than the upper and the middle stretch with 31, 24 and 17 species respectively. *Bellamya bengalensis* was the most abundant benthic macro-invertebrate species in the river with its occurrence in all stretches.

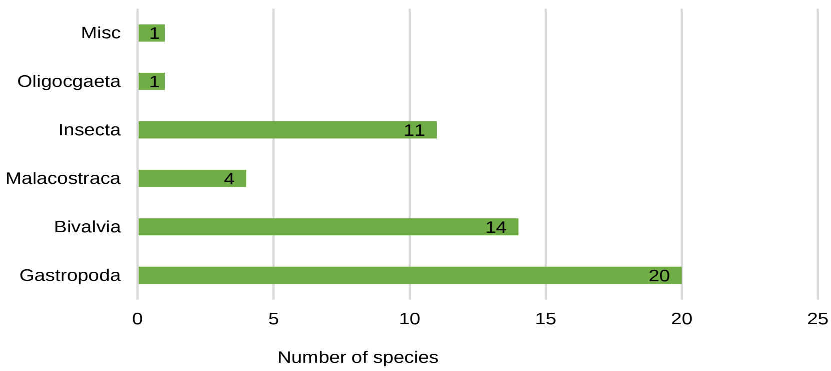


Fig. 27 Benthic macro-invertebrates recorded from river Tapti

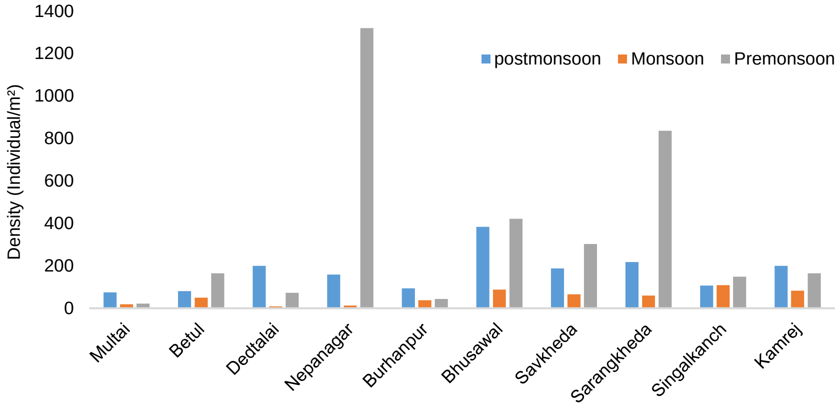


Fig. 28 Comparative density of benthic macro-invertebrates in different seasons in river Tapti

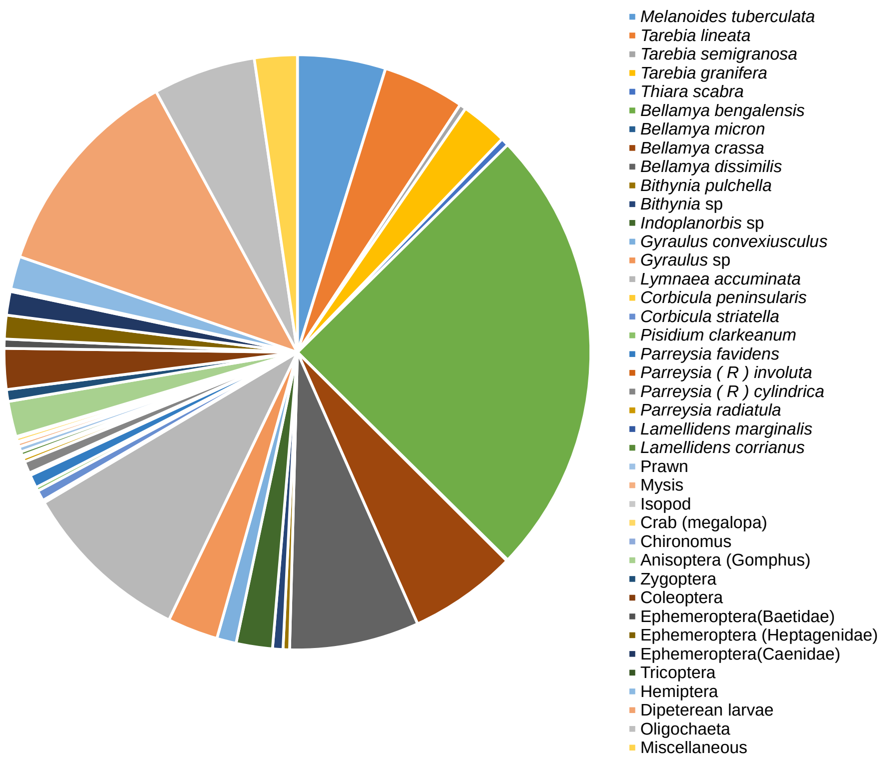


Fig. 29 Community structure of macro-benthos in river Tapti

A total of 78 fish species belonging to 18 families were recorded from the river. Among these, the highest diversity in term of species richness, was at Burhanpur (34 species), followed by Nepanagar (32) and Bhusawal (24 species). The lowest fish diversity was recorded at Multai (12) representing intermittent riverine stretch (IRs).

Tenualosa ilisha was recorded from Singalkanch station during monsoon season. Mature individuals were recorded from the station. The estuarine or marine migrant finfishes were totally absent in the downstream stretches of the river. Exotic fishes such as *Oreochromis niloticus, Cyprinus carpio, Pangasianodon hypophthalmus* and *Hypophthalmichthys molitrix* were also recorded. A major shift in the fish catch structure was recorded in the upper and middle stretch of the river as evident by the collapse of *bhekri* (*Clupisoma garua)* fishery and *khuret* (*Labeo fimbriatus*) fishery which were recorded as major fishery in river Tapti in past. Intensive studies during the past two years could not record any specimens from direct catch as well as fishermen interviews conducted at all stations during the period. The major portion of the fish catch along the stretch was formed by carps throughout the seasons. The exotic catfish, *Pangasionodon hypophthalmus* was recorded at Singalkanch station below the Ukai dam which may be due to cage culture operations in Ukai dam. Gill nets were the most dominant fishing gear along the river in all the seasons. Maximum gillnet catch (>80%) comes from night fishing during winter. *Systomus sarana* and *Cirrhinus reba* were mostly caught by 30 and 40 mm mesh gill nets (>57% and >20% of the total landings of *S. sarana* and *C. reba*). *Tor tor* is mostly caught by 40 and 60 mm mesh size respectively. The most individuals of *Channa marulius* were caught by 60 mm mesh size (60%) and rest 40% by 80 mm mesh size.

Shellfish such as *Macrobrachium tiwari was* most abundant (relative abundance of 36%) during monsoon, followed by *M. kistnense* (30%), *Caridina* sp. (19%) and *M. lamarrei* (15%). Prawn fishing was mostly carried out by women through seining and push nets with average CPUE of 0.48 kg/net/hour and 1.25 kg/net/hour respectively.

The fish catch was estimated for the river Tapti having a length of 724km; of this 75% is under active fishing (524km). Considering the active fished length of the river, the catch was estimated to be estimated to be 1 to 1.1 tonne/km/year and annual total catch for the river for 2017-18 and 2018-19. The lowest fish landing was at Multai (8.2 tonne/year) owing to the absence of wetted area for a major part of the year. The mean gill net CPUE was highest at Dedtalai (0.45 kg/fisher/hour) and lowest (0.25 kg/fisher/hour) at Nepanagar.

Parasitic infestation on fish of river Tapti was investigated and the status was low to moderate. *Puntius terio, Pethia conchonius* and *Parambassis ranga* were found infected with 'Blackspot', while *Wallago attu* and *Mystus cavasius* infested with 'diplostomiasis' caused by the parasite *Isoparorchis hypselobegri.* The cumulative prevalence (%) for

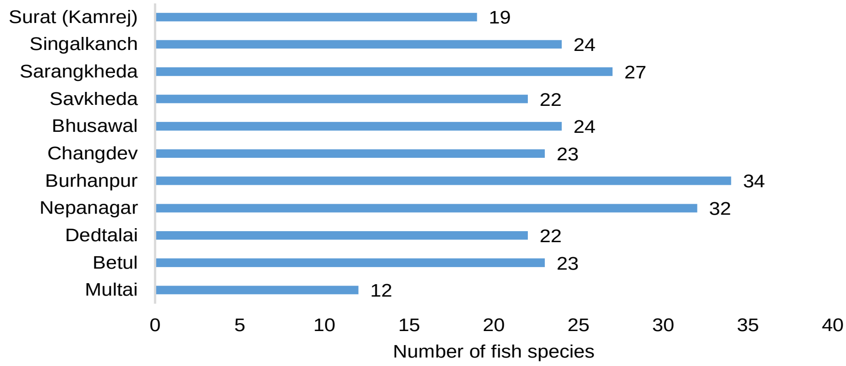


Fig. 30 Fish species richness recorded along selected stations in river Tapti

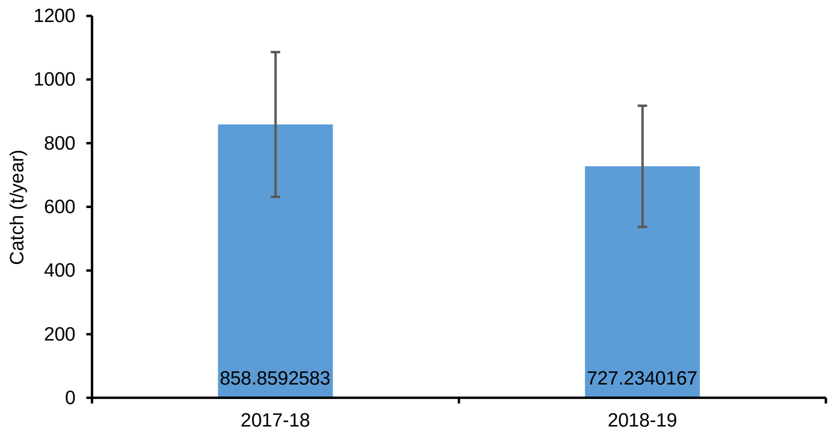


Fig. 31 Annual total fish catch for 2017-18 and 2018-19 from river Tapti

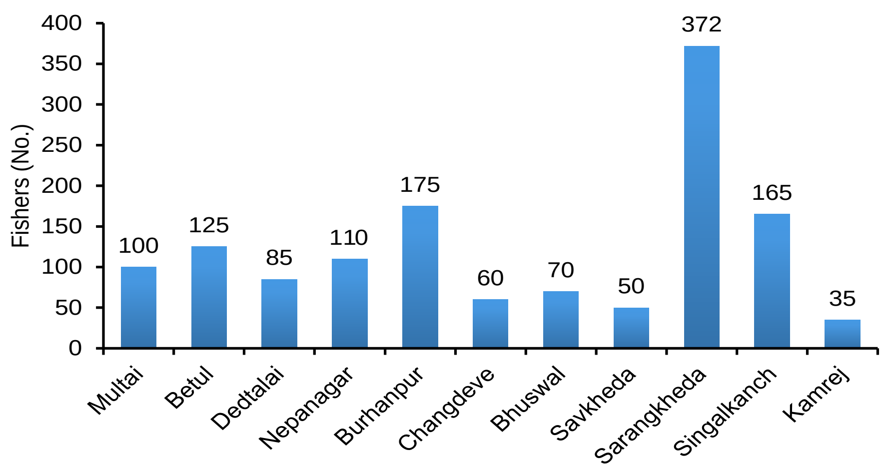


Fig. 32 Station-wise presence of active fishers along river Tapti.

Table 1. Ranking of problems as perceived fishers of river Tapti

Sl. No	Problems as perceived by the fishers	Total Number of Respondents	Total Score	Mean Score	Rank
1	Decline in fish catch and less availability types of fish species	100	9820	98.20	I
2	Erratic Rainfall	100	9362	93.62	II
3	Use of destructive fishing methods	100	8180	81.80	III
4	Siltation in Tapi river	100	5691	56.91	IV
5	Less access to market, less profit due to interference of the middle -man	100	2469	24.69	V
6	No subsidy, loan facility or other compensation from government side	100	1522	15.22	VI

Posthodiplostomum sp. was 0.72%, 0.88% and 0.44% in *P. ranga, Puntius terio* and *Pethia conchonius,* respectively. *I. hypselobegri* has cumulative prevalence of 0.26% and 0.93% in *W. attu* and *M. cavasius*, respectively. The recurrence of 'Blackspot' disease in *P. ranga* at Dedtalai was reported with seasonal prevalence of 0.25% (summer) and 2.53% (winter), respectively. Further, the same disease was recorded for first time from Changdev and Nepanagar stretch of the River during winter sampling.

The number of active fishers along the stations ranged from 35 to 372. Stations wise number of active fishers. 28 Fishers mostly are either landless (59%) or small and marginal farmers. Average income from riverine fisheries is Rs. 5,500/month with average 6.5 man months in riverine fishery 3.5 in agricultural labour and 2.5 in petty employment. Fishers' perception about the problems faced by them identified six major problems and were ranked with the help of Garretts Ranking Technique.

Siang River

The mean water depth recorded along the Siang river ranged from 1.8 to 22 m with dominance of run habitats (5-100%). Water temperature ranged from 10.88-22.63°C, with more fluctuations in post-monsoon. All water quality parameters are found to be in normal range except transparency. Comparatively lower values of transparency were observed during pre-monsoon.

The plankton population represented 61 species in 42 genera. Bacillariophyceae (diatoms) alone contributed 80% of the total phytoplankton,

Table 2. Water quality parameters recorded across six stations of river Siang

Water temp (°C)	19.6-22.63	10.88-18.30
Transparency (cm)	23-32	34-46
Sp. Conductivity (µS/cm)	198-322	274-455
pH	9.0-9.53	6.78-8.2
DO (ppm)	8.45-10.43	9.14-11.15
Free CO_2 (ppm)	0-5.4	0.8-4.0
Total Alkalinity (ppm)	38-68	48-70
Salinity (ppt)	0.06-0.14	0.09-0.14
ORP (mV)	96.2-185.6	106.6-182.1
TDS (mg/l)	130-277	179-295
Total Chlorophyll (mg/m ^{3})	56.61-168.8	55.68-223.1

Fig. 33 Riffle habitat along river Siang at Ying Kiong

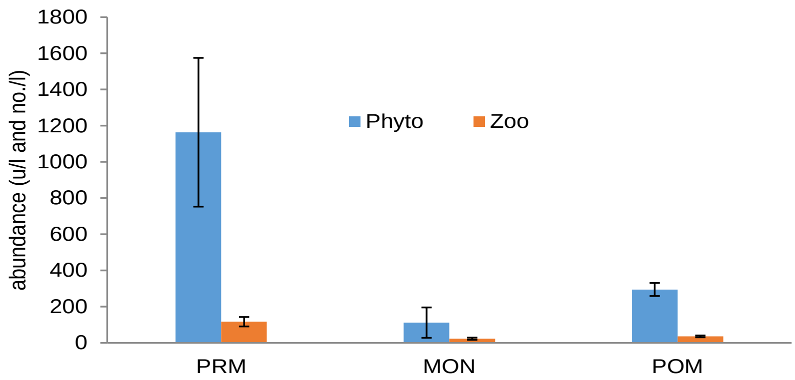


Fig. 34 Seasonal abundance of phytoplankton and zooplankton in river Siang

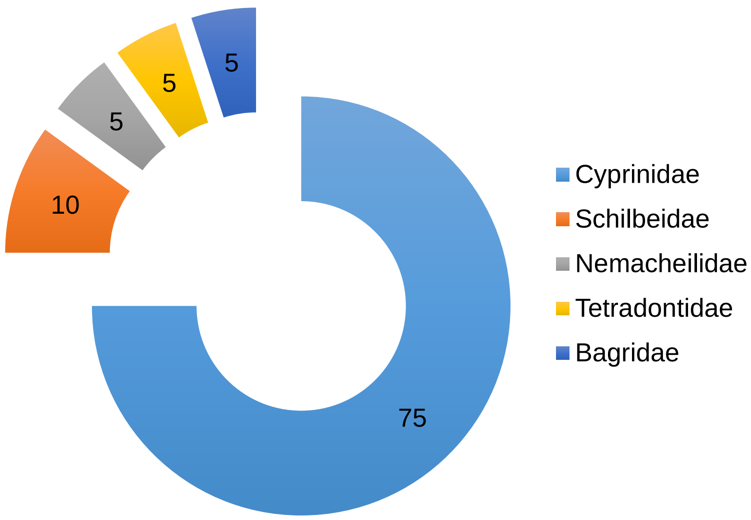


Fig. 35 Family-wise species composition in river Siang

especially in the pool habitats. Diatoms belonging to 32 species were recorded and was dominated by pennales. Their seasonal abundance was highest during pre-monsoon (3157±1949 units/l) and lowest in monsoon season (167±58 units/l). Zooplankton community was represented by copepod nauplius (54.32%), cladocera (24.69%), insect larvae (12.35%) and copepoda (8.64%). The quantitative abundance of zooplankton ranged between 15-354 nos./l. Lower density of plankton populations may be because of high velocity and highly turbid water of the river. Richness and Shannon diversity (H') > 1.75 indicated moderate phytoplankton diversity in the system.

Among macrobenthos, only *Bellamya bengalensis* (Gastropod) was recorded from Oiramghat. The heavy silt load in the river might have some negative impact on the benthos population of the river.

A total of 20 fish species under 5 families were recorded, which brings the total number of fish species recorded to 34 under 8 families in the river. Cyprinidae was the most dominant family contributing 75% of the total species recorded, followed by Schilbeidae (10%), Tetradontidae (5%), Nemacheilidae (5%) and Bagridae (5%). Highest number of species was recorded in Oiramghat (9 species), followed by in Boleng (8 species). *Cabdio morar* was the most dominant species.

Socio-economic survey conducted in river Siang found that almost 87% of the respondent population is dependent on Siang for their livelihood. The number of active fishers in the various stations ranged from 5 to 70. Main occupation of the sampled population is agriculture (66%), livestock farming (18%) followed by fishing from the river (16%). Average dependence of the populace on the riverine fisheries is 4.5 man months. Average income from river fisheries is Rs. 5500/month and Rs. 8000/month for migratory fishermen (*Sahani* Community from Bihar). There are social and cultural values/beliefs among the riparian population, such as white scaled fish like *Labeo gonius*, *Barilius* sp., etc. are considered as sign of good fortune by *Missing* Community, dry fish dish is must in the *Ligang* Festival of *Missing* tribes, fishes like *Clarias magur, Heteropneustes fossilis, Monopterus cuchia, Anguilla bengalensis are therapeutic.*

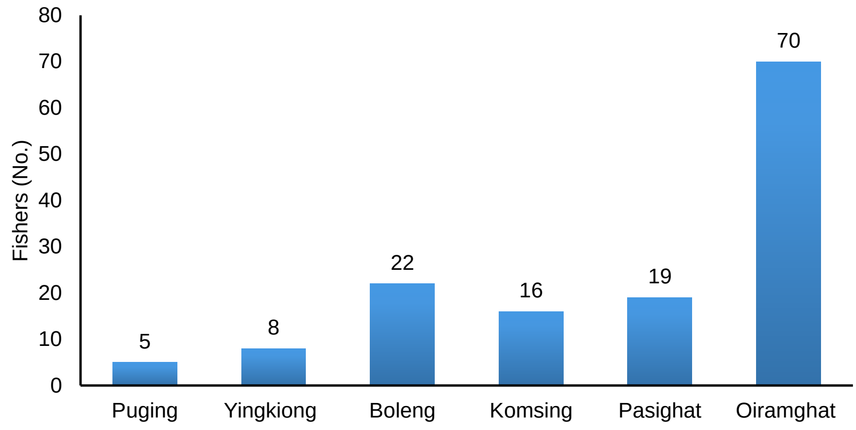


Fig. 36 Number of active fishers along the various stations in river Siang

River Chaliyar

The run habitat of River Chaliyar comprised more than 60% of wetted area in all stations except at Nilambur and Mambad. Riparian vegetation cover and canopy cover on stream were higher in Cholamala, Arapeta and Nilambur as compared to middle and lower stretches. In the lower stretches, the substratum was mainly sandy and gravel type.

Spatio-temporal variations of physicochemical parameters in the water and sediment quality of the river were recorded. The water pH varied from 7.1 to 8.9 in pre-monsoon, and 6.16 to 7.75 in post-monsoon and were within favourable limit for biota. Dissolved oxygen (DO) levels varied from 5.6 to 8.8 mg/l in pre-monsoon and 6.7 to 8.9 mg/l in post-monsoon period. Higher level of DO was observed during post-monsoon period, followed by pre-monsoon

Fig. 37 Sampling from a narrow channel at upper stretch of river Chaliyar

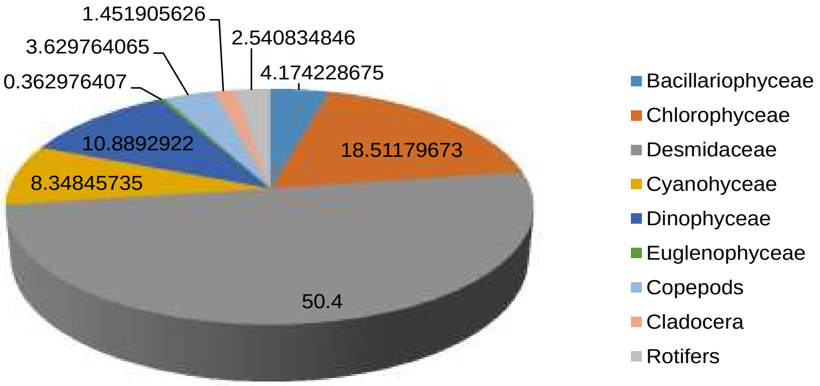


Fig. 38 Plankton groups in Chaliyar River

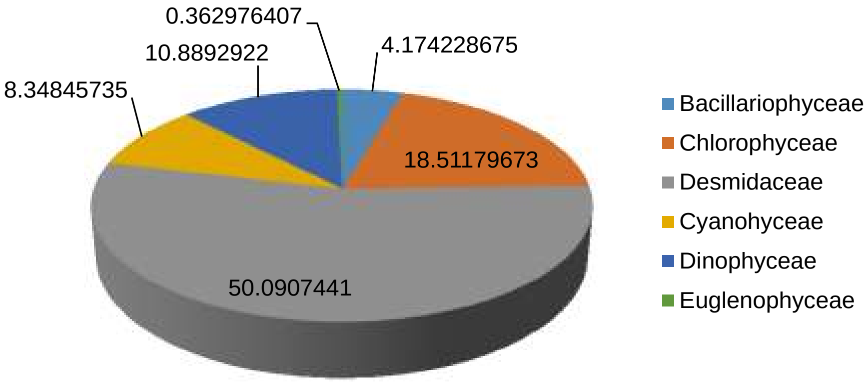


Fig. 39 Phytoplankton composition in river Chaliyar

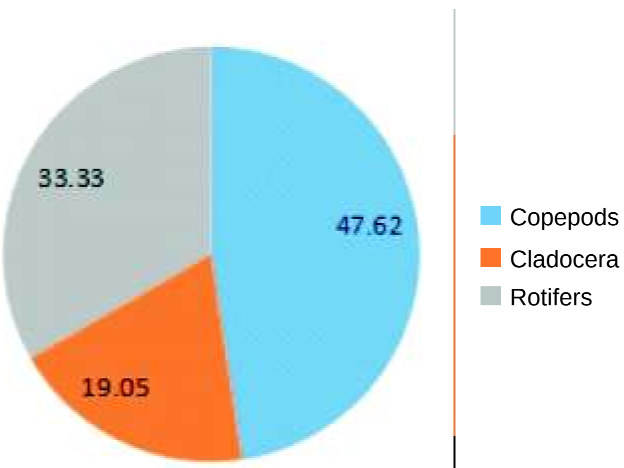


Fig. 40 Zooplankton group in Chaliyar River

due to rapid biological activities during pre-monsoon period. The two lower downstream regions, that is Azhinjilam and Feroke showed comparatively higher values of specific conductivity, alkalinity, hardness and chlorinity due to the influx of saline water as these are part of estuarine zone. Spatio-temporal variation of nitrate-nitrogen content was non-significant. The phosphate content of water in all the stations increased during post-monsoon season (except Areacode and Feroke) which may be associated with post-flood effect in Kerala. Compared to other nutrients, silicate content was very high. In short, the physico-chemical characteristics of Chaliyar river water were almost at optimum level.

Specific conductivity of river bottom sediment show a gradual increase from upstream to downstream, may be due to saline water intrusion from estuarine downstream and the values were low during post-monsoon period due to dilution effect of August, 2018 Kerala flood. The lowest and highest values of sediment pH were 6.4 and 8.1 during pre-monsoon and 6.5 and 8.5 during post-monsoon period. Sediment carbon content (%) was moderate in nature. Available P was moderately rich and ranged from 0.69–5.13 and 0.26–3.22 mg/100g soil in pre-monsoonand post-monsoon period, respectively. Soil available nitrogen (mg/100 g) was in low to moderate range of 11.2–49.6 (avg. 14.5), and 5–16.7 in pre-monsoon, and post-monsoon, respectively. Sediment $CaCO_3$ (%) was observed to be in the range of 3–8.5 (av. 6.1), and 4-6.5 (avg. 4.2) in pre-monsoon, and post-monsoon, respectively.

However, studies in physicochemical parameters in long run will give insight about the balance in the ecosystem.

A total of 38 genera of phytoplankton belonging to five algal groups from eight sampling stations were recorded. The total plankton density ranged from 20-11,220 units/L of which 98% is contributed by phytoplankton. Out of 5 algal groups, Desmidaceae was the most dominant in terms of abundance (20 to 4360 units/L) and Chlorophyceae in terms of diversity (11 species). Cyclopoida is a dominant group of Zooplankton. The quantitative abundance of zooplankton ranged from 20 to 320 nos./L. The quantitative abundance of phytoplankton ranged from 1920 to 11,160 units/L, highest at Areacode and lowest at Cholamala station during 2017-19. Desmidaceae contributed 41.96% of the plankton population in 2017, whereas Chlorophyceae (35.67%) was dominant in 2018.

Diversity indices were also assessed from the collected data. Shannon diversity index was lowest at Areacode and Pielou's evenness index was also lowest at Areacode. All other stations were similar in diversity and evenness indices scores.

A total of 40 species of macro-benthic fauna comprising gastropods (14 species, 9 families), bivalves (9 species, 4 families), insect larvae (5 species), Polychaetes (3 species), Oligochaetes (3 species) and crustaceans (6 species) were recorded. Thiaridae was highest (192.4 nos./m^2) in abundance in monsoon, Unionidae (142.3 no./m^2) in pre-monsoon and Chironomidae (486.8 no./m^2) in

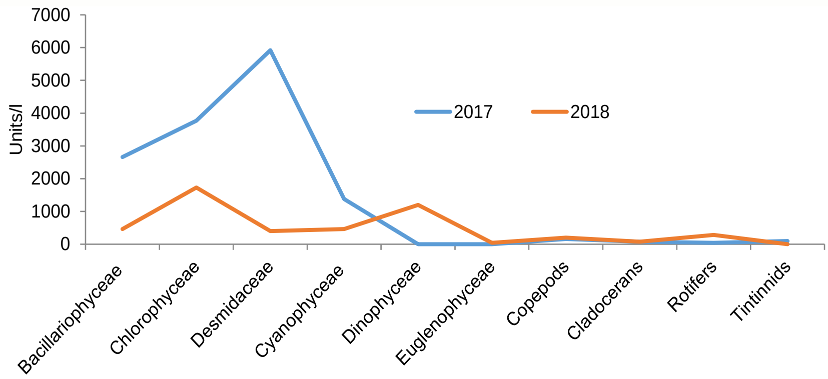


Fig. 41 Year-wise comparison of plankton in river Chaliyar

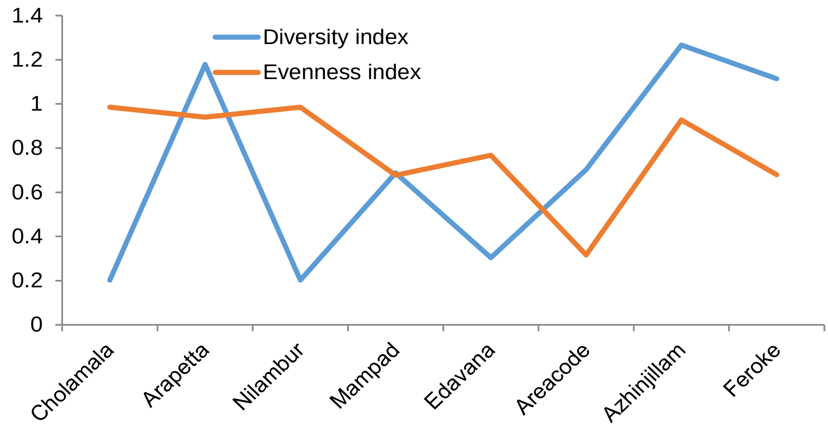


Fig. 42 Station-wise Shannon's diversity and Pielou's evenness indices in river Chaliyar

Fig. 43 Pool habitats at Nilambur along river Chaliyar

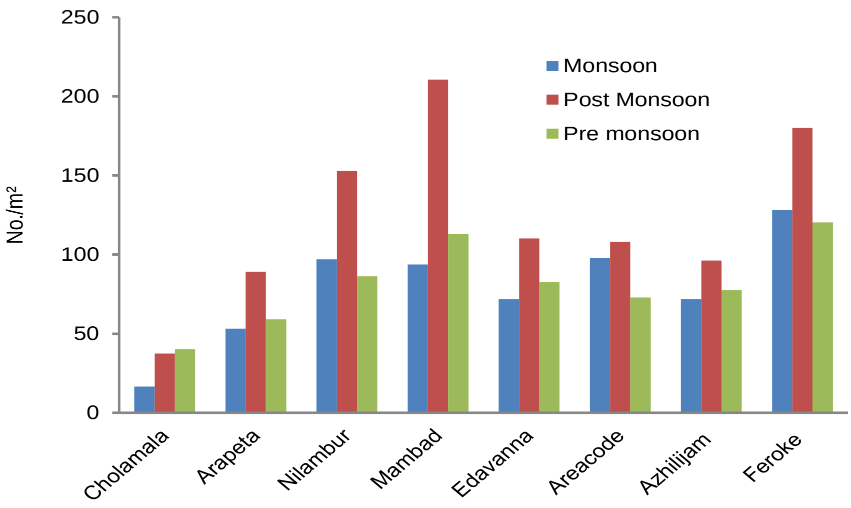


Fig. 44 Spatio temporal variations in total macrobenthic community in river Chaliyar

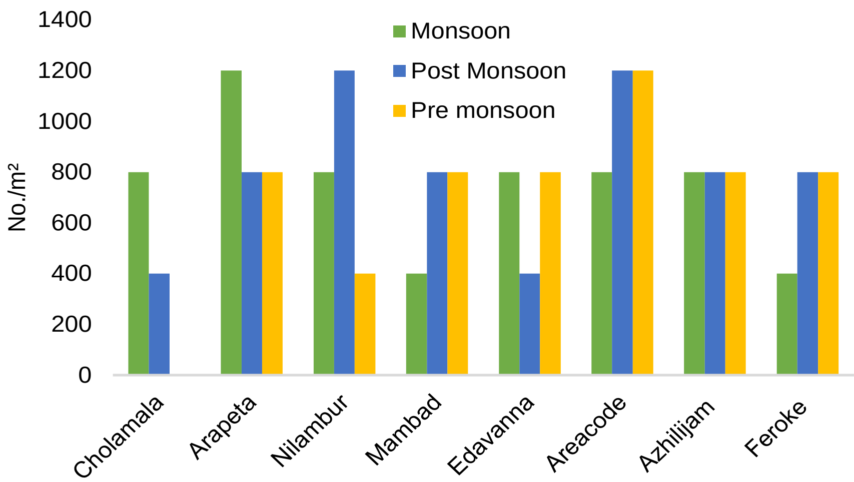


Fig. 45 Spatio and temporal variations in meiobenthos abundance in river Chaliyar

post-monsoon. Meio-benthic abundance was higher in Areacode and Nilambur because substrate had high percentage of silt load. Nematodes abundance was higher in lower stretch, may be because of very high & fine silt-clay, which helped in their diurnal migration. ASPT scores recorded better water and environmental quality. Health of the river was assessed through Benthic Biotic Index. ASPT (Average Score Per Taxon) and EPT (Ephemeroptera, Plecoptera and Trichoptera) indices were assessed based on species wise abundance. Results of biotic index showed Nilambur and Areacode were most disturbed.

A total of 52 fish species belonging to 47 genera, 29 families and 11 orders were recorded during 2018-19. Perciform fishes (61%), followed by mugilids (7%) and siluriformes (7%) were the major groups recorded from the lower stretch of the river. *Arius arius, Caranx ignobilis*, *Glossobius giuris, Etroplus suratensis, Epinephelus diacanthus, Mugil cephalus, Strongylura strongylura, Lutjanus argentimaculatus, Terapon jarbua, Sillago sihama*, *Wallago attu, Hypselobarbus curmuca, Horabagrus brachysoma, Anabas testudineus* and *Systomus sarana* are the commonly observed species from lower stretch. Cyprinids formed the major group (12 species) in the middle stretch of the river, followed by 2 species each of perciformes and silurids. The common species are

Devario malabaricus, E. suratensis, Rasbora daniconius, E. maculatus, H. curmuca, Pethia punctata, Puntius mahecola, Systomus sarana, Hyporamphus limbatus, Mastacembelus armatus, Haludaria fasciata, Barilius bakeri, Bhavania australis, Garra mcclellandi, Osteobrama bakeri, Salmophasia boopis. The upper stretch was characterised completely by cyprinids like *G. mclellandi, S. boopis, H. fasciata, S. sarana, Rasbora daniconius, H. curmuca, E. maculatus, Dawkinsia filamentosa, B. bakeri*.

Commercial fishing is mainly observed in the lower stretch of the river. The major contributor included *E. suratensis, Lethrinus* sp., *L. argentimaculatus,* and mugilids which constituted 20% each during pre-monsoon, while *A. arius* constituted 86% of the catch in post monsoon.

Average income of the fishers is Rs. 11000/month from riverine fisheries. Fishers were dependent on riverine fisheries for about 5.5 man months. Other than fishing, fishers are also involved in small scale business (timber mill and sand mining) spending 4.5 man months in a year.

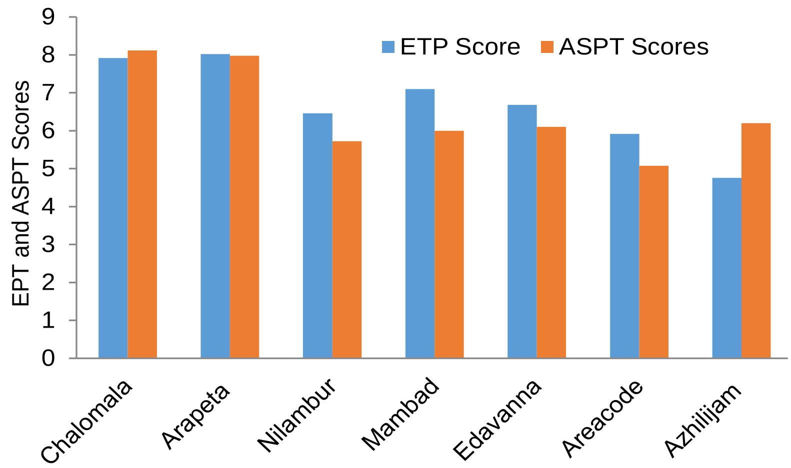


Fig. 46 Station wise ASPT and EPT scores in river Chaliyar

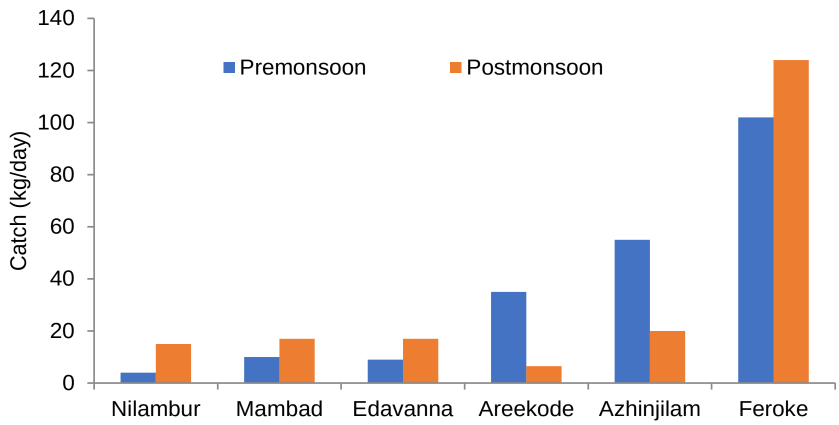


Fig. 47 Catch (kg/day) from each sampling station of Chaliyar River

Project Title	:	**Exploration of canal resources of Punjab and Sundarbans (West Bengal) for fisheries development**
Project Code	:	**REF/17-20/08**
Project Personnel	:	Archana Sinha, Aparna Roy, Pranab Gogoi, Mitesh H. Ramteke and Tasso Tayang
Associates	:	Arunav Mitra, Subhendu Mondal and Abhijita sengupta

Sampling was conducted in Bhetkimari, Bherua and Bishalakhi canals of Sundarbans (W.B.) for sediment, water, plankton, fish diversity and laboratory analysis of samples were completed. On the basis of water and soil quality, plankton availability and productivity, two canals *i.e*. Bherua canal in Shibpur (Shivganj) and Bishalakhi canal in Sagar Island of Sundarbans were selected for the culture of selected fishes in net partitions to enhance the fish production from canals for the improvement of livelihood and social status of the local stakeholders. In Bishalakhi canal the average salinity was 9.21±8.93 g/L whereas in Bherua canal was 5.12±4.37 g/L. The salinity was very low during monsoon months and gradually increases during pre-monsoon season. Thus, freshwater fish species can be grown in these canals during monsoon to post-monsoon months and euryhaline fish species can be culture when water salinity gets higher from post monsoon to pre-monsoon months. Other water quality parameters like D.O. (5.7-6.23 mg/L) were favourable for good production in both the canal. Total alkalinity in both the canals remained in between 100 to 150 mg/L in monsoon and post monsoon season; overall, both the canals have good "buffering" capacity. The pH of both the canals (7.5 – 8.3) was alkaline and favourable. The nutrient concentration was also in favourable range in both the canals of Sundarbans. A total of 62 species of phytoplankton belong to 54 genera were

Fig.48 Net screen partition system in canal

Fig. 49 Net screen partition system in Bherua canal, Madanganj (left) and Bishalakhi canal, Sagar Island

recorded from Bishalakhi canal. Among nine algal groups, Cyanophyceae dominated in terms of abundance and Bacillariophyceae in diversity. Seven groups of zooplankton were recorded where crustacean nauplius (56.5%) dominated among zooplankton community.

A MOU has been signed with the local stakeholders and ICAR-CIFRI regarding culture of fishes in Bishalakhi and Bherua canal. In collaboration with local stakeholders, net screen barriers as partition system were installed in Bherua and Bishalakhi canal. The partitions were made with locally available bamboo poles, HDPE net screen and mosquito net to reduce the construction cost.

In Bherua canal three net partitions were constructed with dimension of each partition was 50m × 45m. Similarly, four numbers of net partition 35m × 22m dimentions were constructed at Bishalakhi canal. Indian Major Carps *i.e. Catla catla, Labeo rohita* and exotic carp *Ctenopharyngodon idella* were stocked in both the canals.

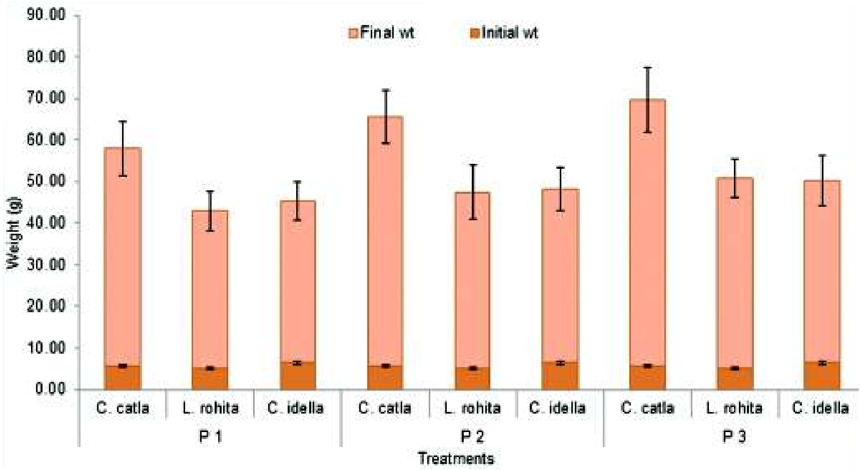


Fig.. 50 Growth performance of fish in Bherua canal

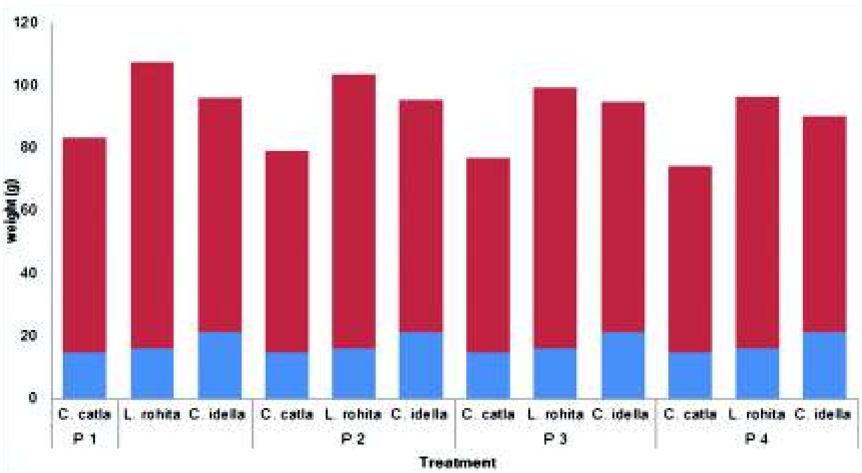


Fig. 51 Growth performance of fishes in Bishalakhi canal

Table 3. Details of fish seed stocking in Bisalakhi canals of Sundarbans, West Bengal

Partition system	Species	Stocking ratio (%)
Partition 1 (C)	*Labeo Rohita*	50
	Catla Catla	30
	Cirrhinius mrigala	20
Partition 2 (T1)	*Labeo Rohita*	50
	Catla Catla	30
	Cirrhinius mrigala	10
	Macrobrachium rosenbergii	10
Partition 3 (T2)	*Labeo Rohita*	50
	Catla Catla	30
	Cirrhinius mrigala	10
	Chelon tade	10
Partition 4 (T3)	*Labeo Rohita*	40
	Catla Catla	30
	Cirrhinius mrigala	10
	Macrobrachium rosenbergii	10
	Chelon tade	10

The fish seeds were stocked @ 2nos./m^2 with the stocking ratio of : *L. rohita: C. catla: C. idella* :: 50: 40: 10. The experiment was designed with different feeding ration to see the difference in growth performance of the fishes in different feeding regime. Partition 1 serve as control in which no feeding was done, whereas in partition 2 and 3 feeding with 2% and 4% feed was given. After 120 days of trial, the study showed higher growth of fish in partition 3 with 4% feeding and lower growth was seen in partition 1 with no feeding. Final results are awaiting.

In Bishalakhi canal, the fishes were stocked in different stocking densities i.e. 0.5 nos./m^2, 1 nos./m^2, 2 nos./m^2, and 4 nos./m^2 in partition no. 1,2,3 and 4 respectively. The species stocking ratio was: *L. rohita*: *C. catla*: *C. idella* = 40: 40: 20 in each partition. The fishes were fed with CIFRI cage-grow feed twice in a day @4% of body weight. After 90 days of study, higher growth was observed in partition 1 with lowest stocking density whereas lower growth was observed in partition no. 4 with highest stocking density.

A study was conducted to investigate the effect of stocking density on growth performance and survival of Indian major carp *Labeo rohita* and *Catla catla* by installing net screen barrier system in Bishalakhi canal of Sundarban. The treatment had four stocking density 0.5 (T1), 1 (T2), 2 (T3) and 4 (T4) nos. per m^2. Advance fingerlings with average weight of *L. rohita* 16.2 ± 2.1 g and *C. catla*14.8 ±1.6 g were stocked into 4 net screen barrier systems at ratio of 1:1. The fish were fed with a diet containing 32% crude protein @ 4% of their body weight for 120 days. The final average weight of fishes ranged from 80.09 ± 6.8 –

91.27 ± 8.7 g & 59.36 ± 5.5 – 68.33 ± 6.2g and average daily weight gain ranged from 0.53 ± 0.02 – 0.63 ± 0.04& 0.37 ± 0.01 – 0.45 ± 0.02 g day^{-1} for *L. rohita* and *C. catla* respectively. Fish stocked at lower stocking density showed better growth performance than higher stocking density. The highest final average weight gain and average daily weight gain was noted at a stocking density of 0.5 nos. per m^2 (T1). However, there was no significant difference between the treatment T1 and T2 (P< 0.05).Survival rate of fishes was not affected by stocking density (p<0.05). Based on growth parameters, the most effective stocking density was at 0.5 nos. per m^2. The study suggests for sustainable use of these unexploited resources.

Project Title	:	**Investigation on environmental flows in river Kathajodi, Siang and Tamas tributary of river Ganga**
Project Code	:	**REF/17-20/09**
Project Personnel	:	A. K. Sahoo, S. K. Das, D. N. Jha, Roshith C. M., Rohan Raman, S. K. Koushlesh,Shravan Sharma, S. C. S. Das, S. Borah
Associates	:	A. Sengupta, A. R. Choudhury, D. Saha

River Kathajodi

Environmental flows estimation through ecological flows classes

In river Kathajodi, based on the daily discharge data at the Naraj upper station, flow duration curve was plotted to classify the river stretch into Class A, B, C, D. During lean period, a minimum flows that requires to maintain the pristine condition the river needs a discharge of 4456 cusec and to maintain river in Class A, B, C, discharge of 4053 cusec, 3798 cusec and 3654 cusec respectively are required.

Biotic communities: A total of 96 fish species belonging to 60 genera

Fig. 52 Upstream of Naraj barrage of river Kathajodi

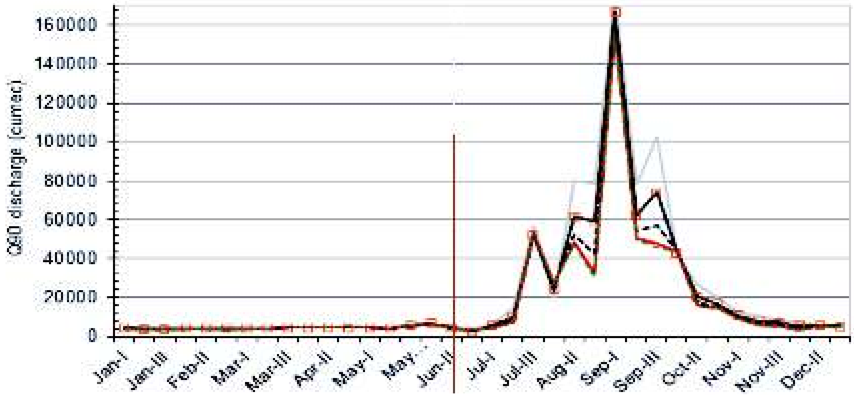


Fig.53 Hydrograph of river Kathajodi at Naraj Upper showing the classes of ecological status

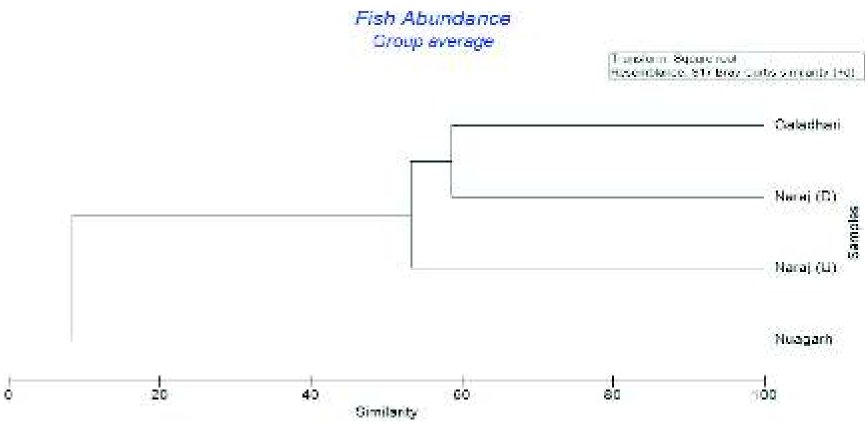


Fig. 54 Cluster dendrogram of sampling sites based on fish assemblages

and 36 families were recorded. About 53 % of the diversity is represented by seven families, *viz*., Cyprinidae (19 species), Clupeidae (7 species), Bagridae (6 species), Mugilidae (5 species), Engraulidae (4 species), Schilbeidae (4 species) and Ambassidae (4 species). The highest fish diversity (53 species) was recorded at Nuagarh (towards the estuarine mouth) due to the dominance of marine migrants. The diversity recorded at Naraj and Galadhari were 36 and 38 species respectively.As per the hierarchical clustering of the sampling stations based on fish abundance (analyzed from PRIMER v6 software package), the stations Naraj [both upstream(U) and downstream (D)] and Galadhari were grouped into one cluster as these stations mainly represented a community with dominance of freshwater fish species. But Naraj (U) formed a separate branch in the cluster as the river channel is deep and fishery is supported by featherbacks (*Notopterus notopterus* and *Chitala chitala*) and large sized carps such *Labeo calbasu* and

Table 4. The water quality parameters in river Kathajodi

Water quality parameters	Mean	STD
Water Temp (?C)	21.82	±10.93
pH	5.92	±3.85
DO (mg/L)	6.07	±3.30
Total Alk (mg/L)	63.32	±30.97
Chloride (mg/L)	0.01	±0.00
Salinity (ppt)	0.02	±0.01
Nitrate-N (mg/L)	0.06	±0.03
Total -N (mg/L)	0.46	±0.07
Phos-P (mg/L)	0.02	±0.01
Silicate-Si (mg/L)	6.90	±3.62
Sulphate (mg/L)	0.00	±0.00
Total Phos -P (mg/L)	0.04	±0.02
Total Hardness (mg/L)	61.95	±29.27
Calcium (mg/L)	13.33	±6.31
Magnesium (mg/L)	6.72	±3.29

Cirrhinus mrigala. Though Naraj (D) and Galadhari are hydro-biologically different (due to tidal influence at the latter), they formed a cluster due to the similarity in the abundance of major fish species such as *Gonialosa manmina*, *Cirrhinus reba*, *Puntius sophore*, *Systomus sarana* and *Wallago attu*. Moreover, the river channel from Naraj (D) to Galadhari is continuous without any barrages or dams which favoured the establishment of a stable population of freshwater fishes in the stretch. Since the fish assemblage at Nuagarh was dominated by marine migrants, it formed a separate cluster.

Phytoplankton population consisted of 33 genus belonging 5 class were recorded in total study stretch. Bacillariophyceae was the dominant group, followed by Cyanophyceae & Chlorophyceae.

ASPT (Average Score per Taxon) indices were used for assessment of river health of Kathajodi. These indices were estimated based on sensitivity

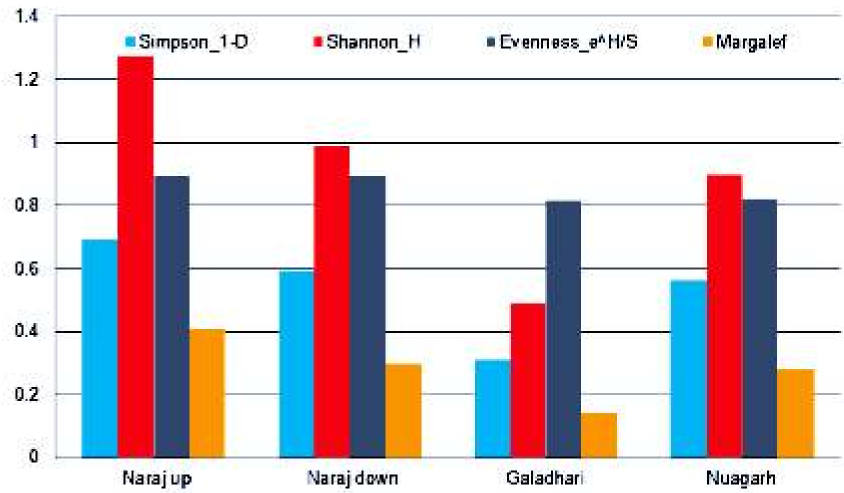


Fig. 55 Diversity of phytoplankton indices of river Kathajodi

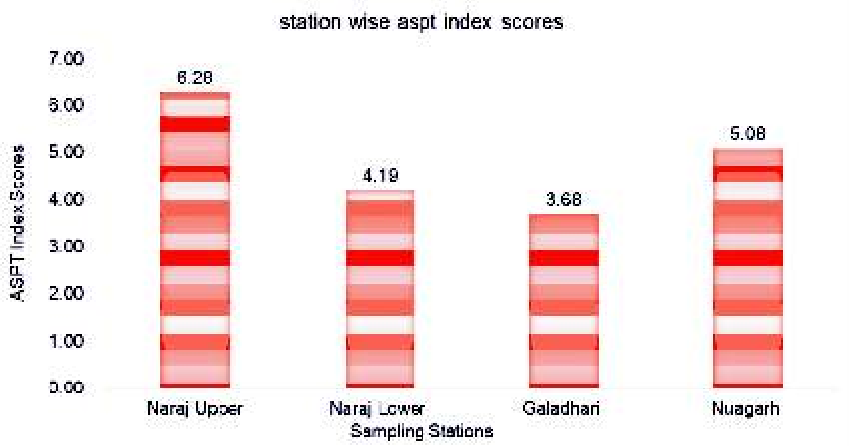


Fig. 56 Station-wise ASPT index scores in river Kathajodi

Table 5. Significant water quality parameters, estimates, significance and R^2 on fish and benthos abundance in the fresh water zone of Kathajodi river

Significant water quality Parameters	Fish richness(no.)		Benthos abundance (no/sqm)	
	Estimates	Significance (p)	Estimates	Significance (p)
Water temperature	-15.30	<0.001	11.14	<0.001
pH	-22.20	<0.001	-15.21	<0.001
DO	14.89	<0.001	-9.27	<0.001
Total Alkalinity	-47.02	<0.001	32.01	<0.001
Chloride	10.70	<0.001	-7.44	<0.001
Total phosphate	0.06	<0.05	-	-
R^2	0.96		0.95	

of macro Invertebrates groups against industrial and municipal pollution, using a score based assessment that ranges from 1 to 10. The ASPT scores ranged from 3.68 (Galadhari) to 6.28 (Naraj Upper) indicating better river health at Naraj Upper than other stations. Habitat suitability indicated that water availability throughout the year is the key factor responsible for the better health.

A total of 15 water quality parameters correlated with the fish and benthic communities for understanding the dynamic relationship. The influence of significant water quality parameters on fish and benthos abundance in the river was studied using stepwise regression modelling approach and it was observed that out of 15 water quality parameters only six parameters are significant for fish richness and five parameters showed significant for the benthos abundance. Except pH water temperature, DO, total alkalinity, chloride showed inverse influence for fish and benthos relationship. Water temperature and alkalinity showed negative influence on fish richness while positive influence on benthos abundance. DO, chloride had positive influence on fish while negative influence on benthos abundance. Total phosphate showed positive influence on fish richness but no influence on benthos abundance in the river Kathajodi.

River Siang

Fish diversity: A total of 20 fish species under 5 families have been recorded across six stations *viz.* Puging and Yingkiong (Upper stretch), Boleng and Komsing (Middle stretch), Pasighat and Oiramghat (Lower stretch) in river Siang, bringing the total number of fish species to 34. Assessment of fish abundance across stations show that fish abundance in lower stretch (Pasighat and Oiramghat) is having a higher percentage of similarity and forms a single cluster and the remaining four stations along upper and middle stretches form another separate cluster, with three sub-clusters. Among these, Komsing forms one sub-clusters, Puging forms another sub-cluster, while Yingkiong and Boleng forms a single sub-cluster. Migratory species recorded during the course of study includes *Schizothorax richardsonii* (at Upper stretch); *Tor tor*, *T. putitora* (at Upper and middle stretch);

Fig. 57 Gauge / Discharge site (Brahmaputra Board) at Pasighat in river Siang

Labeo dyocheilus (at Middle and lower stretch); *Bangana dero* (at Middle and lower stretch). Keystone species include *T. putitora* along Upper and middle stretch and *L. dyocheilus* in lower stretch.

Sampling sites of the Siang river were grouped using Ward's method. Two main clusters were formed : Pasighat and Oiramghat in one cluster and Puging, Yingkiong, Boleng and Komsing sites in another cluster. Of nine water quality parameters, five parameters *i.e.*, water temperature (°C), salinity (psu), transparency (cm), water depth (m) and water velocity (m/s) played significant roles ($p<0.05$) in grouping the sites.

River Tamas

Biotic communities: The river was studied during pre-monsoon, monsoon and post-monsoon seasons at Panasaghat upstream of confluence of Ganga and tons river, 25°26'63", 82°04'64", Chakghat 25°02'10", 81°44'78", Bakia upstream barrage 24°68'75", 81°14'74, Bakia downstream barrage 24°46'44", 81°15'61", Madhavgarh 24°33'62", 80°54'40" and Itahara 24°09'48", 80°42'87". A total 75 fish species belonging to 54 genera, 23 families and 10 orders were recorded. Three exotic fish species *Cyprinus carpio, Hypophthalmichthys nobilis* (Richardson, 1845) and *Oreochromis niloticus* were recorded at Panasaghat, Chakghat and Bakia upstream. Endangered species of mahseer i.e *Tor putitora* (Hamilton, 1822) was found at Chakghat . As per

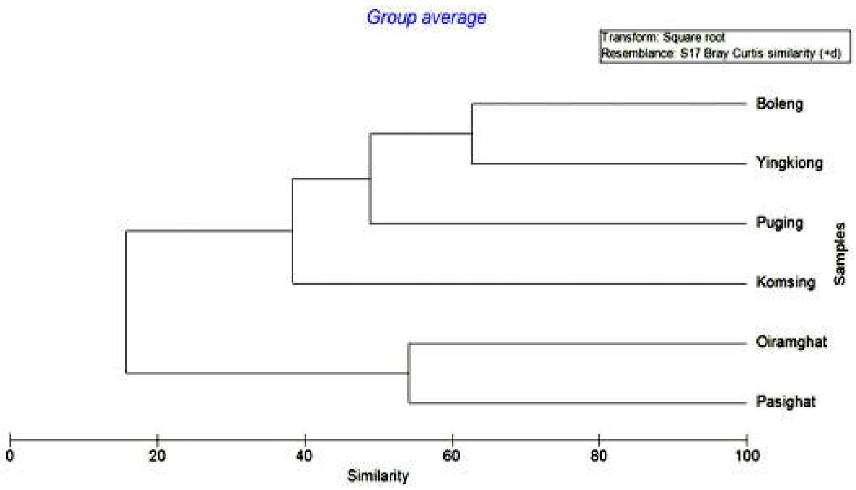


Fig. 58 Dendrogram of fish abundance across stations in Siang river

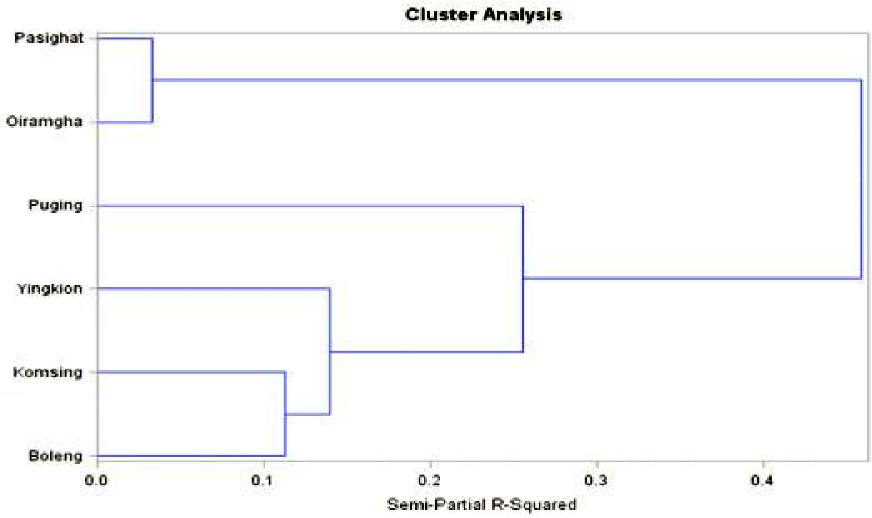


Fig. 59 Cluster analysis sampling sites of river Siang based on waterquality parameters

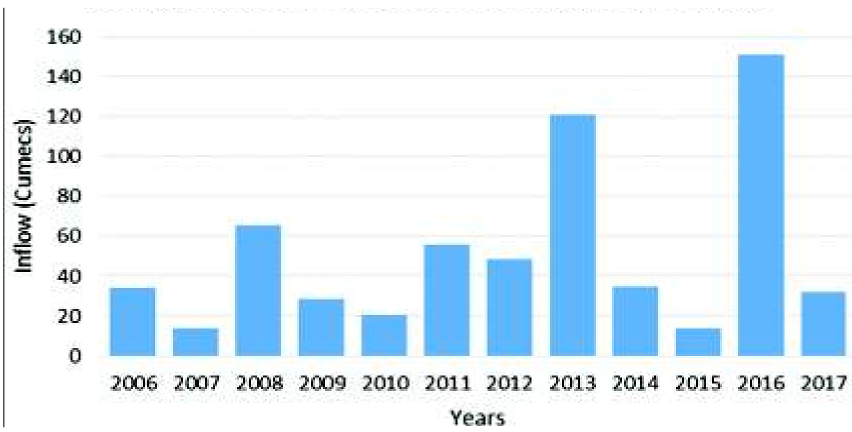


Fig. 60 Average annual discharge of river Tons at Bhimgoda barrage

Table 6. Biodiversity indices at different sampling sites of river Tons/Tamas

Diversity indices	Itahara	Madhavgarh	Bakia U/S	Bakia D/S	Chakghat	Panasaghat
Taxa_S	4	43	48	8	67	58
Dominance_D	0.3878	0.0391	0.0337	0.3355	0.02671	0.03028
Simpson_1-D	0.6122	0.9609	0.9663	0.6645	0.9733	0.9697
Shannon_H	1.154	3.49	3.577	1.372	3.87	3.737
Evenness_e^H/S	0.7925	0.7625	0.745	0.493	0.7154	0.7239
Brillouin	0.7639	3.067	3.294	1.185	3.596	3.429
Menhinick	1.512	3.715	2.96	1.18	3.406	3.448
Margalef	1.542	8.575	8.435	1.828	11.08	10.1

IUCN categorization, seven species *i.e Ompok bimaculatus, Ompok pabda, Chitala chitala, Tor tor, Bagarius bagarius, Wallgo attu, Ailia colia* were found at different sites are listed as Near threatened (NT), and *Botia lohachata* found at Chakghat and Panasaghat is listed as Not evaluated (NE). The diversity indices for the fishes were calculated for the sampling months with an average. The average Shannon Wiener Index (H') varies from 1.154 at Itahra to 3.87 at chakghat. The value increases as both richness and evenness of the community increase. The Evenness index varies from 0. 493 at Bakia DS to 0.7625 at Bakia US when it is close to one more evenly populations that form community. The Simpson diversity varied from 0. 0.6645 (Bakia DS) to 0.9733 at Chakghat indicating higher diversity.

Based on the ecological status, FDC based Global Environmental Flow Calculator (GEFC) environmental flows method was used and estimated that to maintain river in slightly modified class of EMC, 27.8 % of MAR (1607 MCM) discharge should be released into the river.

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

Project Code : **REF/17-20/10**

Project Personnel : R. S. Srivastava, D. N. Jha, A. Alam, S.C.S. Das and J. Kumar

Associates : Kalpana Srivastava, S. K. Srivastava and Vijay Kumar

Ecological parameters like pH, DO, BOD, COD, Sp. Cond. etc. were examined in different stretches of river Ganga. The abundance of Bacillariophyceae and Periphyton were observed in upper stretch (hill stream) whereas the Chlorophyceae and Myxophyceae were found in abundance in downstream of the river Ganga.

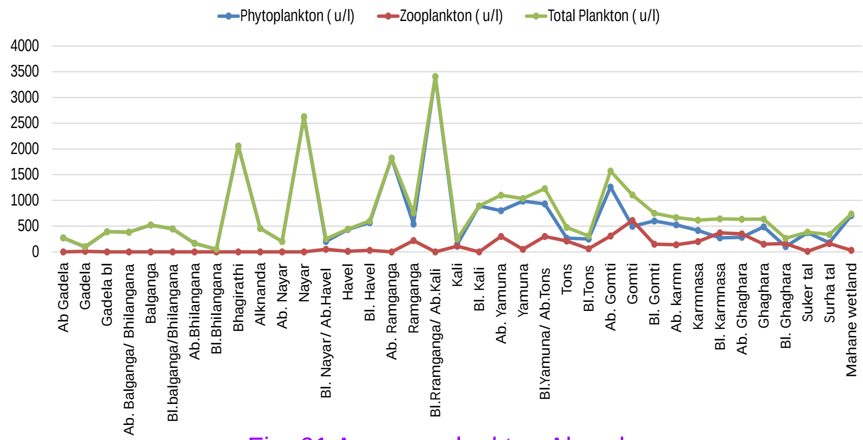


Fig. 61 Average plankton Abundance

Macrobenthic populations

The Insecta was found in abundance in hill streams whereas gastropod was found in abundance in downstream of river Ganga.

A total of 39 macro benthic fauna comprising of 19 insects, 10 gastropods 7 bivalves and 3 annelids were recorded from different tributaries and wetlands of the river Ganga at 38 sites. The average benthos varied from 17-293 N/m^2 with maximum abundance being at Mahane Jheel and minimum at above Bhilangana (Tehri Jheel).

Only one molluscan species, *Physa acuata,* was observed in the upstream tributaries of river Ganga *i.e* Bhilangana (above Balgana) with a abundance of 40nos./m^2. This *Physa acuata* species prefers the polluted water. The abudance might be due to pollution load in the area.

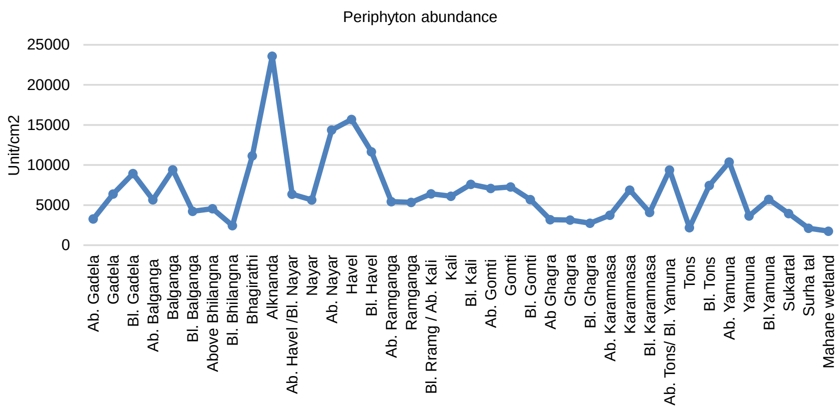


Fig. 62 Average periphyton Abundance

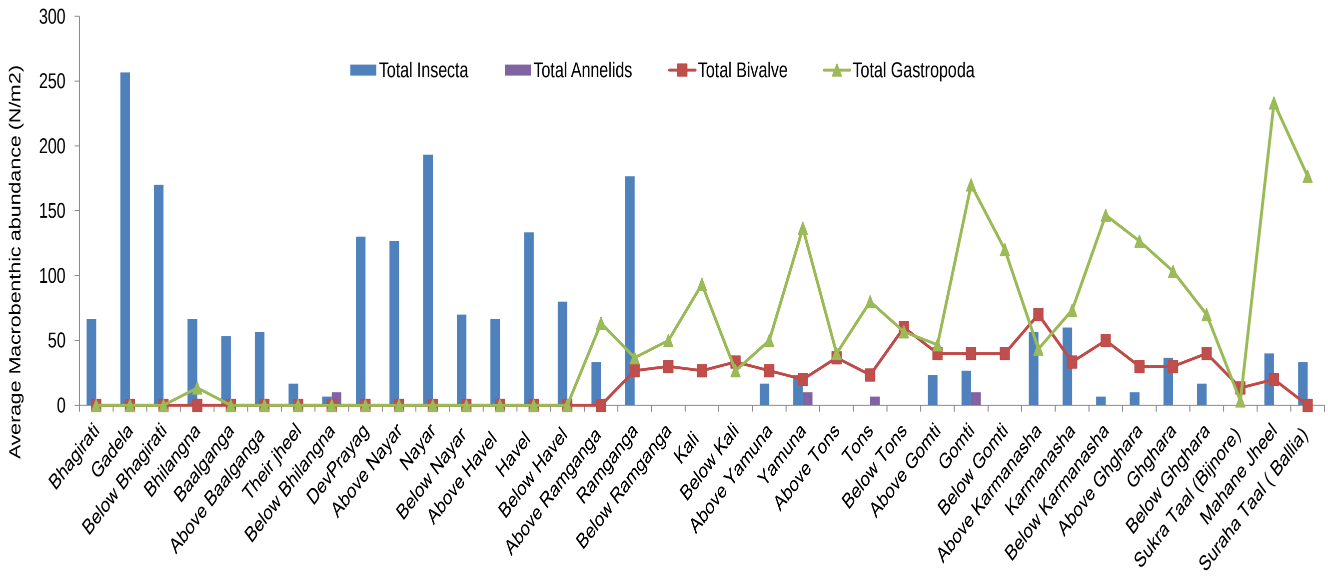


Fig. 63 Abundance of macrobenthos in the different sites of Ganga tributaries

Only Insect component was observed in the upstream of the different tributaries of the river Ganga. During summer highest abundance of *Chironomous* were observed at Ramganga river (470 nos./m^2) followed by Karamnasa river (110 nos./m^2) and Ghagra river (70nos./m^2) indicating the load of organic pollution in the ecosystem. Some of the insect fauna are *Baetis* sp.,*Caenis* sp., *Leptophlebia* sp., *Heptagenia* sp., *Ironodes* sp., *Psephnus* sp., *Laccophilus* sp.,*Cybister* sp.,*Corydalus* sp., *Parargyractis* sp., *Nymphula* larvae, Dragon fly nymph, *Enallagma* sp., *Leptocerus* sp., *Hydropsyche* sp., *Rhyacophila* sp., *Plea* sp., *Togoperla* sp.

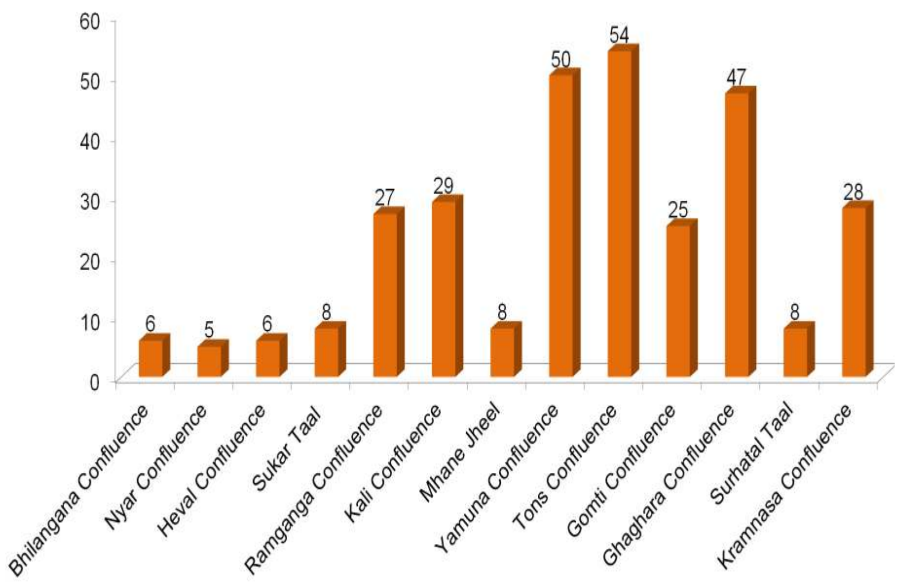


Fig. 64 Fish species richness at the confluence and wetland

Higher mollusan components (Gastropods and Bivalvia) were observed in the middle stretch of river Ganga tributaries. Among Gastropods some of the dominant species *viz.* *Bellamya bengalensis*, *Gyraulus convexiusculus*, *Lymnaea acuminate*, *Physella acuta*, *Tarebia lineate*, *Melanoides tuberculata* were recorded., *Parreysia favidens, Parreysia annandali, Parreysia corrugate,* , *Corbicula striatella* were recorded among bivalves and among Annelids Oligochaets *Tubifex tubifex, Hirudinaria* were recorded from the different sampling sites.

Estimated fish landing from Allahabad stretch of the river Ganga was 158.6 t during 2018 with nearly 34.0 % share of exotic fishes. In total fish catch, other group of fishes (miscellaneous) dominated (43%), followed by exotic fishes, cat fishes (14%) and Indian major carps (9%). Among the exotic fishes, tilapia dominated over common carp dominated while Mrigal has maximum contribution among IMC. There is decrease of about 11% in average fish landing with respect to previous year which could be attributed to marginal decrease in fishing efforts linked with flooding of the rivers and arrangement of a big event like Kumbh on the bank of river.

Fish diversity

A total of 75 fish species belonging to 9 Order 21 families and 49 genera were recorded from the different sampling sites.

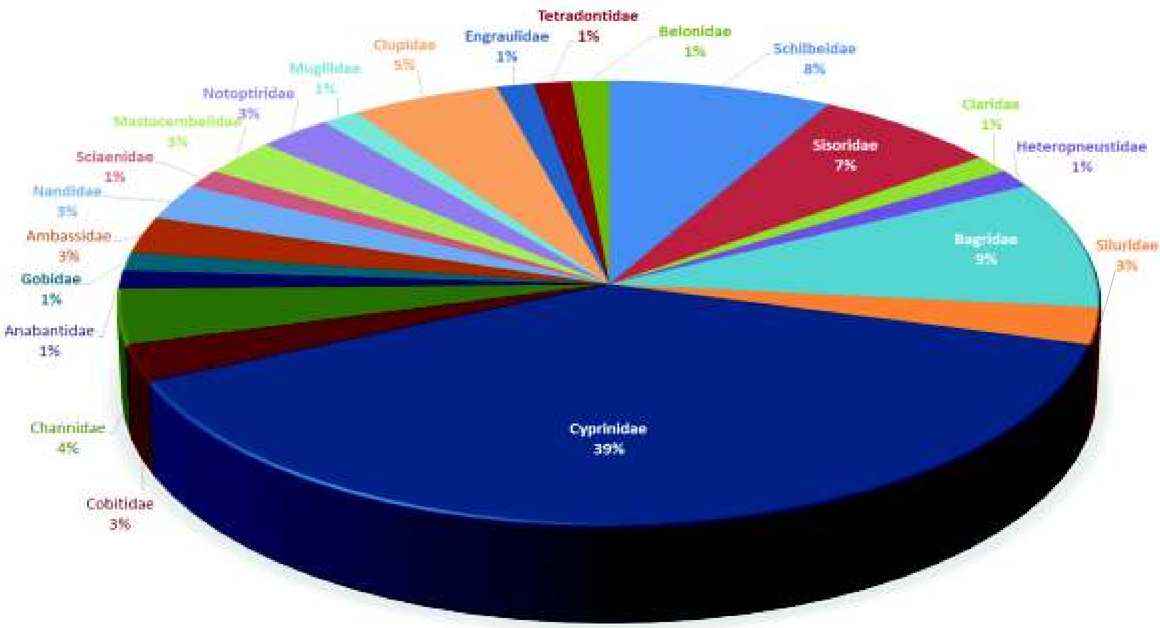


Fig. 65 Fish diversity: Percentage contribution of different families

Reservoir & Wetland Fisheries

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

Project Code : **RWF/17-20/05**

Project Personnel : B. K. Bhattacharjya, U. K. Sarkar, M. A. Hassan, Md. Aftabuddin, A. K. Bera, A. Alam, S. Yengkokpam, A. K. Yadav, D. K. Meena, P. Das, Lianthuamluaia, P. Mishal, Simanku Borah, N. Sharma, Jeetendra Kumar, P. Majhi, P. Gogoi, Venkatesh R. Thakur and P. DebRoy

Associates : K. K. Sarma, S. Srivastava, B. C. Ray, S. Saha, Y. Ali, B. K. Naskar and A. Kakati

Assessment of ecological and biological diversity of selected wetlands (beels) of Assam, West Bengal and Madhya Pradesh

Assessment of resource characteristics especially of vulnerable floodplain wetlands is an urgent need of the hour for devising informed ecosystem based fisheries norms and conservation of the resources and their biotic communities. In this perspective, ecology and biodiversity were assessed in two floodplain wetlands in Assam, four wetlands in West Bengal and one wetland in Uttar Pradesh.

Fig. 66 Fishing in a floodplain wetland

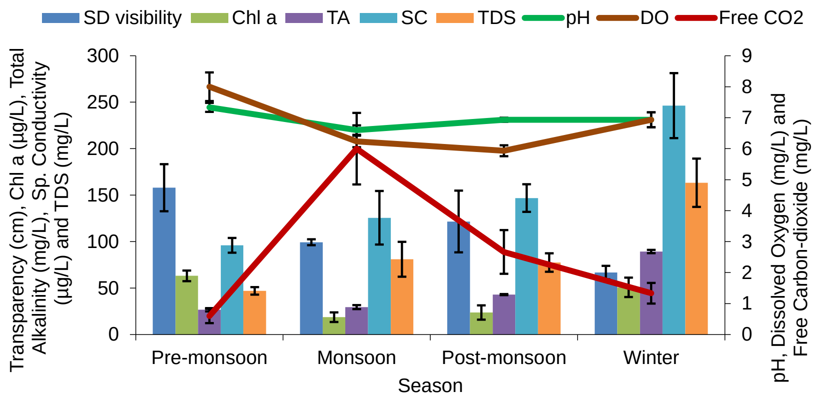


Fig. 67 Water quality parameters in Samaguri beel, Nagaon, Assam

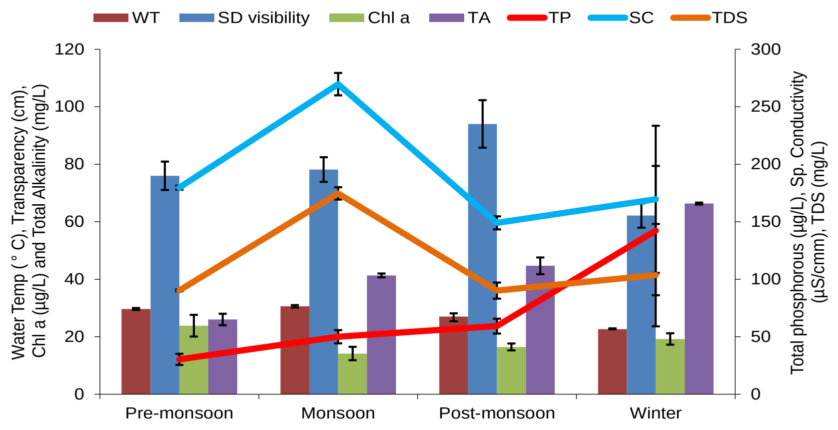


Fig. 68 Water quality parameters of Sibathan beel, Nagaon, Assam

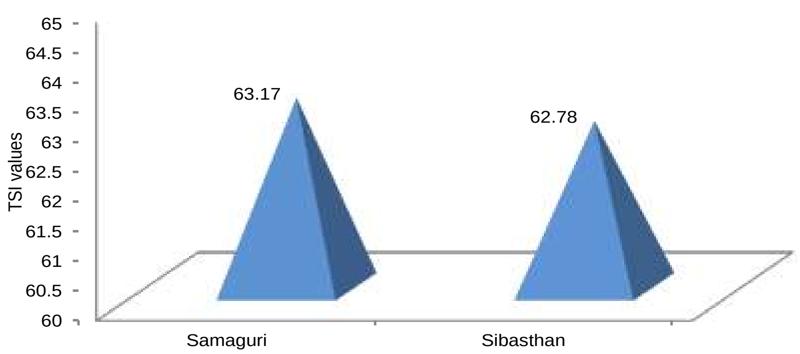


Fig. 69 Overall trophic status of Samaguri and Sibasthan beel, Nagaon, Assam

Wetlands of Assam

A seasonally open Samaguri (60 ha) wetland and a closed Sibasthan-Potakolong (92.13 ha) wetland located in Nagaon district were studied.

Water quality and primary productivity

Both the wetlands have productive environment. Physico-chemical parameters indicated better water quality in Samaguri than in Sibasthan-Potakolong beel which was attributed to better macrophyte management as well as riverine connectivity of the first wetland. T-test showed that, Chl-*a*, pH and dissolved oxygen levels were significantly ($P<0.05$) different between the beels. Total phosphorous and Chlorophyll-*a* was slightly higher in the seasonally open Samaguri beel. Net primary productivity (mgC/m^3/day) was estimated as 930.53-1008.0 in Samaguri beel and 538.4-880.0 in Sibasthan beel. High primary productivity observed were correlated with the higher recorded fish yield in both the beels. The study indicated that, riverine connectivity supported higher productivity in floodplain wetlands.

Trophic status

Trophic State Index (TSI) based on transparency, total phosphorus and Chlorophyll-*a* contents indicated eutrophic state of both the wetlands. TSI was highest during winter. Community fishing activities carried

Table 7. Season-wise TSI values based on Transparency, Total Phosphorus and Chlorophyll-*a* across seasons in Samaguri and Sibasthan Beel.

Beel	Samaguri					Sibasthan				
Season	Pre-monsoon	Monsoon	Post-monsoon	Winter	Average	Pre-monsoon	Monsoon	Post-monsoon	Winter	Average
Tsi-sd	53.4	60.1	53.4	65.8	58.5	63.9	63.6	60.9	66.9	63.7
Tsi-tp	61.6	63.2	64.4	67.9	64.5	53.4	60.6	63	75.6	65.5
Tsi-chl-*a*	71.7	59.3	61.7	69.1	66.6	61.7	56.6	58.1	59.6	59.2
Tsi	62.1	60.8	61.1	67.6	62.9	59.7	60.2	60.7	67.4	62

out in winter disturbed the bottom, which resulted in leaching of nutrients and higher degree of eutrophication.

Biotic communities

Phytoplankton population was higher in the seasonally open Samaguri beel than that in the closed Sibasthan-potakolong beel mainly because of low macrophyte infestation. Similarly, total periphyton population was higher in Samaguri beel than that in Sibasthan-potakolong beel. Numerical abundance of plankton and periphyton population was higher in pre-monsoon season in both the beels indicating higher colonization in stable period.

Both macrophytes-associated fauna (MAF) and benthos population were progressively higher from pre-monsoon and monsoon season to winter season in both the beels. Maximum abundance and diversity were recorded in winter and minimum during the monsoon season. Samaguri beel had richer diversity of MAF which may be due to its riverine connectivity. Similar finding was also reported for benthos population. The MAF consisted of small fishes (11 species), insects (8 species), molluscs (4 species), prawn (1 species) and crab (1 species). The benthic fauna was represented by insects and molluscs with insects being the dominant one.

Fish diversity and catch composition

Higher fin-fish diversity (53 nos.) was recorded in Samaguri than in Sibasthan (42 nos.) may be due to riverine input in the former. Cypriniformes dominated the fish assemblage in the beels followed by Siluriformes and Perciformes. *Nandus nandus*, *Mastacembelus armatus* and *Ompak pabda*, which disappeared during 1996-2002, reappeared in Samaguri beel apparently because of their ingress from river Brahmaputra during high flood. The study indicated that, seasonal riverine connection supported higher fish biodiversity in floodplain wetlands. Among the indigenous fishes, the Indian river shad/Karoti (*Gudusia chapra*) contributed significantly to the total catch in Samaguri beel (35%) whereas small catfishes (*Mystus* spp.) contributed significantly (10%) to the total catch in Sibasthan beel. Stocked fishes contributed 55% of the total catch in Samaguribeel,

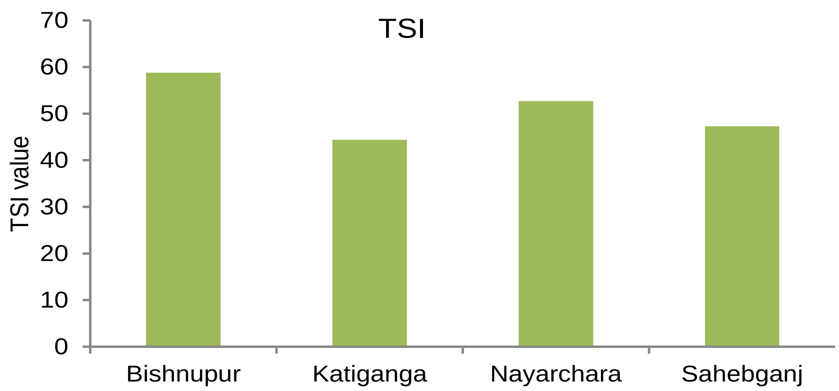


Fig. 70 Trophic state index of studied wetlands in West Bengal

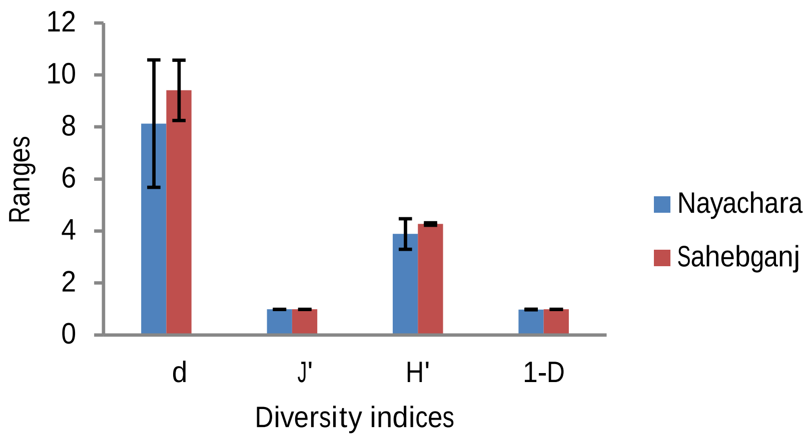


Fig. 71 Phytoplankton diversity indices of North Bengal wetlands

whereas it was 70 % in Sibasthan beel. Fish yield in Samuguri and Sibasthan beel were estimated at 1926 kg $ha^{-1}yr^{-1}$ and 1335 kg $ha^{-1}yr^{-1}$ during 2017-18, which are 28.4% and 2.7% higher, respectively in comparison to previous year.

Wetlands of West Bengal

Study was conducted in four wetlands of West Bengal, viz. Bishnupur and Katiganga in Murshidabad district (middle part of Bengal) in Bhagirathi-Hooghly stretch of lower Gangetic basin and Nayachara and Sahebganj wetlands in Cooch Behar district (North Bengal) in Teesta-Torsa basin.

Water quality

Analysis of water quality parameters indicated that, nutrients (phosphate and nitrate), TDS, alkalinity and conductivity values were higher ($p<0.05$) in Bishnupur wetlands as compared to Katiganga, Nayachara and Sahebganj. Most of the water quality parameters of the wetlands were in the favourable range for fish production. However, the Bishnupur wetland was eutrophic in nature based on water quality parameters due to sewage pollution. Cluster analysis also indicated that Bishnupur wetland has a distinct pattern of water quality parameters as compared to other wetlands.

Primary productivity and trophic state

The gross primary productivity varied from 1875-3562 mgC/m^3/day in Bishnupur, 750-

3187 mgC/m^3/day in Nayachara, 500-1687 mgC/m^3/day in Sahebganj and 562-2062 mgC/m^3/day in Katiganga beel. The gross primary productivity was positively correlated with chlorophyll-*a* content in the water. Assessment of TSI revealed Katiganga *beel* and Sahebganj in mesotrophic state and Nayachara and Bishnupur *beel* in eutrophic state.

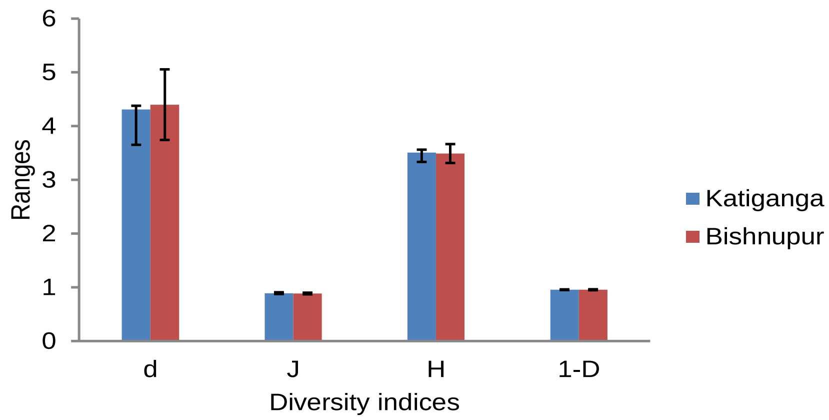


Fig.72 Phytoplankton diversity indices of the Middle Bengal wetlands

Plankton abundance and diversity

Higher phytoplankton species richness was observed in North Bengal beels (Sahebganj and Nayachara) than in middle Bengal beels (Katiganga and Bishnupur). Increase of *Aulacoseira granulate* with the abundance of 91% of the total phytoplankton in Nayachara *beel* during monsoon season indicates presence of excess nutrients in water. Similarly, community structure of phytoplankton revealed that, Chlorophyceae was the dominant group contributing 62.17% - 51.24% of phytoplankton in the studied beels.

About 7 groups of zooplankton were recorded in North Bengal while six groups in middle Bengal wetlands.The dominant zooplanktons were crustacean nauplius (34%) in Sahebganj and rotifera in the other three beels (43-78.5%). Plankton density was higher in post-monsoon season. The Richness and Shannon-Wiener diversity index indicated rich phytoplankton diversity in both North Bengal beels with calculated value of >3.8. Higher value of Shannon–Wiener diversity index (3.50) and Margalef species richness index (4.30) showed healthy plankton community in Katiganga *beel* and moderate to high range in Bishnupur *beel*.

Macrophyte abundance, biomass and diversity

The biomass of macrophyte was found to be moderate in Nayachara (4.7-5.1 kg/m^2) and Sahebganj *beel* (6.55-7.3 kg/m^2) and low in Bishnupur (1.4± 0.6 Kg/m^2) and Katiganga (1.25±0.3 Kg/m^2) *beel*. Macrophyte coverage, diversity and biomass were significantly higher in Sahebganj compared to Nayachara *beel*. Abundance of submerged macrophyte was higher in Sahebganj due to its shallow water depth. Macrophyte coverage in both the wetlands in Murshidabad was within moderate (10-35%) range. Abundance (>80%) of exotic floating plant, *Eichhornia crassipes* was recorded in Coochbehar wetland, while submerged plant *Vallisneria spiralis* was abundant (66%) in Katiganga. Marginal plant *Alternanthera phyloxeroides* (38%) and floating *Eichhornia crassipes* (35%) were almost equally abundant in Bishnupur *beel*.

Community structure and composition of macro-zoobenthos

Community structure and composition of macro-zoobenthos of the wetlands depicted a diverse pattern in the four seasons. Sahebganj showed average density of 151 no./m^2, macrozoobenthos with the dominance of diptera (35 %), followed by gastropoda (34 %), oligochaeta (24 %) and others (7 %), while Nayachara (Closed) had average density of 119 no./m^2 with co-dominance of oligochaeta (41 %) and diptera (41 %) followed by gastropoda (11 %) and others (11 %). The average density was 643 and 218 no./m^2 in Bishnupur and Katiganga which was much higher than North Bengal *beel*s Sahebganj and Nayachara. The Bishnupur *beel*s showed dominance of single group *i.e.* gastropod (69 %), followed by diptera (19 %) and oligochaeta (12 %), while Katiganga showed the dominance of gastropoda (51 %) followed by oligochaeta (23 %), diptera (16 %), and others (10 %).

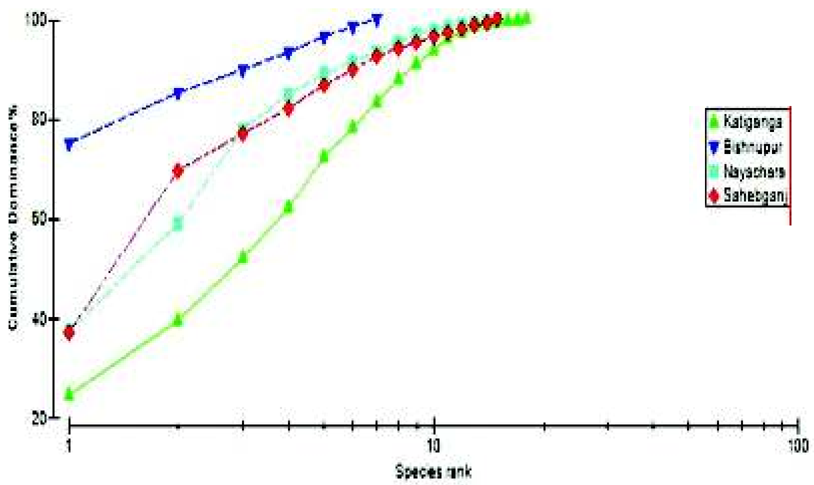


Fig. 73 Dominance curve showing fish diversity of the selected wetlands of West Bengal.

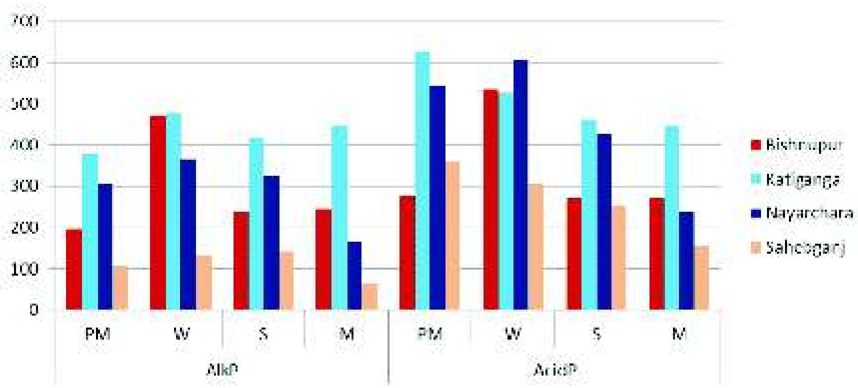


Fig. 74 Phosphatase activity in wetlands of West Bengal

Fish diversity of the wetlands

Bishnupur wetland which is polluted by municipal sewage showed comparatively less indigenous fish diversity and richness as compared to Katiganga, Nayachara and Sahebganj wetlands. The most abundant species (in numbers) in Katiganga, Bishnupur, Nayachara and Sahebganj were *Nandus nandus*, *Amblypharyngodon mola*, *Chanda nama* and *Puntius terio* respectively. The bulk of the fish catch (biomass) was contributed by the stocked fishes including Indian Major Carps (*Labeo rohita*, *Labeo catla* and *Cirrhinus mrigala*) and exotic carps (*Cyprinus carpio*, *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella*) indicating the positive impact of stocking on fish production.

Sediment enzymes activity and related parameters of wetland health

Sediment enzyme activities showed distinct variation both with geographical position, wetlands and season. Wetlands of middle Bengal showed higher alkaline phosphatase and dehydrogenase activities and lower β glucosidase than those of North Bengal. Katiganga and Nayachara had highest phosphatase and glucosidase activities respectively. Sewage fed Bishnupur wetland showed highest dehydrogenase and lowest glucosidase and organic matter than other three natural wetlands. The wetlands also showed seasonal variations in enzyme activities of all four enzymes with highest activities during winter. Wetlands of North Bengal are more organic matter rich and have lower conductivity, total and available phosphorous than middle Bengal wetlands. The sediment enzyme showed different type of correlation with sediment physico-chemical parameters.

Surveillance of disease in wetland

Repeated occurrence of septicemic form of diseases was recorded in sewage fed Bishnupur *beel* with mortality in *P. hypophthalmus*, *L. catla*, *L. rohita* and *H. molitrix*. Fish mortality mostly occurred during winter, followed by spring. Sewage contamination from Berhampore city played a major role as a stressor and predisposing factor for the occurrence of bacterial diseases. Laboratory finding suggested that, the mortality in *Pangasianodon hypophthalmus* was due to *Aeromonas caviae* and *Aeromonas hydrophila.*

Katiganga, a natural *beel* was studied for presence of disease occurrence and we indentified metacercarial stage of Clinostomid infestation in *Nandus nandus.* Severe infestation with *Eustrongylides* sp. was observed in *Xenentodon cancila,* followed by *Nandus nandus.* These fishes feed on lower invertebrates which may have favoured trematode and nematode infestation.

Socio-economic status of fishers

The socio-economic status of fishers in the Katiganga and Bishnupur wetlands of Murshidabad district has been studied. Surveys of 15 fishers in Katiganga wetland conducted through structured and semi-structured interviews revealed that, the mean age of fishers was 45 years (range : 18 to 70 years). The primary occupations of all the respondents surveyed were fishing, shop keeping and cooking along with secondary occupation such as carpentry, small business, daily wage labour, and farming. The average monthly household income was Rs. 9,500. Regarding formal education, 28.57% of the respondents had completed their secondary level of education, 21.43% of respondents had completed primary level of school

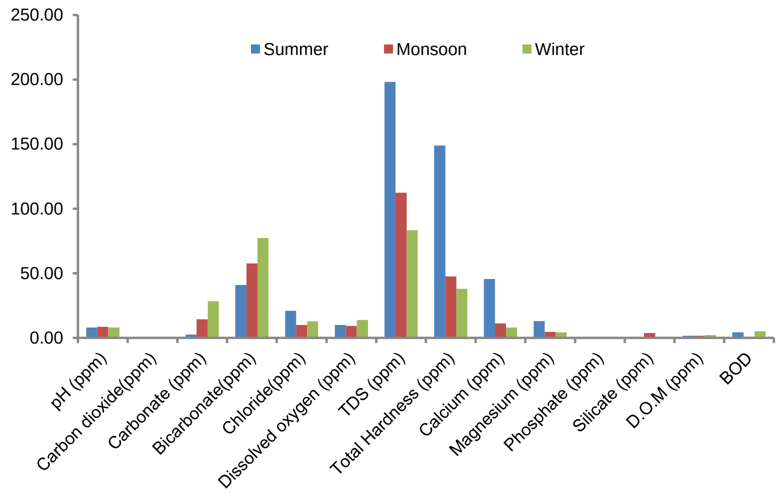


Fig.75 Water quality parameters of Loni wetland

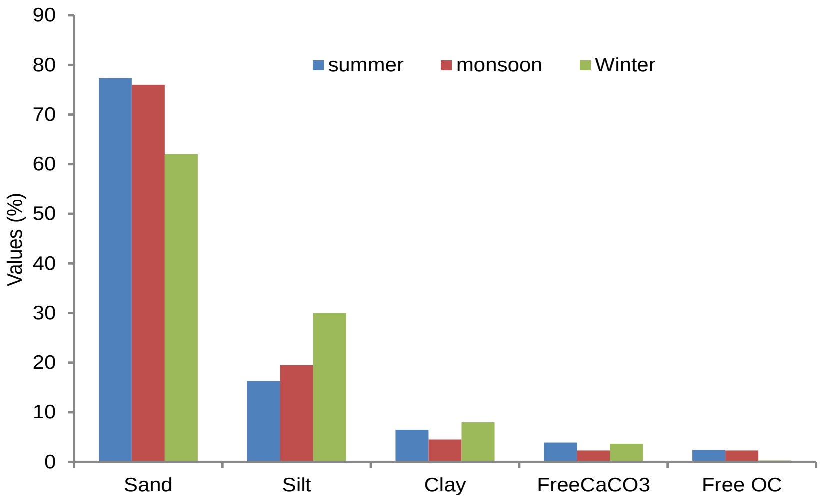


Fig.76 Soil quality parameters of Loni wetland

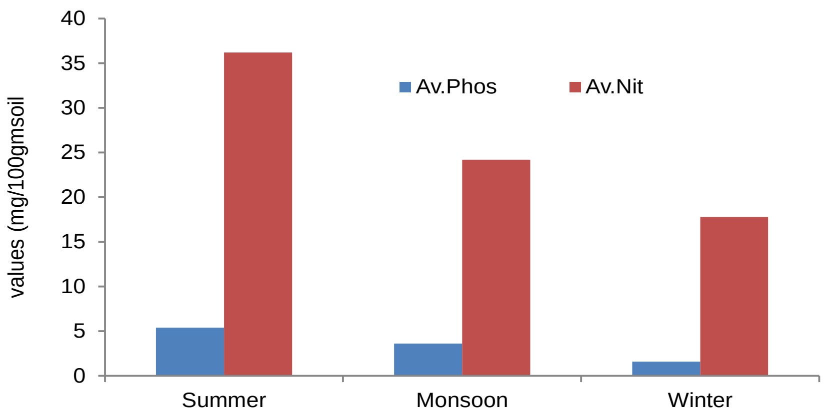


Fig. 77 Soil nutrient availability of Loni wetland

education, and 42.88% of the respondents had no formal education. Fifty percent of the respondents had *pucca* houses, 28.57% of the respondents had semi-*pucca* houses, and 21.43% had *kuchha* houses. Half of the respondents use tube well as a source of drinking water, 21.43% use packaged water, and the remaining others use river water as a source of drinking water. Among the people surveyed 14.28% have mobile phone of their own, 92.86% families have television set in their houses, 92.86% have bicycles, 35.71% have motorbikes. Fifty percent of the respondents have taken loans from banks at present : 40% have taken loans from women SHGs, another 40% from Centralized banks, and rest from the Dept. of Industry, Govt. of West Bengal.

Wetlands of Madhya Pradesh

Ecological and biological diversity was studied in seasonally opened Loni wetland in Rewa district, MP (129 ha). The wetland receives discharge from two seasonal rivers namely Phutahna and Barha river.

Physico-chemical parameters of water and soil

The physico-chemical parameters of the water showed healthy water quality regime in all the seasons. Important water quality parameters were depicted in Fig. 9. The water pH was alkaline (8.27±0.16) in all the seasons. Specific conductance was highest in summer (306 µs/cm), followed by in winter (129 µs/cm) and monsoon (117 µs/cm). Dissolved oxygen content and total alkalinity was highest in winter. Total hardness, chloride content and TDS values were highest in summer.

The sediment of the Loni wetland was alkaline in nature (pH: 7.7±0.07). Average sand, silt and clay contents were 72 %, 22% and 6% respectively; sand percentage was high in all seasons. Organic carbon was minimum in winter (1.7 mg/100g), $CaCO_3$ was highest in summer (3.9 mg/100g) and winter (3.6 mg/100g) except during monsoon (3.3 mg/100g). Available Nitrogen and phosphorus was highest during summer, followed by in monsoon and winter .

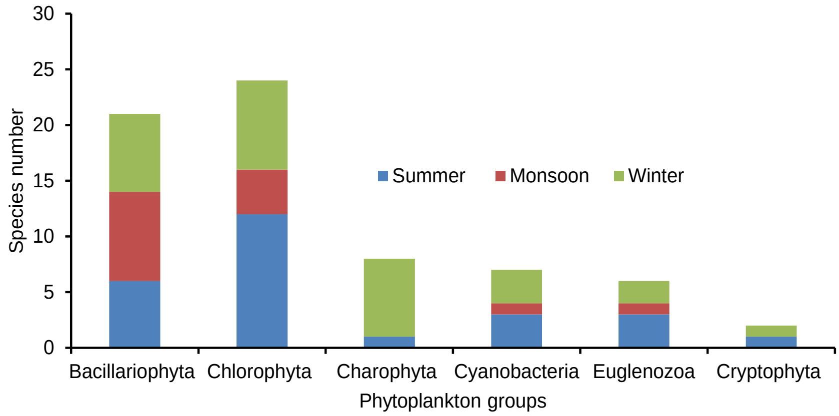


Fig.78 Seasonal Plankton Diversity of Loni wetland

Plankton diversity

A total of 45 plankton species belonging to 6 groups, *viz.* Bacillariophyta (13 species), Chlorophyta (15 species), Charophyta (7 species), Cyanophyta (5 species), Euglenozoa (3 species) and Cryptophyta (1 species) were recorded. Maximum number of species were recorded during winter season, followed by in summer and monsoon season. Density pattern (Ind. L^{-1}) was same as species pattern, i.e., highest density was recorded in winter (25200), followed by in summer (19600) and monsoon (8000). Summer season was dominated by *Cryptomonas* sp. and *Rhodomonas* sp., while winter season was dominated by desmid (*Staurastrum* sp.).

Benthic communities

A total of 11 macrobenthic fauna comprising of 5 insect, 2 bivalve and 4 gastropods were recorded at nine different sampling stations. The macrobenthic populations ranged from 60-310 nos. m^{-2}.

Fish diversity

A total of 32 fish species belonging to 6 orders, 12 families and 27 genera were recorded from Loni wetland. Contribution of IMC was 30-40% to total catch. Present fish yield ranged between 388-453 kg/ha/yr. The catch was contributed majorly by *Labeo rohita,* followed by *Channa marulius*. Considering the photosynthetic efficiency of 0.5%, the production potential at 1.2% of energy conversion was estimated to be between 931 and 1087 kg/ha/yr.

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

Project Code : **RWF/17-20/06**

Project Personnel : U. K. Sarkar, M. A. Hassan, A. K. Das, S. K. Sahu, A. K. Bera, S. Kumari, Lianthuamluaia, P. Mishal, G. Karnatak, P. Majhi, T. Tayung, P. Debroy, P. Panikkar, M. Karthikeyan, A. Saha, V. L. Ramya, S. Mol, S, P. K. Jesna , A. Alam, J. Kumar, R. Palaniswamy, T. T. Paul

Associates : S. Manoharan, Y. Ali, B. K. Naskar and Subrata Das

Spatio-temporal study was carried out in seven reservoirs belonging to six states in eastern, peninsular and northern parts of India on fish diversity, habitat parameters, biotic communities, fish assemblage, stocking details, fish production pattern and socio-economics.

Fisheries Habitat

Habitat study indicated that, the two eastern reservoirs, Patratu and Derjang reservoirs were medium productive. The water quality parameters showed significant difference ($p<0.05$) between the seasons. The gross primary productivity varied from 300-875 mgC/m^3/day in Patratu and 1750-2000 mgC/m3/day in Derjang reservoir. The assessment of the relationship of the habitat parameters with the biotic community using CCA indicated that, fish abundance was positively influenced by DO, pH and conductivity was negatively related with depth. The phytoplankton population was positively influenced by nitrate value and

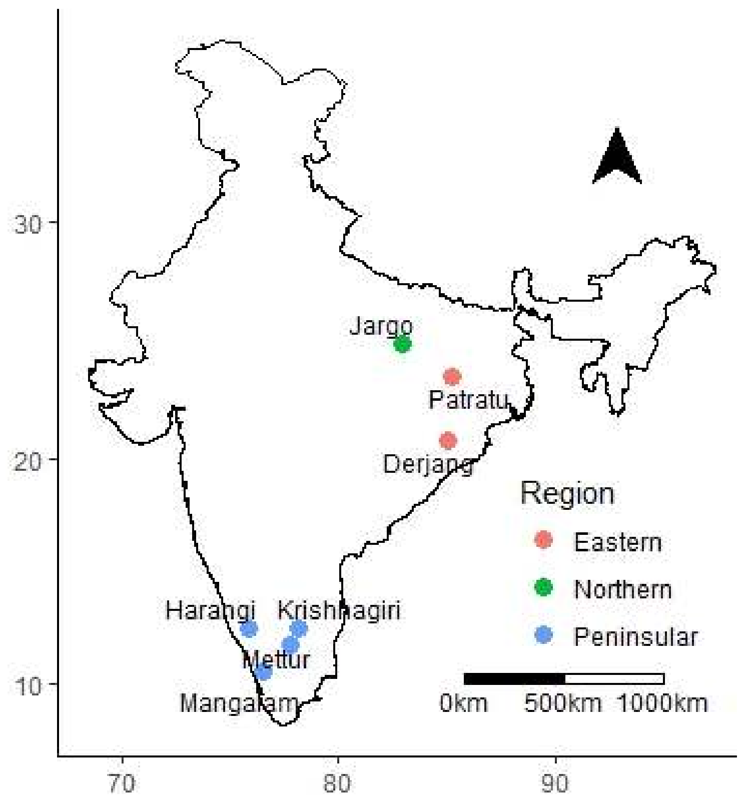


Fig.79 Selected reservoirs in different regions

zooplankton population was positively influenced by temperature. The water was well oxygenated, especially during post-monsoon season in the studied peninsular reservoirs, *viz*. Harangi, Mettur and Krishnagiri reservoirs. The highest electrical conductivity and nutrient level were observed during pre-monsoon season. TSI was 53.075 indicating a mesotrophic-eutrophic condition in Mangalam reservoir.

Plankton diversity

A total of 70 phytoplankton taxa and 29 zooplankton taxa were identified throughout the season in Derjang reservoir. Among the phytoplanktons, Cyanophyceae flora was dominant during most of the time. Among the zooplanktons group, Rotifers were dominant in monsoon and winter, whereas, copepods were dominant in summer. In Patratu reservoir, 46 phytoplankton taxa and 8 zooplankton taxa were identified; zooplankton abundance was higher in lotic zone than in the reservoir, while phytoplankton abundance was higher in the reservoir than the lotic sector, especially during monsoon season.

In Harangi reservoir, 16 species of phytoplankton were recorded with great abundance of *Microcystis aeruginosa*. In Krishnagiri reservoir, 51 species of phytoplankton were recorded, out of which *Microcystis aeruginosa* was the most abundant

Fig. 80 Sampling in Patratu Dam

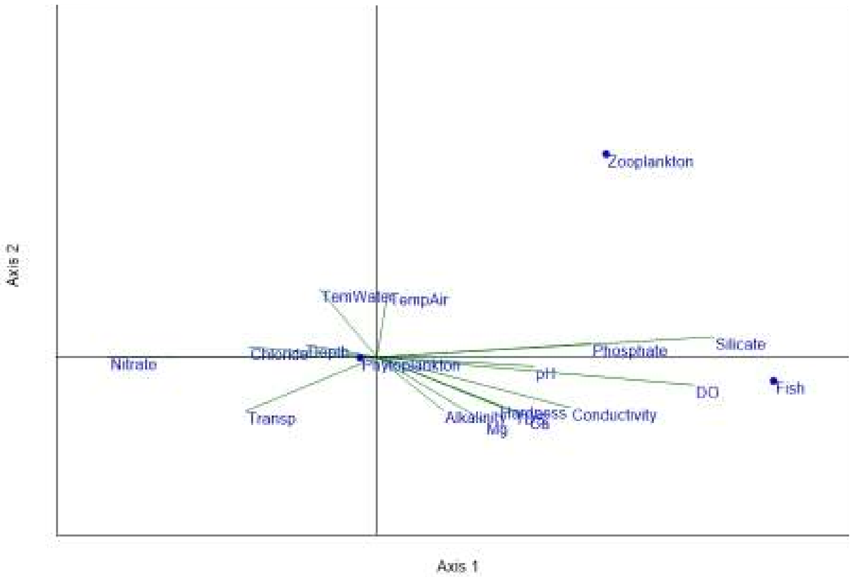


Fig.81 CCA of habitat parameters and biotic community in Derjang reservoir

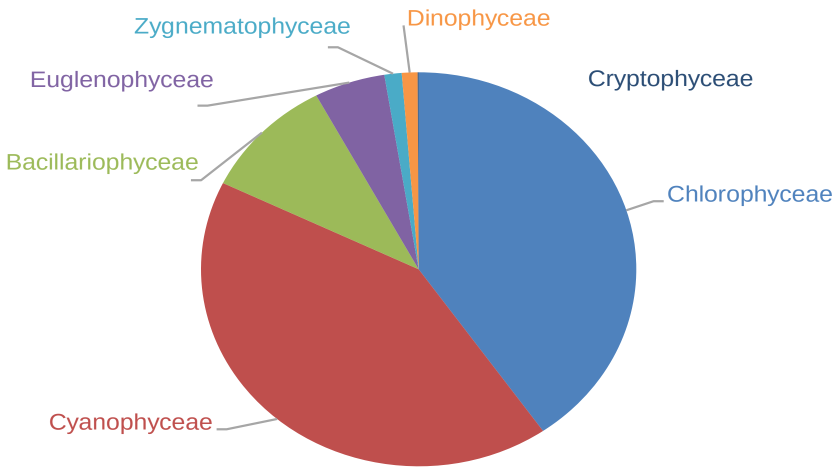


Fig.82 Composition of phytoplankton group in Derjang reservoir

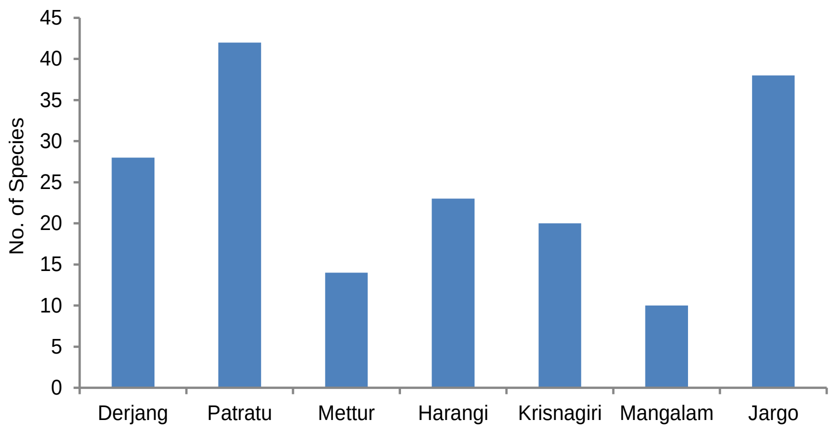


Fig.83 Fish species richness in selected reservoirs

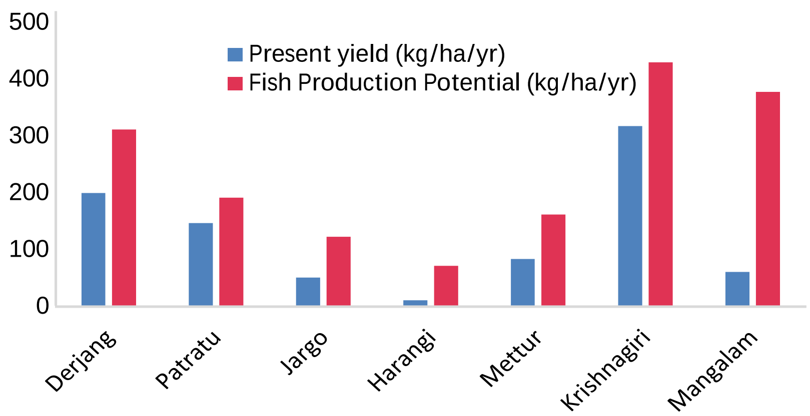


Fig.84 Fish production potential and the present fish yield in selected reservoirs

during pre-monsoon season while, *Gonatozygon* sp. during monsoon and *Chlorella* sp. were dominant in monsoon and during post-monsoon season respectively. In Mettur reservoir, 25 species of phytoplankton were identified, wherein *M. aeruginosa* dominated in all the seasons. Among zooplanktons, rotifers dominated in Mettur reservoir whereas, Cladocerans dominated in Harangi and Krishnagiri reservoir. In Jargo reservoir, 26 species of phytoplankton were recorded with 11 species belonging to Chlorophyceae, 6 to Myxophyceae, 6 to Bacillariophyceae and 2 to Euglenophyceae.

Fish diversity and production

A total of 42 and 28 fish species were recorded from Patratu and Derjang reservoir respectively. Species richness remained higher during monsoon season in both the reservoirs as compared to other seasons. The fish catch in Patratu reservoir was mainly constituted by IMCs (56%) with *Labeo rohita* being the dominant species, while in Derjang reservoir IMCs contributed around 80% of the catch. Patratu and Derjang reservoir showed a fish yield of around 147 and 200 kg/ha/yr respectively, which are lower than their astimated potential.

A total of 23, 14 and 20 species of fishes were recorded from Harangi, Krisnagiri and Mettur reservoirs, respectively. Small indigenous fish species dominated the catch in all the reservoirs. In Harangi reservoir, *Amblypharyngodon mola* dominated the catch while in Krishnagiri and Mettur reservoirs, *Puntius vittatus* and *Pethia conchonius* were dominant respectively. In Harangi reservoir, *Ompok pabo* distribution was common at all sites. However, few species like *Salmostoma bacaila, S. sardinella, Tor puttitora* and *Tor khudree* were generally abundant in lentic sector, however *Macrognathus aral* and *Barilius gatensis* were also common in lotic sector. In Krishnagiri, species abundance remained homogenous in all the sites due to small size of the reservoir. The fish diversity of Mangalam reservoir include 10 species belonging to 10 genera and 7 families. The production potential based on primary productivity of the reservoir was estimated at 378.6 kg/ha/yr; present average production was 14 % of the production potential, leaving a good scope for production enhancement in the reservoir.

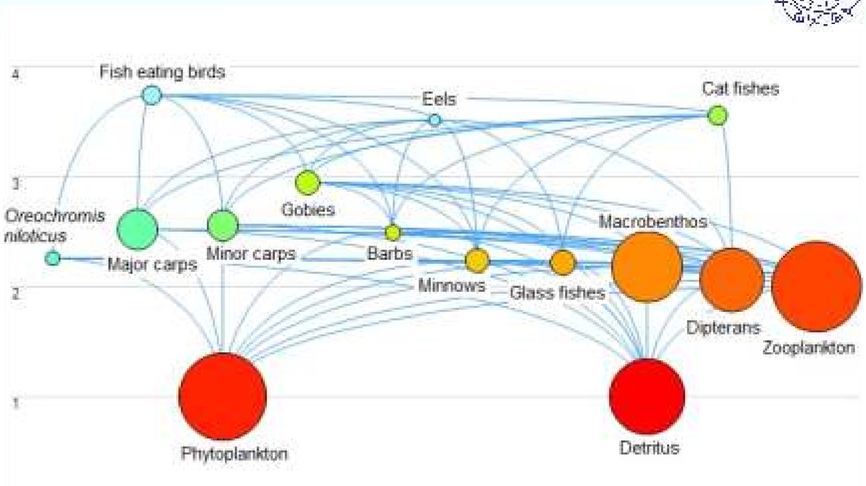


Fig.85 Trophic model of Mettur reservoir in Tamil Nadu

In Jargo reservoir of Uttar Pradesh, 38 fish species were recorded under 30 genera 12 families and 6 orders. The dominant fish species were *Labeo rohita* followed by *Sperata seenghala* and *Cirrhinus mrigala*. The estimated production potential (123.5 kg/ha/yr) was much higher than the present fish yield of 51.3 kg/ha/yr providing a good scope for enhancement of fish production in the reservoir also.

A mass-balanced model of Mettur reservoir in Tamil Nadu was constructed using 15 ecological groups to describe the food web and trophic flows. The mixed trophic impact routine showed that the freshwater eels, *Mastacembelus armatus* has a strong negative impact on minor carps whereas the catfish (*Mystus spp.*) have a negative impact on the major carps, *Glossogobius giuris* and the barbs. The total system throughput was 25639.7 t/km^2/yr and total biomass/total system throughput was 0.004. The primary production/biomass ratio was 101.3. Ratio of primary production to respiration was 7.84. All the attributes of ecosystem maturity and stability explicitly indicate that the ecosystem is in developmental phase.

The 'SMS' based Electronic Data Acquisition System (*eDAS*) was upgraded to 'Internet' based *eMatsya.* Telangana Fishery Department has identified '*fishery friends*' for their water bodies and started implementing *eMatsya* App in all districts. The '*enhancement requirements*' in *eMatsya* requested by the Telangana Fisheries Department are being incorporated in the next version.

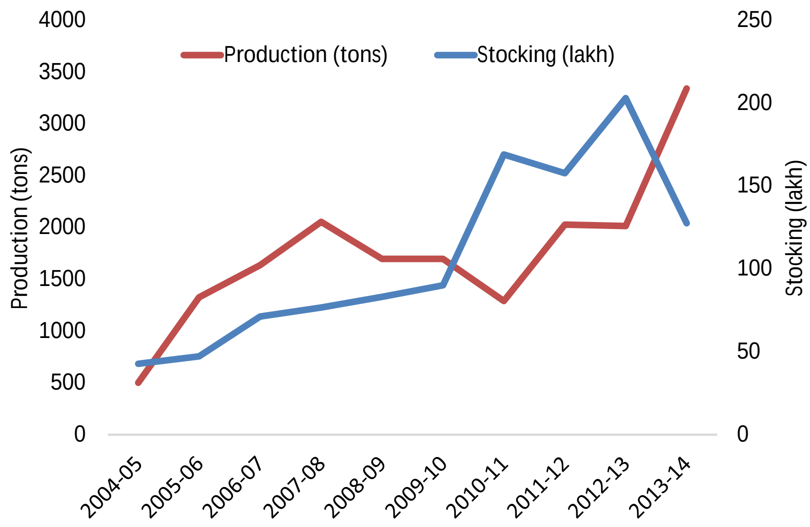


Fig.86 Impact of fish seed stocking in Gandhisagar reservoir, MP

Impact of stocking on fish yield

Assessment of the impact of stocking in Indirasagar reservoir, Madhya Pradesh indicated increase in fish yield from 1.1 kg/ha (stocking density (SD) : 86 fingerlings/ha) in 2004-05 to 43.46 kg/ha (SD: 304 fingerlings/ha) in 2017-18 due to adoption of fish stock enhancement strategy. In the same manner, the fish yield has increased from 12.1 kg/ha (SD) 103 fingerlings/ha) in 2004-05 to 80.8 kg/ha (SD: 308 fingerlings/ha) in 2013-14 in Gandhisagar reservoir.

Socio-economic status of reservoir fishers

The socio-economic status of fishers in the Derjang (Angul district, Odisha), Patratu (Ramgarh district, Jharkhand) and Jargo (Mirzapur district, Uttar Pradesh) reservoirs have been studied. Fishing activities in Derjang reservoir were carried out by a lessee who has taken the reservoir on lease on annual basis. Villages surrounding the reservoir are Haribeni, Rantlei, Benagadia, Portur, Golabandha, Tubei and Derjang. A co-operative society, named, Kalapat Primary Fishermen Co-operative Society, with 118 members to manages the fishing activities in the reservoir. Surveys of 28 fishers in Derjang reservoir, conducted through structured and semi-structured interviews revealed that the mean age of fishers was 38 years (range : 25 to 58 years). The primary occupation of all the respondents is fishing along with secondary occupation such as daily wage labour and farming. The average monthly household income was estimated as Rs. 6,500. Education level of the respondents was low : 53.57% have completed primary level of education, 21.43% have completed secondary level of school education, and 25% of the respondents have no formal school education. The major constraint perceived by the fishers in achieving the desired fish production is decreasing depth of the reservoir. The impending socio-economic problems of the fishers are inability of regular loan repayment on the part of fishers, and low income from fisheries as livelihood.

Fig. 87 Socio-economic survey at Derjang Reservoir

Fisheries in Patratu reservoir is managed by a number of co-operative societies functioning in villages surrounding the

Fig. 88 Study of Derjang reservoir

reservoir with the support of the Dept. of Fisheries, Govt. of Jharkhand. The surrounding villages are Barkhutua, Melani, Ucharinga, Haslajarad, Talatand, etc. A multi-sectoral institutional arrangement exists in the reservoir with fishery, tourism, irrigation and industrial use of water. Mean age of fishers is 35 years (range : 19-65 years). The primary occupations of the fishers are fishing and boat operation, and the secondary occupations are fishing, daily wage labour, farming, business and teaching. The average monthly household income has been estimated as Rs. 9,000 (range : Rs. 5,000-20,000). Most of the respondents are primary literate (37.93%), 34.48% of the respondents are secondary literate, and 24.14% of the respondents also have graduation level of education.

Socio-economic study of fishers in Jargo reservoir revealed that around 1,250 fishers abound in the surrounding villages Raipunia and Sultanpur. There are 80 members in the fisheries co-operative society "*Jargo Jalashay Matsyajibi Sahkari Samiti Ltd*". at Raipunia which exists for fisheries management in the reservoir. There are 80 members in the fisheries co-operative society. The mean age of the fishers is 47 years. The primary occupations of fishers are fishing and daily wage labour. The average monthly household income of fishers has been estimated as Rs. 11,780 (range : Rs. 3,000-60,000). 64% of the fishers have no formal school education.

Project Title : **Assessment and validation of potential fishery zones in medium and large reservoirs using hydroacoustics**

Project Code : **RWF/17-20/07**

Project Personnel : M. Feroz Khan, Sibina Mol

Associate : Vijaykumar M. E.

Hydroacoustics is a great tool in assessing fish distribution in large water resources. Krishnarajasagar(KRS) reservoir, located in the Mandya district of Karnataka state was taken up for study under the project. It is a large reservoir with an area of 12900 ha. River Kaveri with its tributaries Hemavati and Lakshmanatheertha debouch on the reservoir. There are 500 registered fishermen fishing in the reservoir. The major craft operated is fibre coracle and the major gear is gill net. The estimated average catch is about 87 kg/ month/person. The reservoir is stocked with fingerlings of *Labeo catla, Labeo rohita, Cirrhinus mrigala* and *Cyprinus carpio* .

For Hydroacoustic survey of KRS Reservoir, a portable Simrad EY60 split beam echo sounder with frequency 120 kHz and elliptical transducer (opening angles at -3dB were 4 and 10 degrees) was used. The pulse duration was set to medium (0.3 ms), the ping repetition rate to 5 Hz, and the Target Strength and Sv thresholds to –33 dB and –70 dB, respectively.

Fig. 89 Hydroacoustics survey of Krishnarajasagar(KRS) reservoir

Salient water parameters, such as dissolved oxygen, temperature, conductivity were measured at surface using portable instruments and data were incorporated in SIMRAD ER60 software.

The acoustic runs were made and the histograms were de-convoluted to account for random aspect of fish distribution and then used for scaling the integrator values. The acoustic surveys and depth profiling was conducted in intermediate zone. Four transects selected at intermediate zone showed number of fishes ranging from 54-307 by echo counting.

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

Project Code : **RWF/17- 20/08**

Project personnel : Preetha Panikkar, M. Feroz Khan, Jesna P. K.

Associate : Vijaykumar M. E.

Feed incurs the major cost in agriculture and protein-rich ingrediants are very costly. In an effort to reduce feed cost and find alternate protein sources, a cost effective protein rich and palatable insect meal based fish feed was developed using the Black soldier fly (*Hermetia illucens*); pre-pupae meal. Successful feeding trials were conducted in Amur carp, *Cyprinus carpio* and *Pangasianodon hypophthalmus*. Nutritional profile of the Black soldier fly (BSF) pre-pupae grown on vegetable waste was analysed and total protein and crude lipid on dry weight basis were 32.53% and 22.1% respectively. The chitin content of prepupae was 11%. Microbiological analysis of BSF pre-pupae as well as BSF incorporated diet revealed the absence of *Escherichia coli* and Salmonella. The analysis of presence of heavy metals in BSF incorporated diet showed that, the concentration (ppm) of Arsenic, Chromium, Cadmium, Lead and Mercury were well below the EU limits for heavy metals in fish feed.

Evaluation of BSF-incorporated feed in Amur Carp (Cyprinus carpio)

A 90 days feeding trial was conducted to evaluate the potential of BSF pre-pupae meal (BSFM) for complete and partial replacement of fish meal (FM) in Amur carp. Four different types of feed were prepared with 0, 30, 70 and 100% BSFM diet and fed to fish at 10 % of biomass twice a day. There were no significant differences ($P \leq 0.05$) in growth performance among fishes fed different diets with up to 70% fish meal replacement. However, fish fed diet with 100% replacement of fish meal had significantly lower growth with significantly lower ($P \leq$

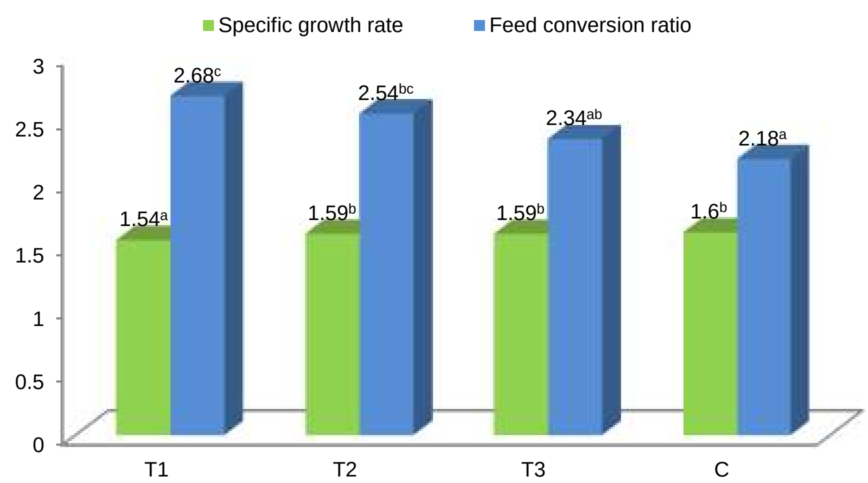


Fig. 90 Specific growth rate and Feed conversion ratio of Amur carp

0.05) average final weight, mean weight gain, percentage weight gain and specific growth rate. Lowest FCR (2.18[a]±0.08) was recorded in fish fed diet with 0% fish meal replacement which was statistically different (P≤0.05) from the treatment with 70% fish meal replacement. The results of the study indicate that up to 70% fish meal can be replaced with BSFM without affecting growth and survival of Amur carp fingerlings.

Evaluation of BSF incorporated diet in Pangasianodon hypophthalmus

An experiment was conducted to evaluate the efficiency of Black soldier fly meal (BSFM) to replace soyabean meal (SBM) as well as fish meal (FM) in diet for Pangas (2.13 ± 0.03g). After 60 days of feeding trial it was observed that there was significant difference in growth of Pangas in different treatments. Mean weight gain was significantly higher in fish fed with BSFM diet (1.56[a]±0.11) as well as for the fishes fed with dried pre-pupae (1.59[a]±0.07) in comparison to fishes fed FM and SBM diet. The percentage weight gain, Feed efficiency ratio (FER) and specific growth rate (SGR) of SBM diet fed fishes were significantly lower than for the fishes fed with BSFM diet. However, the FM diet was not significantly different with any of the diet. Lowest food conversion ratio (FCR) values were observed for fishes fed with BSFM diet and for the fishes fed with dried prepupae. Best growth and FCR was observed with BSFM diet fed groups indicating the propensity of Black soldier fly pupae meal as an alternate animal protein source in freshwater fish feeds.

Fig. 91 FCR, FER and SGR of Pangasius

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

Project Code : **RWF/17-20/09**

Project Personnel : B. K. Das, U. K. Sarkar, A. K. Das, M. A. Hassan, D. Das, D. Debnath, A. K. Sahoo, P. Das, S. Yengkokpam, S. Kumari, G. Karnatak, P. Mishal, H. S. Swain, T. Tayung, M. Ramteke, V. Thakur, S. Kamble, P. K. Jesna and R. Das

Associates : A. Sengupta, Subrata Das, Y. Ali, B. K. Naskar and D. Saha

The main objective of the project is to introduce different fish species of high demand in cage culture. Experiments were conducted to find suitable fish species, their stockings density and beneficial combination in cage culture.

Optimization of stocking density for grow out of Labeo bata *in cages*

Labeo bata (6.18±1.32g) were reared in three stocking densities, *viz*. 50m-

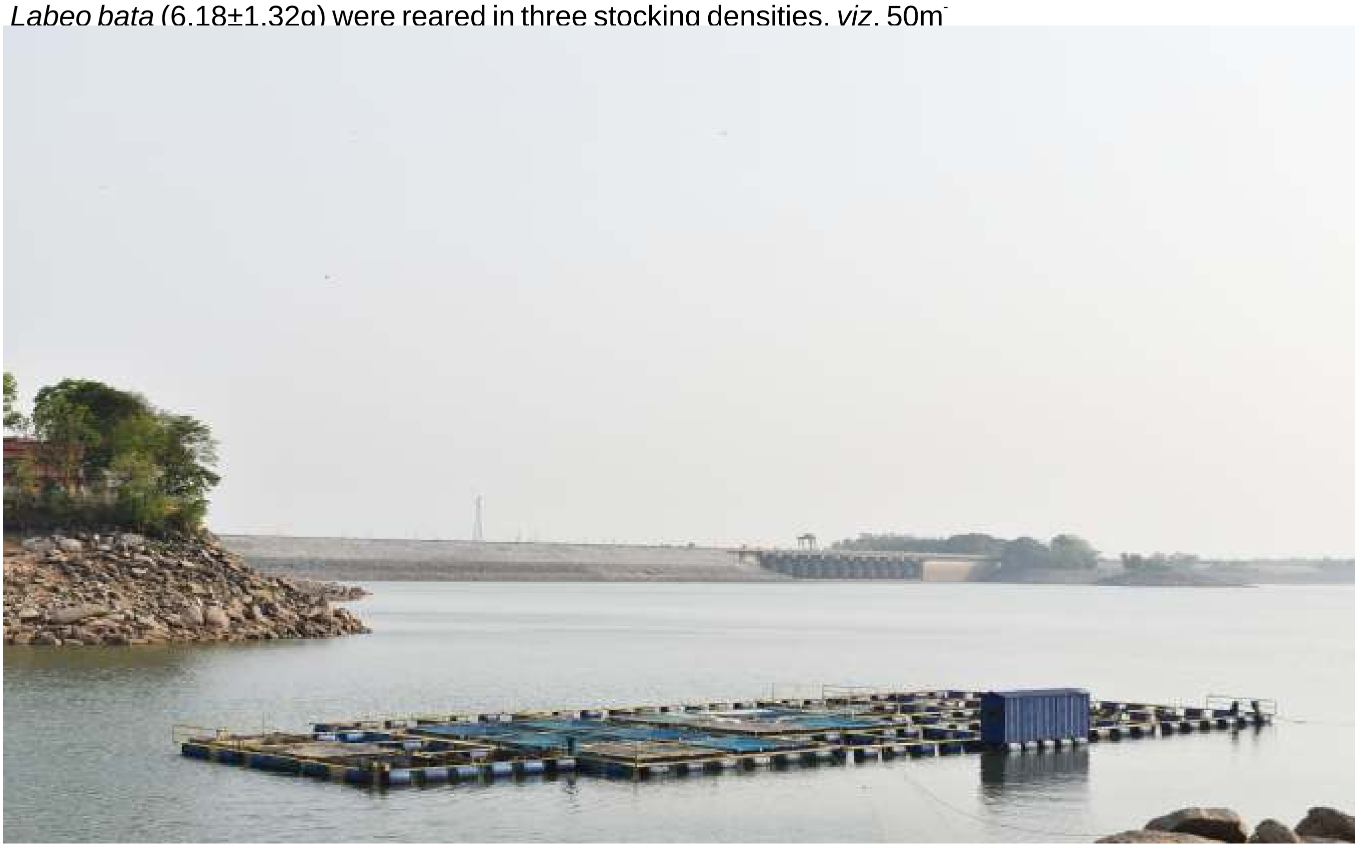


Fig. 92 Cage culture experiment at Maithon reservoir

Fig. 93 Haul of *L. bata*

Fig. 94 *O. bimaculatus* grown in cage

There was no significant difference in growth between the treatments 75m^{-3} and 100m^{-3}. Specific Growth Rate (SGR), feed utilization and efficiency was significantly higher (p<0.05) in lower stocking density *i.e.* 50m^{-3} as compared to 75m^{-3} and 100m^{-3}. Feed Conversion Ratio (FCR) was lowest at stocking density of 50m^{-3}.

Feasibility of polyculture of Ompok bimaculatus *with L. bata in cages*

Butter cat fish, *O. bimaculatus* (2.18±0.78g) in combination with *L. bata* (6.18±1.32g) were stocked in cages (5x5x2) in duplicate at the rate of 50m^{-3} (O:L ::3:2) to study feasibility of polyculture of these species in cages. The fishes were fed with a combination of extruded floating (CP: 32%; CL 5%) and sinking feed (CP:38%; CL 6%, Tray feeding) @5% of the body weight. After 150 days of culture final weight was 31.61±1.45g and 13.9±0.18g with 78% and 60% survival in *L. bata* and *O. bimaculatus* respectively. This preliminary study indicated that polyculture of these two species is feasible in open water cage culture.

Polyculture of Barbonymus gonionotus *and* Pangasianodon hypophthalmus *in cages*

An experiment was conducted to evaluate the perusal of herbivore fish, *Barbonymus gonionotus* (commonly called as 'Java Punti' or Gonionotus) for savaging bio-fouling organisms and salvaging production efficiency, in cage polyculture with *Pangasianodon hypophthalmus* (Pangas) in a tropical Indian reservoir, Salia, Odisha. The polyculture experimental setup followed Randomized Block Design (RBD) in five treatment group of species ratio of Pangas and Gonionotus : (P:G) 80:2 0(T-1), 60: 40 (T-2), 50:50 (T-3), 40:60 (T-4), 20:80 (T-5), and monoculture of Gonionotus and Pangas designated as T-6 and T-7, respectively. All the experimental treatments were carried out in replicates. Stocking density was maintained @ 50 nosm^{-3}. Growth and survival of Gonionotus and Pangas was found significantly (p<0.05) higher in T-1 (80:20, P:G). The growth of biofouling organism was completely controlled in cages stocked with Gonionotus. Plankton and periphyton densities were also found lower in polyculture and monoculture of Gonionotus than the monoculture of Pangas. The food selectivity index of Gonionotus indicated positive preference towards the biofouling organism while Pangas shows negative preference (value). Thus, present study suggested that 20% incorporation level could enhance production efficiency in commercial grow-out Pangas cage farming on one hand, and pave a prolific way for creating a green environment by salvaging the inland cages through savaging the

Fig. 95 Poly culture of *B. gonionotus* and *P. hypophthalmus* in cage

biofouling organisms for sustainable cage farming in tropical reservoirs on other hand.

Feasibility study of grow out farming of Labeo rohita *in cages*

Cage culture has emerged as a new potential sector to enhance the fish production from inland open waters. However, proper fish species selection which is having good market demand is the need of the hour as the traditional cage cultured species, Pangas and Tilapia are having least market demand in India and abroad as well. Therefore, a study was conducted to evaluate the feasibility of grow out farming of *L. rohita* for cage culture in different tropical reservoirs of India. The study was undertaken at three different agro-climatic conditions *viz*. Salia reservoir, Odisha, Palair reservoir, Telengana and Kamath reservoir, Maharashtra. The advanced fingerlings of *L. rohita* were collected locally as per the size availability and stocked in the cages @10 nos m^{-3}. The initial stocking size of *L. rohita* was 30.0 ± 6.24 g, 45.5 ± 7.50 g and 10.79 ± 3.54g in Salia reservoir, Palair reservoir and Kamath reservoir respectively. After 180 days of culture the final weight of *L. rohita* in Salia reservoir and Palair reservoir were 298.5 ± 16.23 g and 450.77 ± 32.76 g respectively; growth of the fish was 415.58 ± 27.62 g at Kamath reservoir after 240 days of culture. The results showed feasibility of incorporation of rohu in inland cage culture along with species like Pangas and Tilapia. Further, stocking density and stocking size of Rohu is need to be standardized for inland cage culture.

Effect of stocking densities on the growth performance of Pangasianodon hypophthalmus *in cages*

Pangas, *Pangasianodon hypophthalmus, is* commonly known as the world's third most important freshwater cultivable species due to its fast growth and versatile feeding habit. In India, the inland fresh water cage culture is dominated by Pangas. It was observed in many states that Pangas is being stocked @ 60-100 nos. m^{-3} in inland cages of reservoirs of India. However, the growth and survival of Pangas is inversely proportional to stocking density and many farmers are also facing size differentiation at the above stocking densities. Addressing the above practical problem, the present study was conducted in order to know the effect of different stocking densities on the growth performance of Pangas in cages in Salia reservoir of Odisha. Advanced fingerlings of Pangas with an average weight of about 48.24±1.45 g were stocked in six different stocking densities *viz*. 20, 30, 40, 50 and 60 nos. m^{-3} designated as T-1, T-2, T-3, T-4 and T-5. The experimental treatments were conducted in duplicate for a period of 240 days. The final weight (1225.12 ± 40.533 g),


Fig. 96 *P. hypophthalmus* harvest from cage

Specific growth rate (1.35 ± 0.016) and Survival (91.00 ± 2.646 %) were highest in lowest stocking density (20 nos. m^{-3}) whereas, the lowest growth was observed in highest stocking density (60 nos m^{-3}). However, total fish biomass production was significantly ($p<0.05$) higher at the stocking density of 30 and 40 nos. m^{-3} and FCR was found lower in these two stocking densities . Therefore, the study suggest that the culture of pangas in lower stocking densities (30-40 nos.m^{-3}) can be considered as an optimum for the inland fresh water cage culture to reduce the feed and seed cost with higher growth and survival for maximization of economic return

First record of sponge infestation in inland cages

Biofouling is a serious problem in cage aquaculture. However, organisms causing biofouling have not been identified properly. In this study occurrence of sponges was recorded from cages under operation from two different reservoirs (Salia reservoir and Maithon reservoir) of India. Sponges were found strongly attached to the cage net which were carefully collected. Study of the spicules and gemmules using light and scanning electron microscopy revealed characters that of a closely related spongillid, *Spongilla lacustris.* The same was confirmed through molecular marker COX I & 16S rRNA gene sequencing and further BLAST analysis revealed the 96%-98% similar to *S. lacustris.* Proximal and mineral profiling of the sponge was performed and the ash content was found to be high (74.75%). This is the first report on fresh water sponge infestation in fresh water cage aquaculture in India and may pave the way for developing antifouling agent for inland cage net

Fig. 97 Biofouling in inland cage

Compatibility of Labeo rohita *with* Oreochromis niloticus *and* Pangasianodon hypopthalmus *cage culture*

Grow-out study on compatibility of *Labeo rohita* (Rohu) with *Oreochromis niloticus* and *Pangasianodon hypopthalmus* had been initiated in cages in Kamath reservoir, Sangli, Maharashtra. The four treatments used were: T-1 : *P. hypopthalmus* at 5000 nos/cage, T-2: *O. niloticus* at 5000 nos/cage, T3: *P. hypopthalmus* and *L. rohita* at 4000 and 1000 nos/cage respectively and T4: *Oreochromis*

Fig. 98 Sponge in inland cage

niloticus and *Labeo rohita* at 4000 and 1000 nos/cage respectively. The average initial size of rohu, Pangas and Tilapia were 10.8, 15.2 and 13.3 g, respectively. Standard procedures of pre-stocking and post stocking managemnt were followed in cages. Fish were fed with a commercial floating pellet (cp 28%). Fish growth was assessed every month and daily feed requrement was re-determined based on the average fish growth and survival. After 240 days of culture, the growth of Pangas and Tilapia in terms of average body length and weight were higher in combination with Pangas-Rohu (T-3) and Tilapia-Rohu (T-4) compared to single stockings treatments T-1 and T-2, showing no competition between Pangas, Tilapia and Rohu. Growth of Rohu in both treatments shows similar trend, and no much deviation in growth while compared with pond culture.

Optimization of stocking density of Labeo bata *fingerlings in ICAR-CIFRI GI cage in wetland*

A cage aquaculture experiment was carried out in ICAR-CIFRI GI-cages to optimize the stocking density of *Labeo bata* fingerlings for production of table-sized fish in floodplain wetlands. Sixteen units of cages (individual cage dimension: 5x5x2 m each) were installed in Samaguri beel of Nagaon district, Assam, India. The cages were stocked with *L. bata* fingerlings (av. weight 13.05 g) at five different stocking densities : 10 (S1), 20 (S2), 30 (S3), 40 (S4) and 50 fingerlings m^{-3} (S5), in triplicates. Fish were fed with floating feed containing 32% CP @ 3-5% body weight twice-a-day for six months. Water quality parameter were assessed bimonthly inside and also outside the cages. The water quality parameters were observed to be similar in all the sites at any particular sampling time. Results of the experiment indicated that with increase in stocking density, the growth rate of *L. bata* decreased. Fig. 1. The specific growth rate at different stocking densities were: 1.03 (S1), 0.88 (S2), 0.84 (S3), 0.67 (S4) and 0.52 (S5) with corresponding weight gain of 533.33%, 385.82%, 353.26%, 232.18% and 155.94%. However, the highest biomass was achieved at stocking density of 30 fingerlings m^{-3} (71 kg/cage), which was significantly higher than S1 and S2 but similar to S4 and S5. Economics of rearing *L. bata* showed that B:C ratio was the highest at stocking density 30 fingerlings m^{-3}. Hence, a stocking density of 30 fingerlings m^{-3} can be considered optimum for producing table-sized *L. bata* in GI-cages in the beels of Assam.

Nursery Rearing of Singhi in Recirculatory System

Heteropneustes fossilis, called Singhi, is a highly priced and sought-after catfish in India. It is also an ideal and climate resilient species for aquaculture and fisheries for growth in high stocking densities, survival in low oxygenated waters, low fat, high protein and iron contents. To grow table size *Heteropneustes fossilis* in cage is an objective of the study. Before stocking in cages, the Institute successfully raised *H. fossilis* seed in Recirculating Aquaculture System (RAS). Fish seed weighing 0.2g was stocked in RAS with appropriate management practices and grown to an average weight 8-12g, with 80% survival, in two months rearing period. Fingerlings of this size are suitable for rearing in cages and pens for enhancement fish production in wetland and reservoirs.

Feasibility of Etroplus suratensis *in cages in Krishnagiri reservoir*

Etroplus suratensis was stocked at the rate of 10 nos.m^{-3} in HDPE floating cages (3x3x2m) in Krishnagiri reservoir (12°29'37?N 78°10'41?E), Tamilnadu. Fishes of average weight 5.98 ± 0.52g grew to 68.28 ± 0.35g after 6 months of culture. Mean weight gain was low during the first two months of culture but steadily increased after that. Percentage weight gain, specific growth rate, food conversion ratio, feed efficiency ratio and protein efficiency ratio of the fishes after 6 months were 1041.8 ±1.41%, 1.16±0.04, 2.35±0.02, 0.42±0.01 and 1.32±0.01, respectively. Overall, the growth of *Etroplus* was found to be satisfactory in freshwater cages, despite survival (52%). Comparison of plankton abundance between cage site and

Fig. 99 *H. fossilis* grown in RS system

reference point (100 m from the cage) showed that zooplankton density (no. of individuals/litre) at cage site (91.67±6.66, 422.33±12.66, 574.01±4.58 was significantly higher than the reference site (67.17±6.66, 232.66±10.02, 452.05±9.21) during 1st, 3rd and 7th month respectively. Similarly, phytoplankton density (no. of cells/litre) at cage site (152283±134.63, 437546±56.86, 226513±23.09 was significantly higher than the reference site (112243±40.42, 330516±67.62, 148286±175.94) during 1st, 3rd and 7th month respectively. The high density of plankton at cage site may be due to the availability of primary nutrients derived from the decomposition of leftover feed in the cage.

Pen culture in Loni wetland

Pen culture was done for seed raising in the Loni wetland situated in Rewa district in Bundelkhand region, Madhya Pradesh (Loni 25°08'18'' N and 81° 34'14'' E). The pen (50m x 20m) was stocked with 20000 numbers of Catla, Rohu and Mrigal with initial weight 2.1, 2.83 & 2.82g, respectively @20/m^2. After a culture period of 60 days, Catla, Rohu and Mrigal attained a final weight of 24.25, 19.58 & 15.42g, respectively. The juveniles were harvested and released in to the wetland for stock enhancement.

Fig. 100 Fish seed before stocking in pen in Loni wetland

Fishery Resource and Environmental Management Division

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

Project Code : **FREM/17-20/11**

Project Personnel : S. Samanta, S. K. Nag, M. Naskar, Sajina A. M., Vikas Kumar

Associates : S. Bhowmick, K. Saha, S. K. Paul, S. Bandyopadhyay, A. Ghosh

River Godavari

The entire stretch of river Godavari from Gangapur Dam at Nashik to Yanam was surveyed for assessment of pollution, water and sediment quality aspects and fisheries status. The total river length of approximately 1465 km was divided into 8 sampling stretches and 10 sampling sites *viz.* Nashik (Gangapur Dam), Nashik (Nasardi), Nanded (dam), Markandyaghat (Nanded), Sriramsagar, Ramagundam, Bhadrachalam, Polavaram, Rajamundry and Yanam.

Fig. 101 Sampling sites of river Godavari

Water and sediment quality

The water availability in the upper stretch of the river *viz.* Nasik to Ramagundam, in the states of Maharastra and Telangana, is limited due to construction of a series of dams. The water availability in the Nashik to Nanded stretch was very low, even during monsoon season. Major part of the city effluent is diverted to the river which is running like a drain with unsuitable aquatic habitat.

During pre-monsoon, water quality parameters recorded were highly stressful to aquatic communityin the Nashik to Ramagundam stretch. A very low DO (1.0 mg/L at Nashik Nasardi), high BOD up to 32 mg/L (at Nashik Nasardi, Markandya ghat Nanded), high specific conductivity (up to 1370 µS/cm at Markandya ghat Nanded), high alkalinity (up to 360 mg/L at Markandya ghat Nanded), high hardness (up to 360 mg/L at Markandya ghat Nanded) and high nutrient loading of phosphate (up to 1.74 mg/L) and nitrate (up to 0.54 mg/L) were recorded. During monsoon the situation improved partially. Lower BOD (up to 12 mg/L), higher DO (up to 4.2 mg/L), lower specific conductance (up to 567 µS/cm) were observed. In Telangana and Andhra Pradesh stretch of the river (Sriramsagar to Yanam) its condition has gradually improved with relatively more flow.

The river Godavari sediment is sandy in nature (sand 86 to 99.5 %) except in impounded areas like Nanded Barrage (66%) due to construction of dams and barrages. Impact of pollution was prominent in Nasik Nasardi area with high organic matter accumulation (3.9%) and high specific conductance (1621 µS/cm). Sediment reaction was alkaline for the entire stretch of the river (pH 7.6-8.9).

Heavy metal contamination

The trace metal (Cd, Cr, Cu, Mn, Pb and Zn) contents in water of the river Godavari was assessed. Other than Mn, all the other metals were recorded at below detection limit of the flame mode of Atomic Absorption Spectrometer. Recorded concentration of Mn was 47-560 µg/l. Thus, the water metal contents were safe for the aquatic community.

The river Godavari was moderately contaminated with the trace metals Cu, Zn and Cr. In almost entire stretch except Ramagundam and Yanam, High Cu level upto 171 mg/kg was recorded and the level is much higher than the pollution limit of 25 mg/kg. In some of the sampling stretches such as Nasik (Nasardi), Nanded (Dam site)

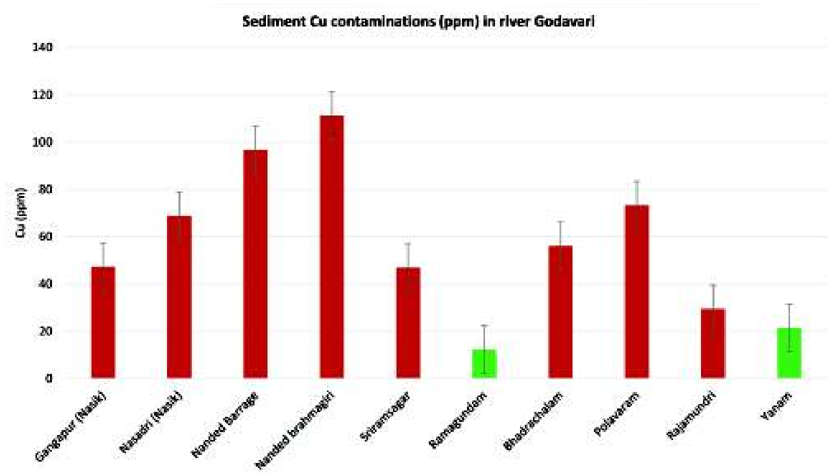


Fig. 102 Sediment Cu contaminations in river Godavari

and Bhadrachalam, Zn contamination was also recorded to be above the pollution limits of 90 mg/kg.

Study on metal contents in fish fleshes indicated that Cd, Cr and Cu were below the detection limits. Mn was recorded in the range of BDL to 5.3 mg/kg, and Zn 1.28-15.13 mg/kg. Comparison of the data with the permissible limits in fish flesh for human consumption indicated that the fishes were safe for human consumption.

Water (n=15) and fish (n=25) samples collected from different sampling spots along the river were analysed for multiple pesticide residues belonging to 3 groups, *viz.* organochlorines (OC), organophosphates (OP) and synthetic pyrethroids (SP). In water samples, contamination with the OCs was least (13%), followed by OPs (26%) and SPs (33%). Among the different OCs, only HCH in one and -HCH in another sample was detected. The concentration of -HCH (1.21 µg/l) was, however, higher than CMC value of 0.95 µg/l as recommended by USEPA for aquatic life. Residues of two OPs *viz*., chlorpyriphos and dichlorvos were present in water samples. Chlorpyriphos residues was recorded in water samples of Nanded, Sriramsagar, Mancherial and Ramagundam at concentration 0.089 – 1.73 g/l and these values exceed both CMC (0.083 g/l) and CCC (Criterion Continuous Concentration) value of 0.041 g/l recommended by USEPA. Dichlorvos (0.193 g/l) was detected in Mancherial sample. Fenpropathrin (0.01-0.148 g/l), cyhalothrin (0.02-0.08 g/l) and cypermethrin (0.014 – 0.039 g/l) were the SPs recorded in water samples of most of the spots.

In fish, residue of OC could be found in only one sample. However, OP and SP residues were detected in 16% and 11% samples respectively. Chlorpyriphos (0.005-0.834 mg/kg) was the predominant OP recorded in fish species like *Wallago attu, Osteobrama vigorsii, Eutropiichthys murius* and *Ompok bimaculatus. Among* the SPs, like water samples, residues of fenpropathrin (0.01-0.15 mg/kg) in *Oreochromis niloticus flesh* and gill, cyhalothrin (0.083 mg/kg) *O. niloticus* flesh and cypermethrin (0.015-0.212 mg/kg) were recorded in *Sperata seenghala* flesh and *O. niloticus gill.*

Fig.103 *Pterygoplichthys disjunctivus*, caught at Nashik from River Godavari

Fish Diversity

A total of 96 fish species including 6 exotic species, recorded from 10 sampling stations under 35 families were. The Invasive Coefficient Index (ICI) values were less than 0. 1 for all species except *O. niloticus,* which was as high as 0.83 at Nashik. The distribution of species in various metrics such as higher number of omnivores, less number of rheophiles and low number of species with high PDT (Population Doubling Time) point towards impairment of ecological health of the river. A total of 28 macro-invertebrate species which comprises 8 gastropods, 9 bivalves, 4 insects, 2 polychaetes, 3 oligochaetes and 2 crustaceans were also reported from the river. Chironomid larvae dominated in Nashik sample indicating organic pollution in the river stretch. The large scale immersion of idols during Ganeshotsav was also found to pollute the river.

Fig. 104 Idol immersion in river Godavari

Kathjodi River

Studies in river Kathajodi was continued. The influence of Cuttack city effluent was prominent which increased BOD load above 6 mg/L at Matagajpur-Italanga stretch of the river. Enrichment of the nutrients *viz.* NO_3 (up to 0.5 mg/L) and PO_4 (up to 0.30 mg/L) were recorded in water phase. During monsoon the water flow in the river was high and the Cuttack city effluent had no impact on the river water and sediment quality aspects.

Fig. 105 Various categories of IBI metrics for River Kathjodi

In order to assess the ecological health of River Kathajodi, Index of Biotic Integrity (IBI) scores were estimated for the freshwater stretch and Estuarine Fish Community Index (EFCI) scores were estimated for the tidal influence in brackish water stretches. The IBI adopted was 13 metrics based on taxonomic richness, habitat and ethological guild composition, trophic guild composition and species resilience. While selecting the 12 metrics for EFCI, the metrics reflecting the nursery and breeding function of estuarine stretches of rivers were also incorporated. The IBI scores varied from 29-44 indicating that ecological health of some of the freshwater stretch was severely impaired and the remaining stretches were moderatly impaired. EFCI scores revealed slightly and moderately impaired ecosystems in the tidal stretch of river.

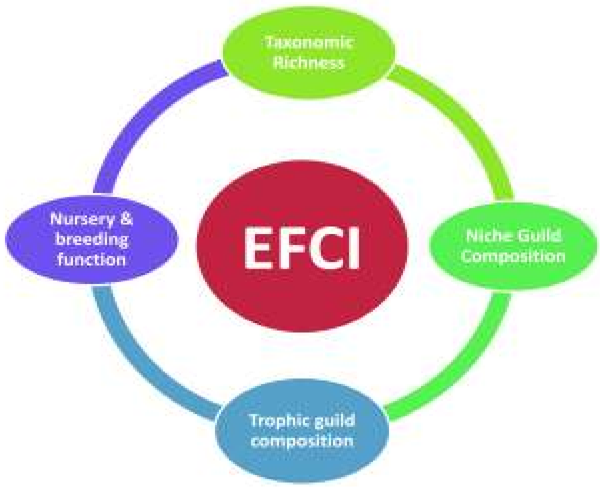


Fig. 106 Various categories of EFCI metrics for River Kathjodi

Water (30) and fish (57) samples collected from different

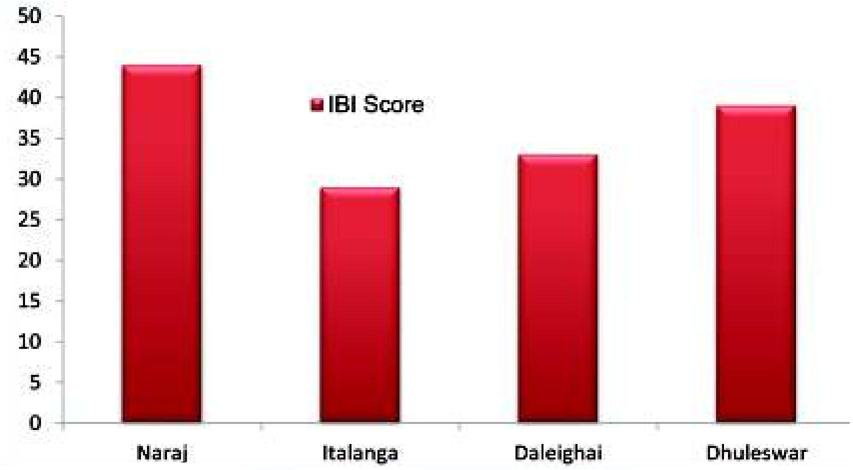


Fig. 107 IBI Scores of freshwater stretch of River Kathajodi

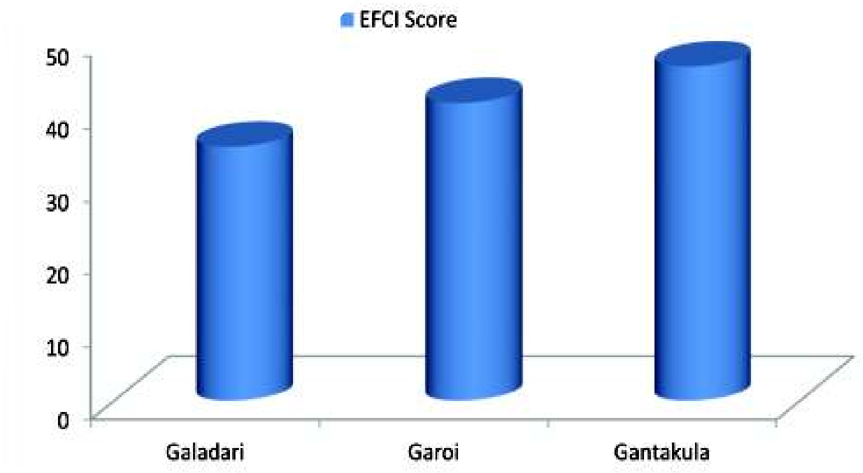


Fig. 108 EFCI Scores of tidal estuarine stretch of River Kathajodi

sampling spots along the river were analysed for pesticide multiresidues organochlorines (OC), organophosphates (OP) and synthetic pyrethroids (SP). In water 20% samples were contaminated with OCs and OPs and with SPs contamination was much higher at 67%. About 23% fish samples had OC residues but OP and SP residue contamination in fish were comparatively much lower, to the extent of 12 and 9% samples respectively.

Water samples

Among the OCs analysed, HCH isomers (HCH 0.099 µg/l), DDTs (DDT 0.01-0.034 µg/l) and endosulfans (Endosulfan 0.043-0.081 µg/l) were detected through GC-ECD in few samples. In regard to OP residues only chlorpyriphos (0.014-0.31 µg/l) was detected. Among the SPs cypermethrin (0.01µg/l) and fenpropathrin (0.01-0.075 µg/l) were present. The concentrations of pesticides in water were within the critical maximum concentration (CMC) as recommended by USEPA for aquatic life.

Biota (Fish)

More than one third fish samples were found to contain OC residues. In flesh of *Cirrhinus reba* and *Liza macrolepis* residue of HCH was detected and its concentration (0.53-0.68 mg/kg) was higher than tolerance level (TL) of 0.25 mg/kg. However, concentration of DDT (0.001-0.008 mg/kg) and endosulfan (0.001-0.035 mg/kg) in positive samples were much lower than their respective TLs. Among the OPs residues of chlorpyriphos (0.006-0.008 mg/kg) and dichlorvos (0.004-0.56 mg/kg) were mainly detected flesh of different fish species. Among the SPs, cypermethrin residue (0.259 mg/kg) could be detected in *Mugil cephalus* while fenvalerate (0.018-0.029 mg/kg) was found in flesh of *Labeo boggut*, *Wallago attu*and *Sillago sihama.*

Project Title	:	**Emerging contaminants in rivers (Teesta, Torsa) and East Kolkata Wetland and their effect on selected biota**
Project Code	:	**FREM/ER/17-20/12**
Project Personnel	:	S. K. Nag, Md. Aftabuddin, Soma Das Sarkar, Kavita Kumari, Rohan Kumar Raman
Assosiates	:	Keya Saha, S. Bandyopadhyay, S. K. Paul, A. Ghosh

During the year (2018-19) water, sediment and fish samples were collected during pre-monsoon (June) and post-monsoon (November) seasons from different sampling sites *viz.* Dalshingpara, Subhasini Tea Estate, Silbarihut, Kachubon and Harinchora along the River Torsa. Water and sediments were analysed for physico-chemical properties. For monitoring occurrence of pesticide residues samples were extracted, cleaned up and analysed in gas chromatograph. Residues of antimicrobial compounds Triclosan, its

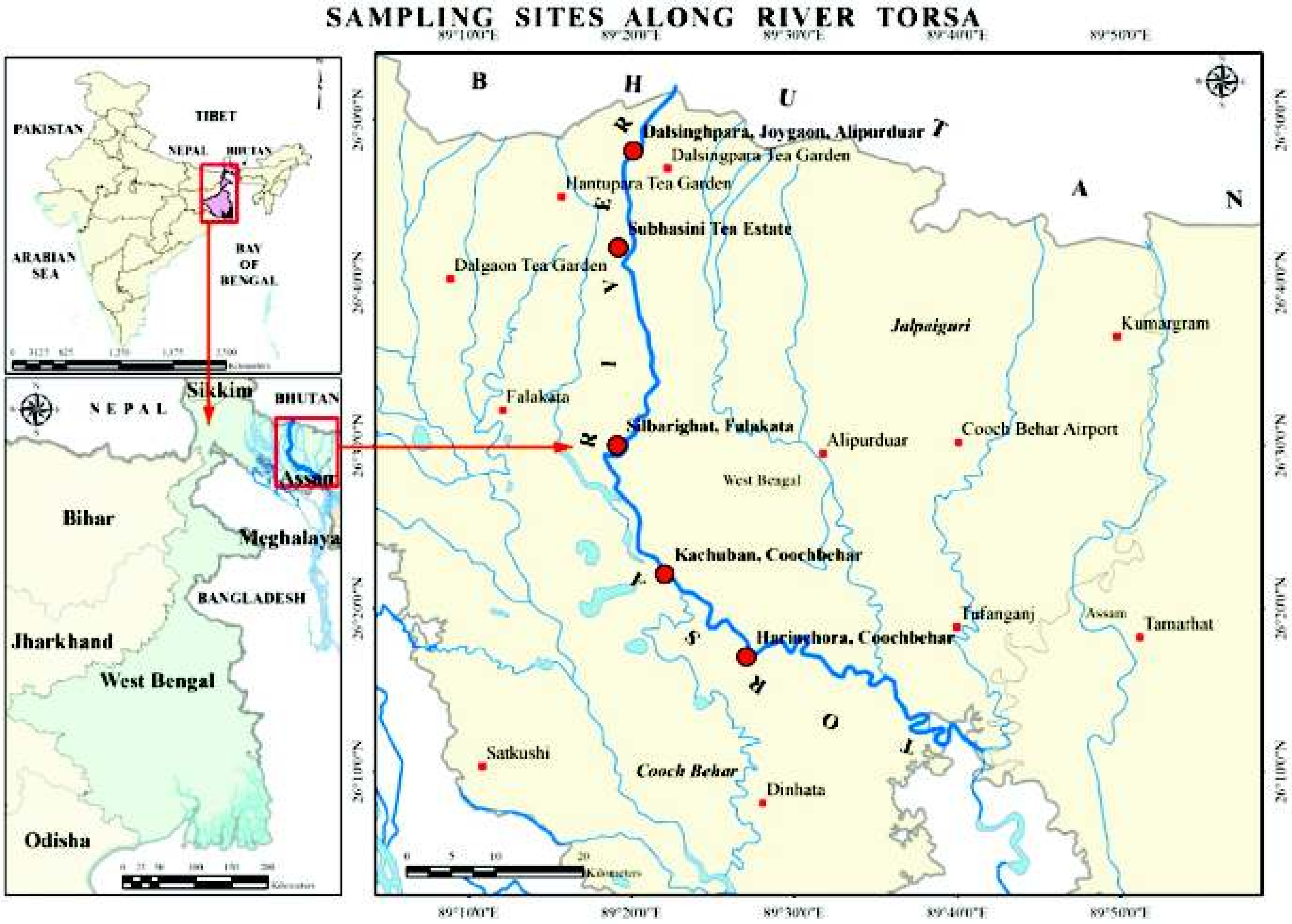


Fig. 109 Sampling points on River Torsa

methyl derivative and Triclocarban were also monitored in East Kolkata wetland ecosystem. Ecotoxicological studies of selected contaminants present in the environment were also conducted.

Pesticide residues in river Torsa

A total of 34 compounds including pesticides and their metabolites belonging to three groups viz., Organochlorines (OC), Organophosphates (OP) and Synthetic pyrethroids (SP) were examined for their presence in different matrices.

Water

No residue of any OCs was detected in water. However, OPs and SPs could be detected in 20% and 37% of water samples respectively. Among different OPs, only chlorpyriphos residue was present at concentration from 0.04-0.92 µg/l. So, as per the USEPA aquatic life criteria of different contaminants for fresh water, the critical maximum concentration (CMC) of chlorpyriphos (0.083 µg/l) was exceeded in few samples. Cypermethrin (0.695 µg/l) and fenpropathrin (0.011-0.047 µg/l) were the two SPs recorded.

Sediment

About 7–10% of sediment samples were contaminated with all the three groups *i.e.* OC, OP and SP. Among the 16 OC compounds, only op-DDE and pp-DDD were recorded and total DDT concentration (0.001-0.003 mg/kg) was negligible. Chlorpyriphos was the only targeted OP pesticide detected at concentrations 0.002-0.005 mg/kg. However, out of eight targeted SP pesticides, only three *viz.*, cypermethrin, cyhalothrin and fenvalerate were present at concentrations 0.253 – 2.41 mg/kg.

Plankton

To find out accumulation of residues along the food chain in aquatic systems, plankton samples were also analysed. Out of three groups of pesticides, residues of only OCs were detected. DDE (op and pp) and DDD (op) were the OCs recorded. Total concentration of DDTs was between 0.1 - 0.16 mg/kg.

Fish

With regard to fish, 33% samples were found to be contaminated with OCs, 7% with OPs and 13% with SPs. OC compounds *viz*., HCH isomers, DDTs and endosulfans were detected in different finfishes collected from the river. However, the concentration of HCH, DDT and Endosulfan detected were 0.007-0.014, 0.001-0.696 and 0.091 – 0.104 mg/kg respectively, and were much lower than the respective Tolerance level (TL) recommended by FSSAI.

Like water and sediment, chlorpyriphos was the only OP pesticide detected in fishes, such as *Puntius sophore*, *Barilius* sp., and *Gagata gagata*. However, the concentration of chlorpyriphos found in fishes (0.018-0.058 mg/kg) was below TL of 0.1 g/g set by FSSAI for carcass fat of meat and poultry.

Among the SPs, cypermethrin and deltamethrin residues could be found. Cypermethrin at concentrations 0.138-0.155 mg/kg was detected in *Barilius* sp., *Labeo calbasu* and *Heteropneustes fossilis,* while deltamethrin (0.045-0.054 mg/kg) was detected in *Barilius* sp., and *Changunius* sp. Detected cypermethrin concentrations were below the TL of 0.2 g/g recommended by FSSAI for carcass fat of meat and poultry.

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

Antibacterial compounds, widely used in different personal care products, like Triclosan [TCS, 5-chloro-2-(2,4-dichlorophenoxy)-phenol], one of its more persistent metabolite methyl-triclosan (Me-TCS) and Triclocarban (TCC, 3,4,4'-trichlorocarbanilide) were monitored in water and fish from Jhagrasisa and Gompota wetland of East Kolkata. In water the level of TCS was 0.09-4.01 g/l indicating that it exceeded the predicted no effect concentration of TCS i.e. 0.05 g/l. TCC concentration (0.05-1.49 g/l) was comparatively lower than that of TCS. Me-TCS was not found in water. In muscle tissue of fishes such as *Oreochromis mossambicus* and *O. niloticus,* TCS and TCC were recorded at levels 0.15-0.57 and 0.04-0.44 mg/kg respectively. Like in water, in fish tissues too, the level of TCC was lower than that of TCS. Me-TCS was also recorded at concentration 0.01-0.55 mg/kg. Keeping in view the acceptable daily intake (ADI) of TCS *i.e.* 50 g/kg body wt the present level of TCS detected in fish would not pose any health hazard to the consumers but might affect the aquatic biota.

Triclosan and Triclocarban residues in fish of River Torsa

Residues of TCS (0.694±0.138 mg/kg), TCC (0.25±0.08 mg/kg) and Me-TCS (0.043±0.01 mg/kg) have been detected in fishes of multi-trophic strata. Study revealed higher concentration of TCS in demersal fishes (1.18±0.04 mg/kg) in comparison to bentho-pelagic (0.81±0.05 mg/kg) from different sites. Same trend was also noticed in case of TCC and Me-TCS.

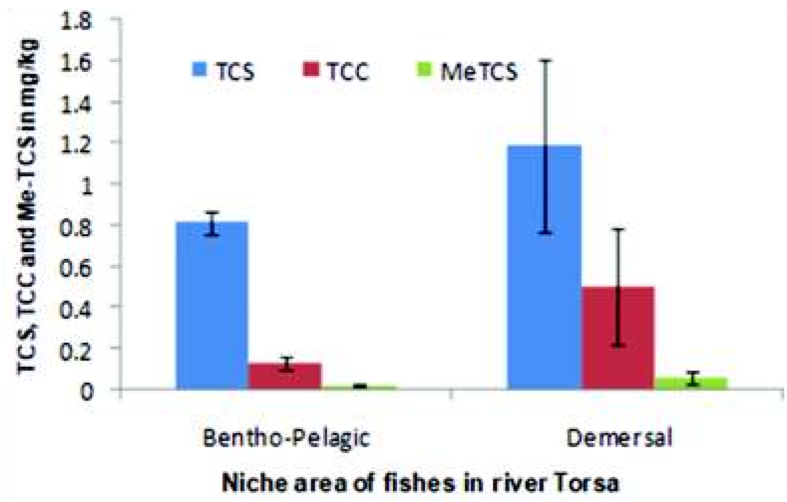


Fig. 110 Occurrence of TCS, Me-TCS and TCC in Torsa river fishes

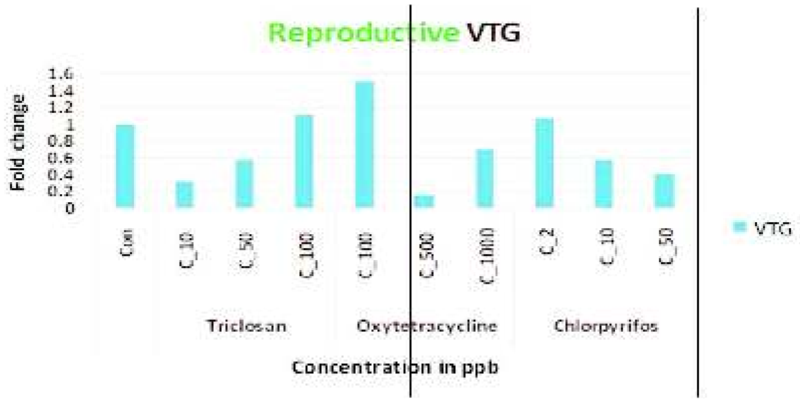


Fig. 111 Fold change in expression of Phase I Biotransformation, Stress, Growth, Immune genes of *L. catla*

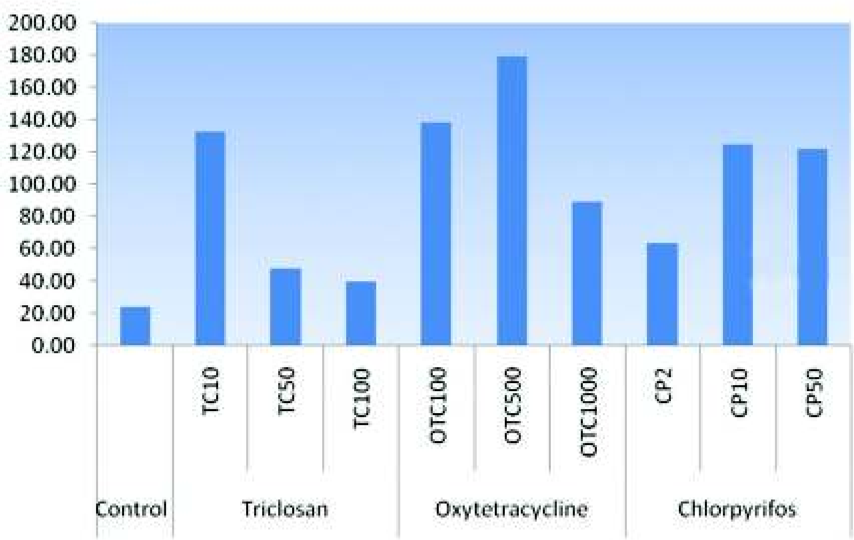


Fig. 112 Effect on plasma SGOT activities

Ecotoxicological studies of toxicants

Effect of selected toxicants on gene expression in fish

Effect of TCS (10, 50 and 100 ppb), OTC (Oxytetracycline) (100, 500 and 10000 ppb) and Chloropyrifos (2, 10, 50 ppb) on Phase I biotransformation (CYP1A1), reproductive (Vitellogenin), Growth (IGF1, Pyruvate Kinase) and Stress (HSP, CuZnSOD, Transferin) gene of *Labeo catla* (4-6 gm) has been evaluated by static non-renewal acute toxicity test. The EF1α gene was found to the most stable housekeeping gene among several other genes and used as internal standard. The efficiency was evaluated by cDNA standard.

The CYP1A gene showed upregulation at all the concentration of the TCS and Chlorpyriphos nd IGF1 also showed upregulation on TCS. Chlorpyriphos exposure as compared to control. At higher concentration of TCS, transferrin also showed upregulation. However, no trend was observed for *HSP 70* and *PYR Kinase*. *Vitellogenin* gene showed concentration dependent upregulation on TCS exposure and downregulation on Chloropyriphos exposure, however the fold change in expression was low.

Effect of toxicants on metabolic activities and immune function in fish

Effect of TCS, OTC and chlorpyriphos on metabolic activities and immune function of *L. catla was also investigated.* Enzymes of metabolic significance assessed in plasma showed higher SGOT activities in all the concentration of TCS, chlorpyrifos and OTC than control and that highest activity was observed in OTC followed by chlorpyrifos and TCS Marked increase in SGPT activities was noticed due to treatment of TCS and OTC than control. However, chlorpyrifos showed no noticeable change in activities. Except OTC at 500 ppb, all other treatments showed decreased alkaline phosphatase activities than control. The activities gradually increased with increase in concentration for TCS and chlorpyrifos.

TLR2 expression was up-regulated in Chlorpyrifos in concentration dependent manner while down-regulated by OTC and TCS. NOD-2 was under-expressed for all concentration of triclosan and over-expressed for most of the concentration of Chlopyrifos and OTC.

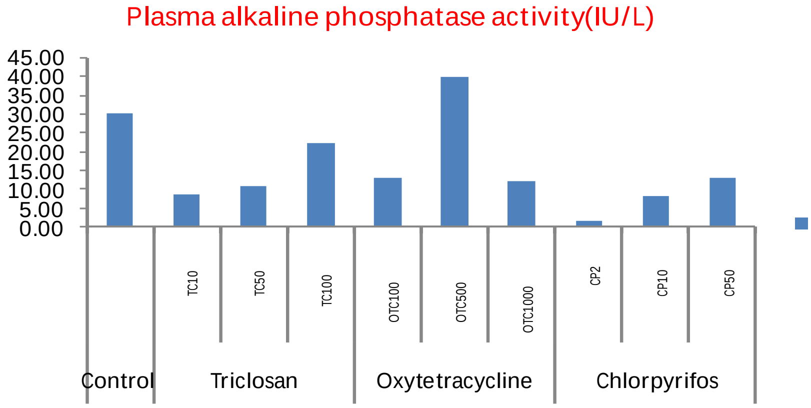


Fig. 113 Plasma alkaline phosphatase activities

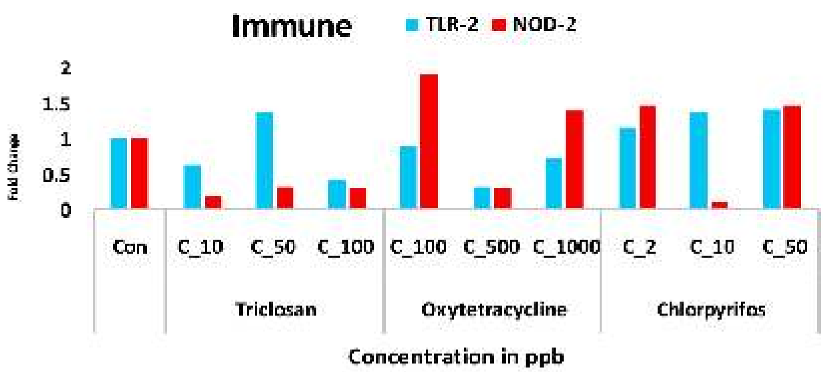


Fig. 114a. Effect on expression of immune function gene

Fig. 114b. Fishing with local fishermen of Torsa river in Dalsinghpara, Alipurduar

Fig. 114c. Sampling on River Torsa

Project Title	:	**Environmental impact assessment and mitigation of arsenicosis as a serious environmental challenge with special reference to fish and fishery resources**
Project Code	:	**FREM/17- 20/13**
Project Personnel	:	B. P. Mohanty, S. Samanta, S. K. Manna, S. K. Sahu, A. K. Bera, P. Maurye, S. D. Sarkar, P. K. Parida, P. Majhi, N. Sarma, P. R. Behera, R. K. Raman and G. Chandra
Associates	:	S. Bhowmick, K. Saha, S. K. S. S. Hameed, S. Banerjee, S. K. Pal and Sk. Rabiul

Arsenic residues in biotic and abiotic compartments of inland aquatic ecosystem

Arsenic (As) accumulation and cycling was studied in different strata of trophical niche of inland aquatic resources in As endemic zone of Nadia district, West Bengal. Biotic (phytoplankton, periphyton, zooplankton, aquatic macrophytes, gastropods and fish) and abiotic (water and sediment) samples were collected from three aquaculture ponds of Ghetugachi (23° 1'42.55"N; 88°34'40.39"E), Gontra (23° 1'32.81"N; 88°34'55.70"E) and Dakshin Panchpota (23° 0'19.99"N; 88°36'4.20"E) besides the three wetlands *viz.* Khalsi (23° 0'0.08"N; 88°38'42.52"E), Bhomra (22°59'14.88"N; 88°37'47.69"E) and Chandania (22°57'59.49"N; 88°43'4.48"E) and were analysed for total arsenic (As) level.

As contamination in Water and Sediment

The study revealed higher level As in the studied water bodies. Total As concentrations in surface water ranged between 11-26 µg/L, which is above the guideline value (5 µg/L) for the protection of aquatic life by the Canadian Council of Ministers of the Environment (CCME, 2001) and a moderate contamination was observed in sediment (13-33 mg/Kg) as per New York State Department of Environmental Conservation (NYSDEC, 1999; >6 mg/Kg – moderately contaminated, >33 mg/Kg- severely contaminated).

Accumulation of As in Phytoplankton

The phytoplankton samples collected from selected sites of As endemic zones were analyzed. *Euglena* sp. of the class euglenophyceae was the dominant taxa followed by cyanophyceae, chlorophyceae, bacillariophyceae, dinophyceae, zygnematophyceae. The other phytoplankton species such as *Pediastrum simplex*, *P. duplex, Phacus* sp., *Cymbella* sp., *Scenedesmus* sp., *Anabaena* sp., *Cymbella* sp., *Coelastrum* sp., *Crusigenia* sp., were also observed during the study period. Residues of total As widely varied (480-9927 µg/Kg) in the studied area with the highest accumulation at Bhomra (9927.945 ± 875.5 µg/Kg) and the lowest at Gontra (480±21.5µg/Kg).

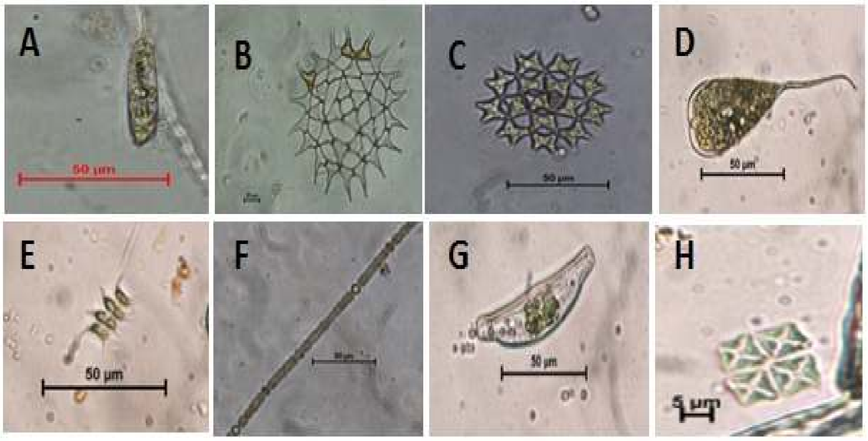


Fig. 115 Spectrum of phytoplankton in As endemic zone – A) *Euglena* sp. B) *Pediastrum simplex* C) *Pediastrum duplex* D) *Phacus* sp. E) *Scenedesmus* sp. F) *Anabaena* sp. G) *Cymbella* sp. H) *Crucigenia* sp.

Accumulation of As in Zooplankton

The zooplankton species collected from selected sites of As endemic zones comprised mostly of calanoid copepods (*Diaptomus sp.)* and cladocerans (*Diaphanosoma* sp.). The rest was a mix of rotifers, crustacean nauplius and protozoa. Among rotifer community *Brachionus fulcatus, B. diversicornis, B. caudatus*, *B. forficula* and *Keratella tropica,* were recorded. Residues of total As also widely varied (387–8874µg/Kg) in the studied area with the highest accumulation at Bhomra (8874.5± 824.72 µg/Kg) and the lowest at Gontra (387.75±113.48 µg/Kg).

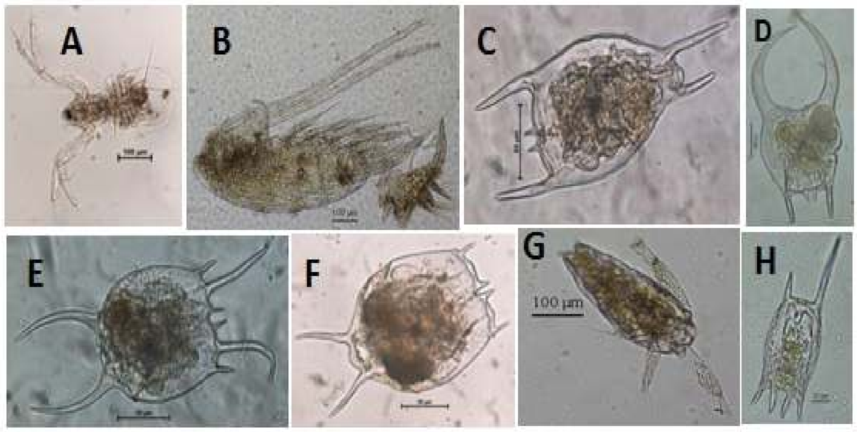


Fig. 116 Zooplankton profile in As endemic zone – A) *Diaphanosoma* sp. B) *Diaptomus* sp. C) *Brachionus diversicornis* D) *B. forficula* E) *B. fulcatus* F) *B. caudatus* G) *Crustacean nauplius* H) *Keratella tropica*

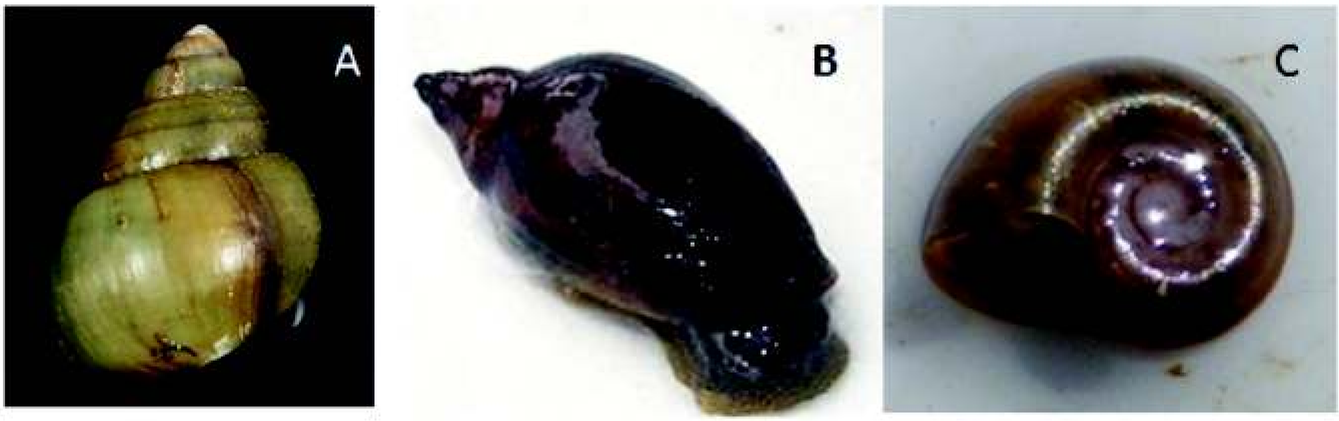


Fig. 117 Gastropods of As endemic zone; A) *Bellamya* sp.; B) *Radix luteola*; C) *Indoplanarbis exustus*

Accumulation of As in Periphyton and gastropods

Periphytic attachments of Bhomra beel have exhibited higher As accumulation (4226.17± 88.34 µg/Kg) in comparison with other aquatic bodies.

Arsenic accumulation in Macrophytes

In the present study, higher accumulation of total As has been observed in roots (391.96-900.55 µg/Kg), followed by leaf (58.90-94.55 µg/Kg) and stem (46.13-55.13 µg/Kg) of macrophytic vegetation in Arsenic affected area of Ghetuganchi.

Arsenic concentration in Fish

Total As concentration was found to range from 3.114 - 451.99 µg/Kg in different fish species. *Labeo catla* (451.99 ±154.75) was the highest accumulator, followed by *L. rohita* (100.5 ±28.43), *Puntius sophore (*52.84 ± 13.56), *Cirrhinus mrigala* (28.3 ± 22.1) and *L. bata* (3.114 ±1.97µg/Kg). This variation could be the result of species-wise food habit and water surface preference.

Arsenic exposure studies

Study of ameliorative effect of curcumin against arsenic toxicity in fish

To test ameliorative effect of curcumin, if any, on survival and health, *Labeo rohita* was orally administered with arsenic at a dose rate of 5 mg As^{+3}/kg fish daily for 30 days. It was observed that compared to 33.3% mortality of arsenic-treated fish, only 3.7% of fish receiving both arsenic and curcumin died clearly showing protective effect of curcumin against arsenic-induced mortality. Thus curcumin could be a potential remedy against arsenic toxicity.

Clinical analysis of serum samples showed significantly higher SGPT and SGOT levels in fish receiving both arsenic and curcumin as compared arsenic-treated fish as well as control group of fish. Although this increase in SGPT and SGOT levels suggest liver damage, it also indicated that the curcumin treated fish were physiologically able to mount a protective response against the toxicant. The gut microbiome analysis of the arsenic exposed and curcumin supplimented diet fed carps is under process.

Liver transcriptome analysis under Illumina Hiseq platform to evaluate the toxicogenomics of arsenic and ameliorative potential of curcumin against arsenic toxicity in Labeo rohita

Our earlier studies have reported that combination of ApoA1, A2ML, Wap65 and transferrin proteins serve as biomarkers of hepatotoxicity and chronic liver disease due to arsenic exposure. Objective of the present study was to revalidate the biomarker response of above mentioned proteins and their isoforms along with identification of novel biomarkers of arsenic toxicity. Besides, the ameliorative potential of curcumin, an herbal extract given as a food/feed supplement, against arsenic toxicity in *Labeo rohita* have been evaluated.

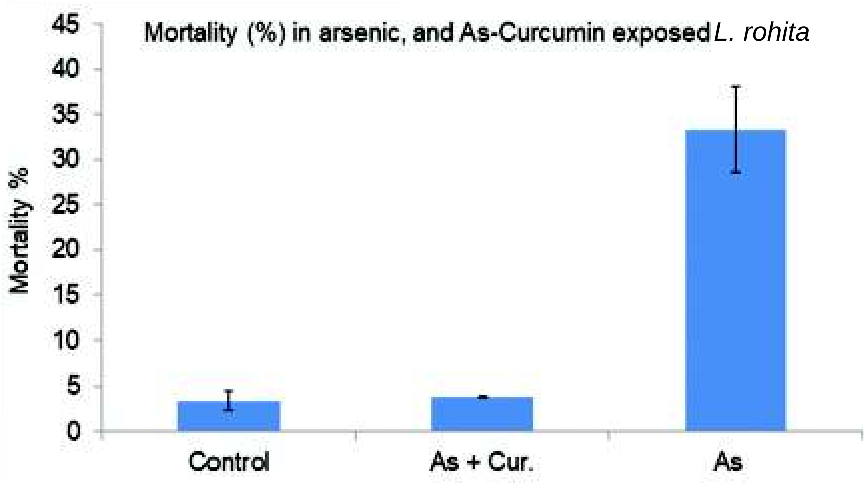


Fig. 118 Fish mortality caused by arsenic and protective activity of curcumin

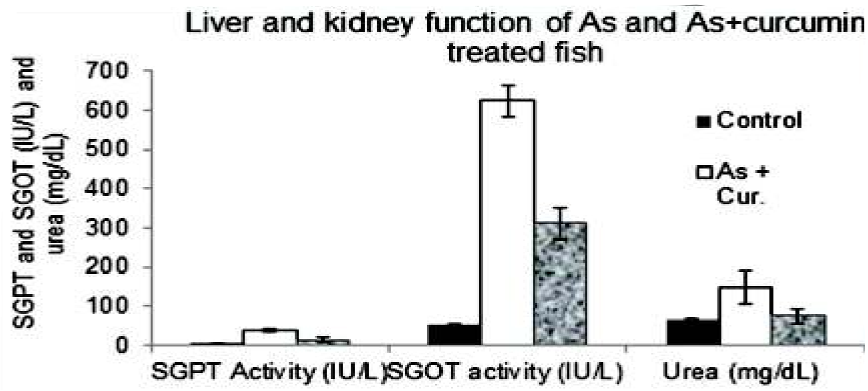


Fig. 119 Salient clinical profiles highlighting liver and kidney functions in arsenic and arsenic-plus-curcumin treated fish

Liver transcriptome analysis was carried out, under Illumina Hiseq platform, to evaluate the toxicogenomics of arsenic and also to evaluate the ameliorative potential of curcumin against arsenic toxicity in *Labeo rohita*. Fishes were divided into three groups (A, B, C) containing 20 fishes in each group. Basal feeds were prepared using soyabean oil cake (290 g Kg^{-1}), mustard oil cake (524 g Kg^{-1}), fish meal (50 g Kg^{-1}), vitamin-mineral premix (20 g Kg^{-1}), and edible veg. oil (15 g Kg^{-1}) and de-oiled rice bran (100 g Kg^{-1} in control feed). For curcumin supplemented feed, curcumin (Himedia) the quantity of de-oiled rice bran was replaced with equal amount of curcumin. Fishes in tank A and B were fed with basal diet and in tank C were fed with curcumin-supplemented feed for seven days prior to arsenic (Sodium arsenate; Himedia) exposure and this continued during the exposure period. Fishes from tank A serve as control and fishes from tank B and Tank C were exposed to 15 mg/L arsenic for 12days.

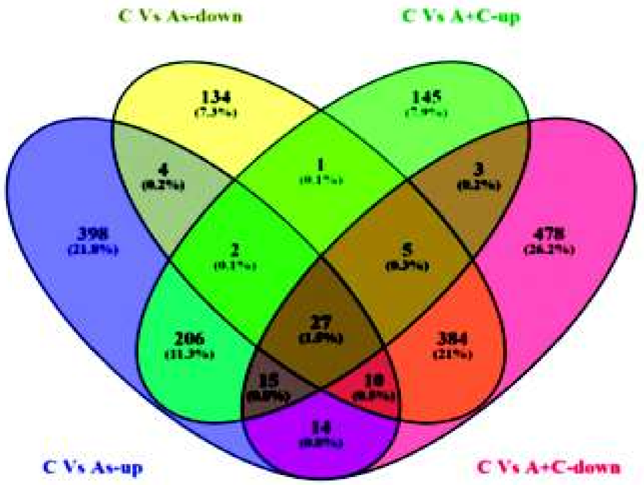


Fig. 120 Venn diagram showing alterations in transcripts on exposure to arsenic

Libraries of three groups of *Labeo rohita* generated information about 135,102unigenes with N50 1209 bp were generated by using Trinity assembly program. The mean transcripts size was720bp. About 44.39% transcripts were 500 bp and 1913 transcripts were ≥ 5000 bp in length. The largest and smallest transcripts lengths were 15,107 bp and 201 bp, respectively. Blast analysis of nr transcripts showed that 60.87%, 17.04%, 6.06%, and 3.19% of total transcripts were annotated against public databases including UniProt, GO, COG and KEGG database, respectively. Blastx analysis indicated a high level of similarities and conservedness of transcript information of *Labeo rohita* with *Danio rerio* (23.49%), followed by *Astyanax mexicanus* (1.65%), *Cyprinus carpio (*1.31%). De novo assembly was deposited to NCBI (SRA accession No. SRR6365041).

Analysis of differentially expressed genes and pathways in fishes exposed to arsenic

To compare the response of biomarker genes, expression profile of Apo A, A2ML, Wap65 and transferrin were searched in differentially expressed genes and it was observed that number of Apo variants, two isoforms of A2ML were up-regulated in exposure to arsenic exposure. Among biomarker proteins, seven number of Apo variants (ApoAIVb, Apo AIV2, ApoA1-2, ApoIV, ApoBb, ApoE, and Apo14kDa) were identified from transcriptome analysis. The DESeq2 program identified a total of 4922 differentially expressed genes (DEGs) including 1853 down-regulated and 3069 up-regulated transcripts. Among the DEGS, 162 transcripts were also found in CTD database. According to the Gene Ontology (GO), 113,444 nr transcripts were classified into three functional categories; biological process (387,84 transcripts), cellular component (469,20 transcripts), molecular function (277,40 transcripts).

4922 DEGs were performed GO enrichment analysis showed that extracellular matrix, cell surface, external side of plasma membrane were the highly affected cellular components by arsenic exposure. Similarly, responses to external stimulus, regulation of acute inflammatory response, response to stress were the significantly affected biological processes in exposure to arsenic. In molecular function category, glycosaminoglycan binding, receptor regulator activity, cyclin-dependent protein kinase activities were significantly affected molecular functions by pollution.

The KEGG and Reactome pathway analysis revealed that DEGs are involved in Post-translational protein phosphorylation (ENSDARG00000001818, SPP2, apoa4, apobb.2, c3b.1, cst3, fam20a, hsp90b1, igfbp1b, lgals2b, pdip5), Arginine and Proline metabolism (aldh9a1b, ckmt1, gatm, got2b, nos2a, p4ha1b, p4ha2, prodha, srm), Complement and coagulation cascades, Pathways in Cancer, Carbon metabolism pathways. PFAM and SMART protein analysis revealed that 50S ribosome-binding GTPaseand Sushi repeats domains were affected by arsenic exposure.

Analysis of differentially expressed genes and pathways in fishes fed curcumin supplemented feed and exposed to arsenic

DESeq2 programme identified a total of 5564 differentially expressed genes including 3516 down-regulated and 2048 up-regulated transcripts. GO annotation showed that curcumin supplementation showed significant alterations in cellular components like endoplasmic reticulum membrane, integral component of membrane. Similarly, biological processes like iron ion binding, heme binding, ATP binding, metal ion binding and molecular functions like immune response, nucleic acid binding, DNA binding showed significant alteration in curcumin supplemented arsenic exposed group.

Pathway analysis of DEGs showed that 75 no. of pathways are affected in curcumin supplemented and arsenic exposed group. List of affected pathways, pathway ID, no. of up/down-regulated transcripts and p-value were presented in. Based on fold change and significance analysis (p-value) it was observed that molecules related to cell adhesion molecules, CYP reaction pathways were up-regulated and regulations of complement cascades, Innate immune system, post-translational protein phosphorylation pathways were down-regulated. Additionally, expression patterns of DEGs related to arsenic exposed were studied to evaluate the ameliorative potential of curcumin under arsenic toxicity. Results showed that some of the transcripts, related to glycerolipid metabolism, protein processing in endoplasmic reticulum and signal transduction pathways pathway which showed down-regulation in response to arsenic, were found to be unchanged upon curcumin supplementation. PFAM and SMART analysis showed that complement control proteins, cytochrome p450 family proteins, alpha-2 microglobulin were up-regulated and Sushi repeats related protein, A2ML receptor proteins were up-regulated in curcumin supplemented group.

Based on findings of the present study it was observed that arsenic toxicity highly effects the PPAR signaling pathways, Complement and coagulation cascades. It appears that Up-regulation ApoA1-2, A2ML and down-regulation of C3b appears to be potential biomarkers of arsenic toxicity. The present study also showed the ameliorative potential of curcumin through nrf-2-induced expression of biotransformation enzymes which could facilitate the excretion of arsenic along with curcumin. Moreover, curcumin supplementation showed useful impact on inactivation of apoptosis pathways and partial stimulation on immune response of arsenic exposed organism.

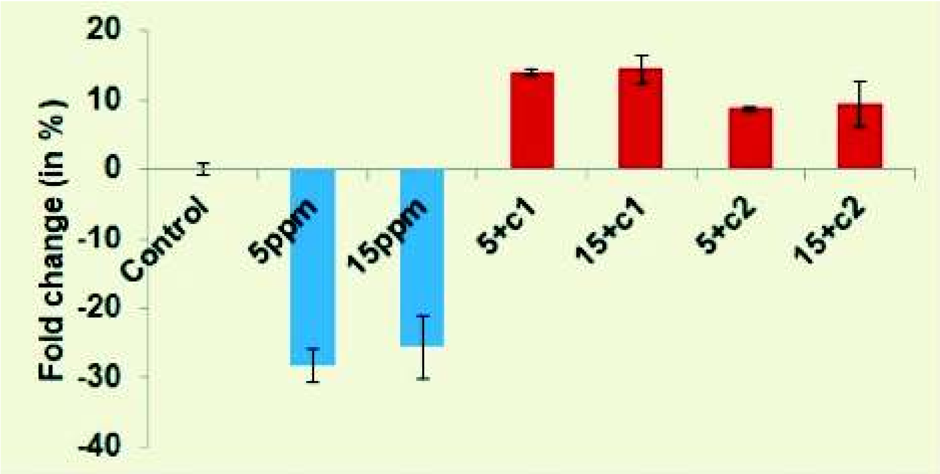


Fig. 121 Fold change (%) of the antioxidant compound PD in lens tissues from *Labeo rohita* exposed to arsenic and ameliorative potential of curcumin against arsenic toxicity. In the carps exposed to arsenic, the level of PD in eye lens isdepleted; however, in the carps fed curcumin-supplemented diet the level of the antioxidant PD is not depleted.

Toxic impact of Arsenic on Eye lens and protective Effect of curcumin on the Eye Lens

To investigate the impact of arsenic on the lens crystallin and fatty acid composition of lens lipids, gene expression profile of alpha, beta and gamma crystallins and GC-MS fingerprinting of fatty acids of lens lipids were carried out. To evaluate the impact of curcumin in arsenic toxicity gene expression profile of alpha, beta and gamma crystallins were carried out in fish fed with curcumin-supplemented diet and exposed to arsenic. Gene expression of *α* and *β-crystallin* was down-regulated in arsenic-exposed groups (fed basal feed); however, insignificant alterations were observed in the arsenic-exposed group fed curcumin-supplemented diet. Similarly, fatty acid fingerprint of arsenic-exposed group exhibited reduction in saturated fatty acid and DHA content in fish lens; however, fatty acid profile in arsenic-exposed groups remained unchanged in the curcumin supplemented group. Interestingly, concentration of one non-fatty acid, antioxidant compound (PD) that was identified by GC-MS NIST library search decreased in response to arsenic-exposure which got restored to normal level in curcumin supplemented groups thus indicating protective effect of curcumin in eye-lens through its anti-oxidant properties against arsenic toxicity.

Impact of Arsenic toxicity on Innate Immunity of Labeo rohita *and ameliorative effect of cucumin*

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

Delineation of As contaminated zone in West Bengal and Bihar

Arsenic contamination level in ground water of tube wells in the surveyed area of district of Bihar and West Bengal were studied. For this, secondary data were taken from the “Ministry of drinking water and sanitation-National Rural Drinking Water Programme” web site for the year 2016-17. A total of nine available district data sets of Bihar and four district data set of West Bengal of village level arsenic contamination (µg/L) from shallow and deep tube wells water data were collected (https://indiawater.gov.in/ imisreports /Reports/Water Quality/ rpt_WQM_Contamination WiseLabTesting_S.aspx? Rep=0&RP=Y). A total of 741 villages of nine selected districts of Bihar was found where As contamination was more then WHO permissible limit (10 µg/L). A map is prepared depicting the As contamination in different districts of West Bengal and Bihar along with the river network. It is evident from the map that most of the district across the Ganga have the As contaminated ground water above permissible limit (0.01mg/L) except Patna and Begusarai.

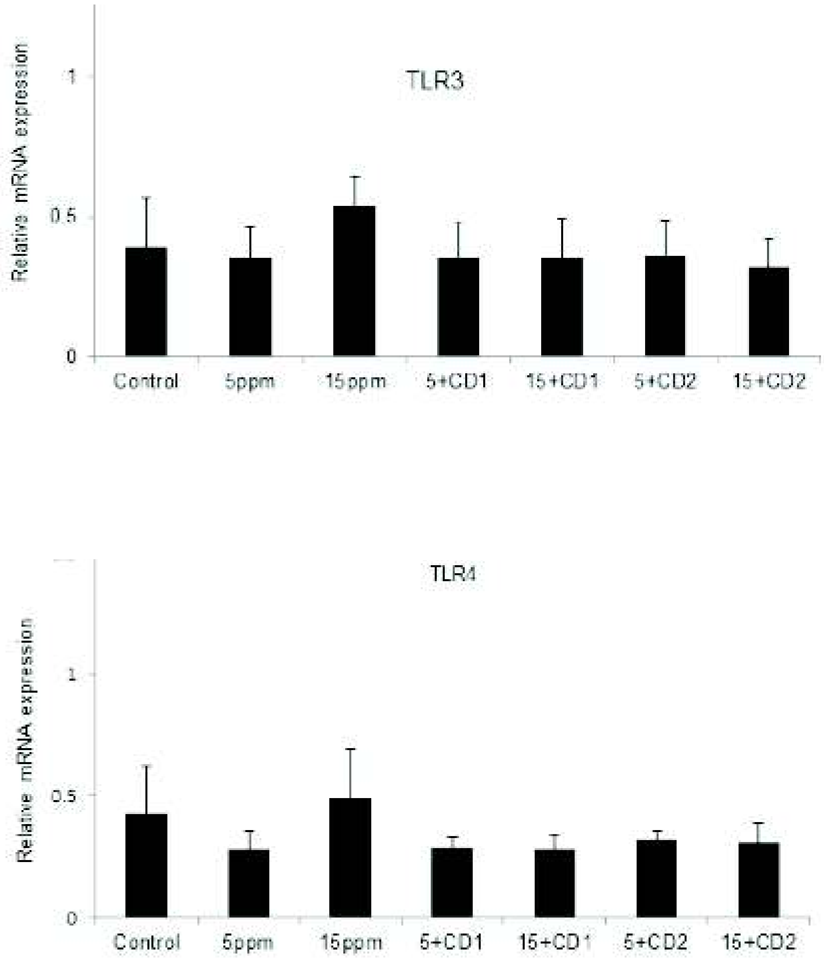


Fig. 122 Gene expression of *TLR3* and *TLR4* in kidney of *Labeo rohita* fed with normal feed (control), As (5mg/L) + basal feed, As(15mg/L) + basal feed, As(5mg/L) + Curcumin (dose 1), As(15mg/L) + Curcumin (dose1), As(5mg/L) + Curcumin (dose 2), As(15mg/L) + Curcumin (dose2) groups.

Table 8. Statistics (mean ± std) of arsenic (mg/L) contamination level in shallow and deep tube wells water in nine selected district of Bihar

Sl No.	District	No of surveyed villages	As(ppm)(mean ± std)
1	Samastipur	70	0.017 ± 0.004
2	Buxar	107	0.023 ± 0.014
3	Bhagalpur	207	4.58 ±9.34
4	Bhojpur	152	0.019 ± 0.005
5	Katihar	19	0.034 ± 0.009
6	Vaishali	48	0.012 ±0.005
7	Munger	99	0.014 ± 0.005
8	Khagaria	9	0.013 ± 0.005
9	Lakhisarai	30	0.02 ± 0.006

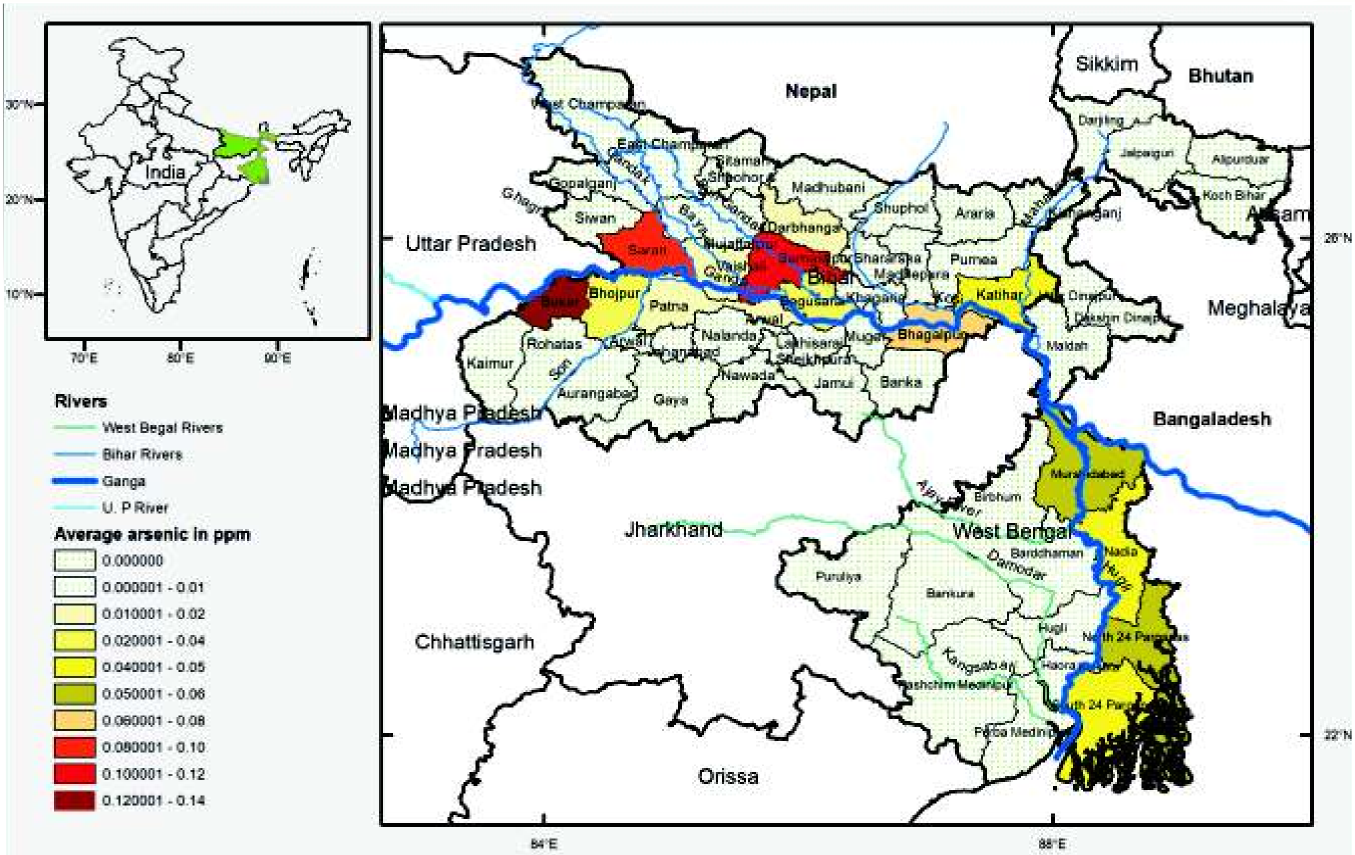


Fig. 123 Arsenic contamination level in ground water in different districts of Bihar and West Bengal

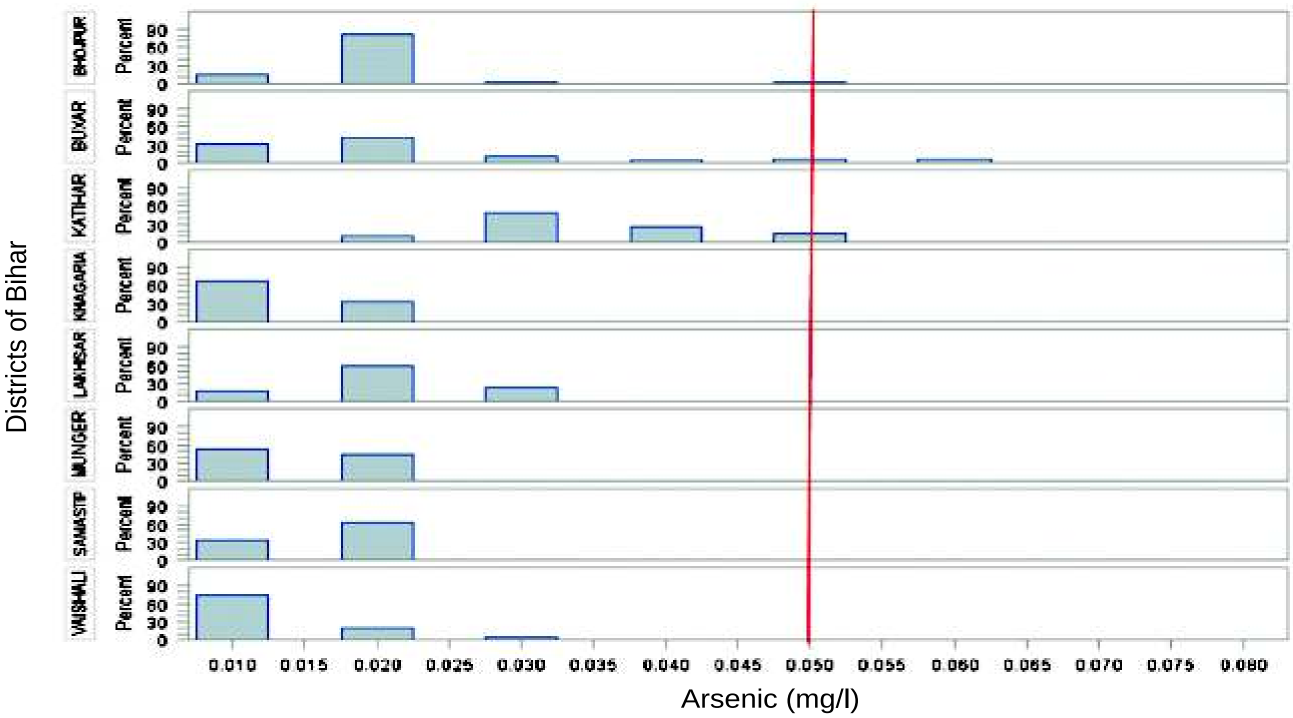


Fig. 124 Arsenic contamination level in the surveyed shallow and deep tube well waters in Katihar, Buxar and Bhojpur districts of Bihar having arsenic content above 0.05 mg/L

In Bihar, the average maximum arsenic level in tube well water was found in Bhagalpur district (4.58±9.34 mg/L) and minimum in the Vaishali district.

Ground truthing done in Mahanar and Bidupur blocks of Vaishali district showed that out of 11 panchayats of Bidupur, 9 were affected by As above permissible limit (0.01 mg/L (10 µg/L) . In Mathura panchayat, out of 11 wards, 10 had arsenic problem, affecting 90% of the household. Almost every household pays Rs 25-40 daily for safe commercially available drinking water. Government has proposed to establish a new water treatment plant in this panchayat.

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

Project Code : **FREM/17-20/14**

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

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Fish disease investigation in inland open waters

Physico-chemical characteristics of East Kolkata wetlands and Moyna wetland vis-a-vis disease occurrence

East Kolkata wetlands (constituted by about 264 numbers of wetlands locally known as *bheri,* 5852 ha) at Kolkata and Moyna wetland (6000 ha) in Purba Midnapore District, West Bengal have average yield of 9-10 tonnes/ha/year and were surveyed in relation to health status of fishes. Frequent occurrence of different types of fish diseases was reported from all the three study areas; hence regular monitoring was carried out in these wetlands for epidemiological study. Water and soil quality was also monitored to correlate with the disease prevalence. Data of common water parameters of water bodies surveyed in East Kolkata wetlands were given in Table 1. Nutrient loading from sewage caused high specific conductivity and TDS in both the wetlands. Supersaturated dissolved oxygen (up to 12.4 mg/l) was indicative of highly eutrophic nature of these wetlands. Regular sewage loading also created high BOD (30 - 50 mg/l) load. Total alkalinity was also high (122 - 192 mg/l) in some occasions. Concentration of total N was much higher as compared to available N, indicative of sewage nitrogen conversion in plankton. Low transparency indicated intensive aquaculture practice with chlorophyll ranging from 15.58 - 36.24 mg/m^3.

Table 9. Physico-chemical characteristics of water of selected bheris in East Kolkata wetlands

	BoroChhainavi (Borokhol)	BoroChhainabhi (Chhotokhol)	Gomukpota
Location	22° 32' 1.28?N 88° 26' 29.8?E	22°32'59.076?N, 88°26'27.732?E	22°32'35.9?N, 88°27'23.9?E
Area (ha)	28.9	0.90	72.0
Month of sampling	April, June, Aug, Nov, Dec-2018	Nov, Dec-2018	Nov, Dec-2018
Watertemperature (°C)	22.9-31.8	22.2-28.8	22.6-24.1
Depth (cm)	75-100	210-243.84	76.2-106.68
Transparency (cm)	24.5-25.0	35.5-42.5	19.5-23.5
Turbidity (NTU)	12.9-18.8	11.23-16.9	9.23-28.7
pH	8-8.9	7.3-8.1	8.4-8.4
Sp. Cond. (µS/cm)	639-741	766-796	646-678
Dissolved O_2 (mg/L)	7.2-12.4	6.2-6.8	7.5-9.2
BOD (mg/L)	30-36	30-35	45-50
Free CO_2 (mg/L)	0-3	4-6	0-0
Total alkalinity (mg/L)	122-180	182-192	168-168
Total hardness (mg/L)	140-204	232-240	153-168
Phosphate - P (mg/L)	0.18-0.19	0.026-0.030	0.034-0.040
Total P (mg/L)	0.19-0.23	0.047-0.055	0.052-0.062
Nitrate - N (mg/L)	0.06-0.11	0.209-0.256	0.042-0.058
Total N (mg/L)	0.8-2.0	1.07-1.30	1.35-1.46
Chlorophyll (mg/M^3)	18.42-21.30	16.94-19.95	15.58-36.24

Data of common water parameters of water bodies surveyed in Moyna wetlands. Total alkalinity and total hardness were higher (206 and 980 mg/l respectively) in some wetlands. Among nutrients, available and total P, total N were higher in some cases. BOD was significantly high. Dissolved oxygen in most of the cases was in supersaturated condition, except at Dhanbhanga (4.0 mg/l) in winter, where severe fish mortality were often recorded. High conductivity and TDS are indicative of use of brackish water for aquaculture. Low total N in Moyna wetlands (as compared to East Kolkata wetlands) revealed lower density of plankton as there is less fertilisation and supplementary feeding is being practiced. Use of tidal water from nearby estuarine channels led to mild salinity and thereby increased specific conductivity (up to 6420 µS/cm) in water. Data of common soil parameters of water bodies surveyed in East Kolkata and Moyna wetlands were given in Table 3. Soils of all the wetlands were alkaline in nature. Intensive aquaculture practice has led to significantly higher soil specific conductivities (0.89-2.75 mS/cm). Lack of water exchange and more dependence on supplementary feed in Moyna wetlands might have a role in recurrent fish diseases. Low C/N ratios (3.1-5.4) were recorded in all the studied wetlands.

Disease occurrence studies in these wetlands showed that *Aeromoas veronii, Enterobacter cloacae, Shewanella putrefaciens* were the major bacterial pathogens present in the fishes (*Labeo rohita*, *L. bata* and *Oreochromis niloticus*). *Shewanella putrefaciens* (MK559741.1) infection in *O. niloticus* is also identified for the first time in India.

Table 10 Environmental parameters (Water) of selected waterbodies of Moyna wetlands at East Midnapur district, West Bengal

	Runner chak	Dhangbhanga	Saolar math	DakhinAnukhachak (left)	DakhinAnukhachak (right)
Location	22°11'11.7"N 87°47'53.3"E	22°11'10.9"N 87°47'58.2"E	-	22°15'06.2"N 87°46'08.3"E	22°15'06.2"N 87°46'08.3"E
Area (ha)	21.25	-	-	12	13
Month of sampling	April, July-2018	July, 2018; Jan, 2019	April, 2018	April, July-2018; Jan, 2019	Jul-18; Jan, 2019
Water temperature (°C)	32.5-33.8	20.6-32.5	34.3	22.4-33.3	20.7-33
Depth (cm)	75-100	157	150	25-86	90-100
Transparency (cm)	30	37	35	20.25	32
TDS (mg/L)	3480-3550	1280-1564	4960	3090-5570	2950-5522
pH	8.7-8.8	7.4-7.9	8.2	8.1-8.6	7.8-8.3
Sp. Conductivity (µS/cm)	4930-5010	1834-2266	7040	4360-6420	4150
Dissolved O_2 (mg/L)	11.6-13.1	4.0-5.2	10.4	9.2-10	7.5-10.2
BOD (mg/L)	15-30	2.6-7.0	>10.4	6.6- >10	5.6-7.0
Free CO_2 (mg/L)	0-0	0	0	-	2
Total alkalinity (mg/L)	176-206	138-198	208	80-120	125-176
Total hardness (mg/L)	552-620	228-280	980	368-900	400-472
Av. phosphate – P (mg/L)	0.04-0.11	0.04	0.15	0.03-0.10	0.03
Total-P (mg/L)	0.12-0.66	0.08	0.21	0.09-0.12	0.11
Nitrate - N (mg/L)	0.05-0.09	0.05	0.11	0.05-0.12	0.04
Total N (mg/L)	1.0-1.39	1.06	1.29	1.39-1.9	1
NH_3-N (mg/L)	0.01-0.05	0.02	0.02	0.01-0.03	0.01

Identification of pathogens from disease outbreaks in various inland open water systems

Disease outbreak of fish in Khalsi Beel of West Bengal, India was investigated and two bacteria, *viz*., *Acinetobacter junii* and *A. pittii* were identified. This is the first report of *concurrent infection* by *A. junii* and multidrug resistant (MDR) *A. pitti* as emerging fish pathogens causing severe mortality in *Labeo catla* and *Hypophthalmichthys molitrix* in freshwater wetland.

Investigation was also made on disease problem in Pangasianodon hypophthalmus in cage culture in Chhattisgarh. The causative agent was identified as *Aeromonas hydrophila* (GenBank acc. - MK478894) and *Edwardisiella ictaluri* (GenBank acc. - MK478896, MK478898, Mk478901).

Bacteria isolated from diseased *P. hypophthalmus* have been identified and their pathogenic potentiality was studied in laboratory condition. Administration of *Edwardsiella ictaluri* in *P. hypophthalmus* led to development of petechial hemorrhage on tail, fin, skin within 48 h and 100 % mortality within 4 days.

Fig. 125 Fish mortality with *Aeromonas veroni* at Moyna wetland

Fig. 126 Tilapia lake virus infection collected from East Kolkata wetland

Table 11 Details of pathogenic bacteria isolated from diseased fishes

NCBI Accession number	Bacteria isolated	Fish species
MH532962.1	*Aeromonas veronii*	*Labeo rohita*
MH532961.1	*Pseudomonas aeruginosa*	*Clarias batrachus*
MH532964.1	*Stenetrophomonas maltophila*	*Labeo bata*
MK559741.1	*Shewanella putrefaciens*	*Tilapia niloticus*
MK447732	*Aeromonas veronii*	*Heteropneustes fossilis*

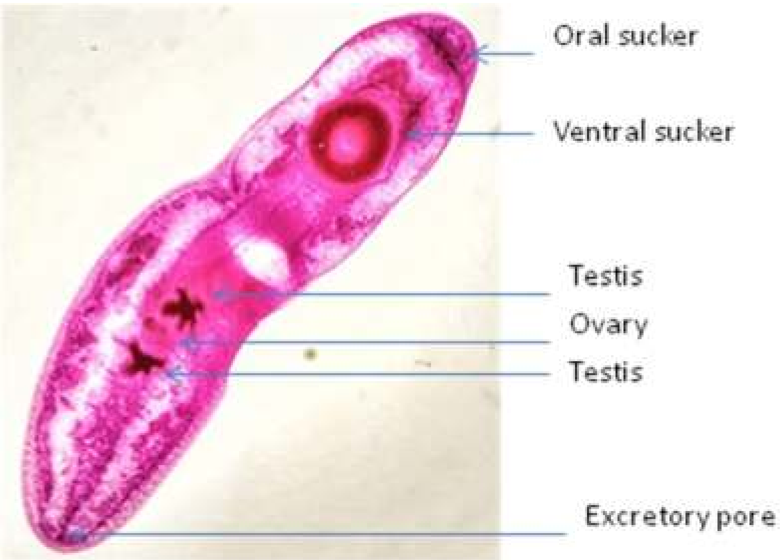


Fig. 127 Metacercarial stage of *Clinostomum complanatum* isolated from *Macrognathus aral*

Klebsiella pneumoniae isolated from cage culture of Chattishgarh and Himachal Pradesh were also found pathogenic with significant clinical signs and mortality.

Using molecular technique (18S rDNA fragment amplification), parasites, namely, *Clinostomum complanatum* and *Eustrongylides* sp. were identified from *Nandus nandus* and *Macrognathus aral* and *Xenentodon cancila.* Sequence information for both the trematode and nematode were generated and confirmed.

Structural characterization of ORF encoded functional genes from Tilapia Lake Virus (TiLV)

In recent years, large-scale mortalities are being observed in Tilapia due to infection with a novel orthomyxo-like virus, named Tilapia Lake Virus (TiLV), which is a serious threat to tilapia industry globally. To understand the spread of TiLV in different organs of *Oreochromis niloticus*, RT-PCR analysis has been carried out. The whole genome sequence of TiLV was retrieved from the NCBI database for *in-silico* analysis of 14 different ORF encoded protein. The 14 functional genes were predicted from 10 gene segments of TiLV. A combinatorial approach involving phylogenetic study, molecular modeling, and molecular dynamics simulation was employed to gain a better understanding for the evolution, structure, and functional dynamic of TiLV gene. To study the stability, residual fluctuation as well as residual interaction a molecular dynamics simulation has been performed at the 10ns simulation time frame. These findings may play a crucial role and pave a way in the field of therapeutics for TiLV infection in the near future.

De novo whole transcriptome profiling of Edwardsiella tarda *isolated from* L. catla

Edwardsiella tarda is a Gram-negative bacterium mainly associated with edwardsiellosis, one of the most common fish disease

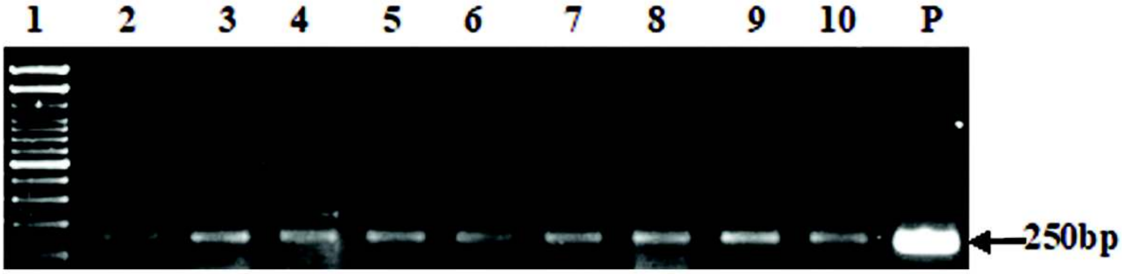


Fig.128 RT-PCR of Tilapia Lake Virus in different tissues of *Oreochromis niloticus* where 1-10 represent the lane number and P is positive control of Tilapia Lake Virus. Lane 1 to 10 contains 100bp molecular marker ; Brain ; Liver; Kidney; Spleen; Intestine; Heart; Gill; Eye and Muscle tissue of *O. niloticus*.

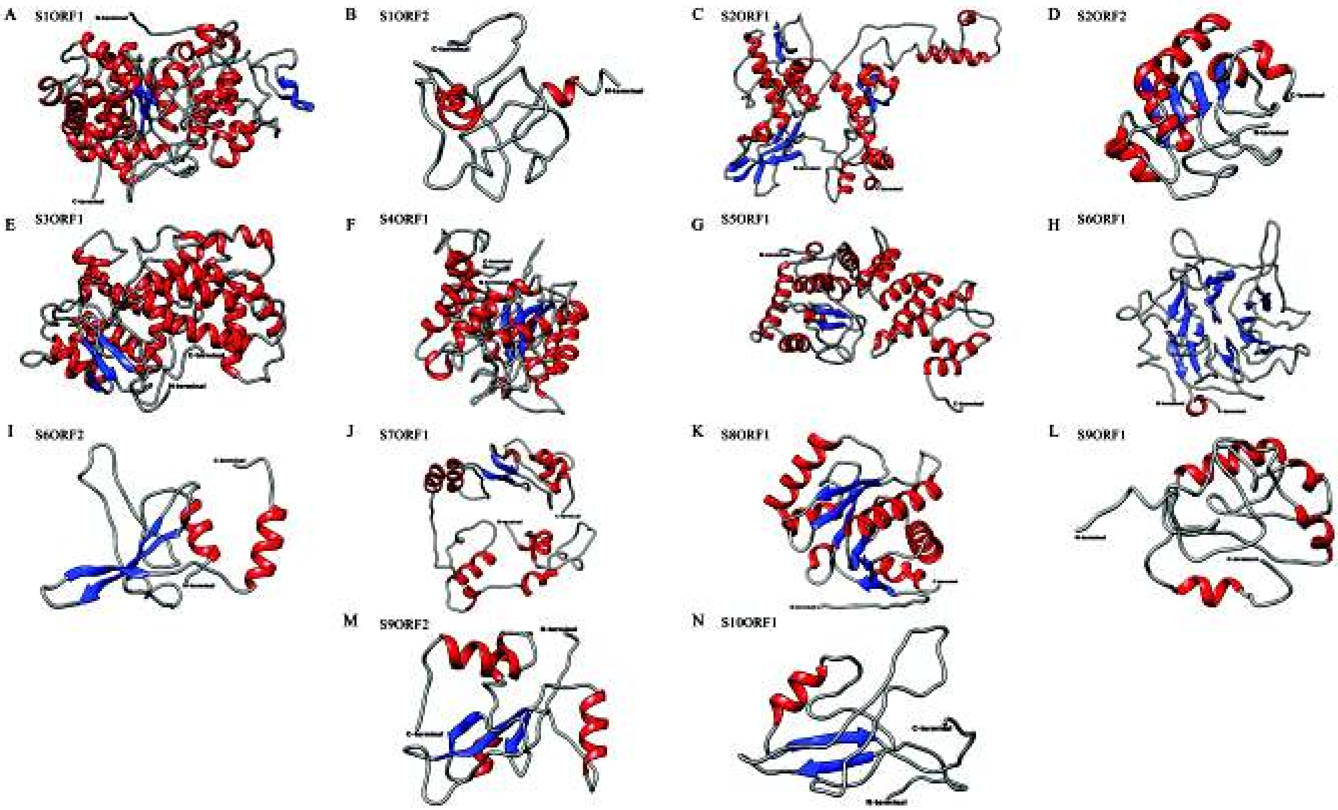


Fig 129 3D model structure of ORF encoded protein derived from Tilapia Lake Virus (TiLV) genome where S1ORF1 to S10ORF1 denotes ORF encoded proteins of gene segment 1-10 respectively. The protein is shown as ribbon with α-helices (in red), β-sheets (in blue), and turns (in white).

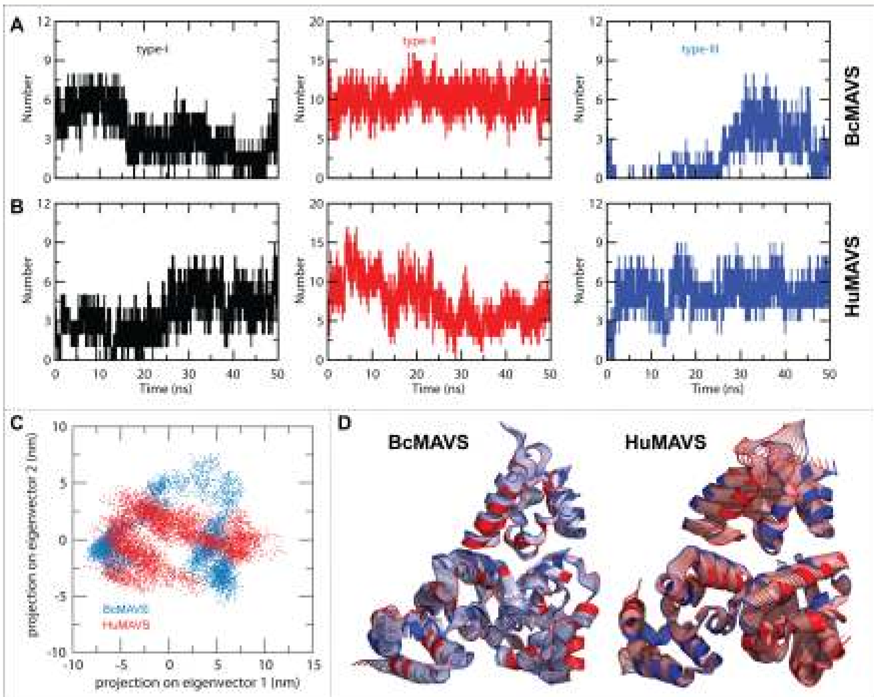


Fig. 130 Analysis of intermolecular H-bonds in all the interfaces as a function of simulation time. (A) BcMAVS; (B) HuMAVS. The H-bonds are displayed different colors represents the interfaces (black: type-I; red; type-II; and blue; type-III). (C) Principal component analysis. Distribution of eigen values in phase space; (D) the global motion of the homotrimers illustrated structurally. Blue cartoon- initial structure; Red-final structures; and light-blue (BcMAVS) and salmon (HuMAVS) indicate the intermediate ones.

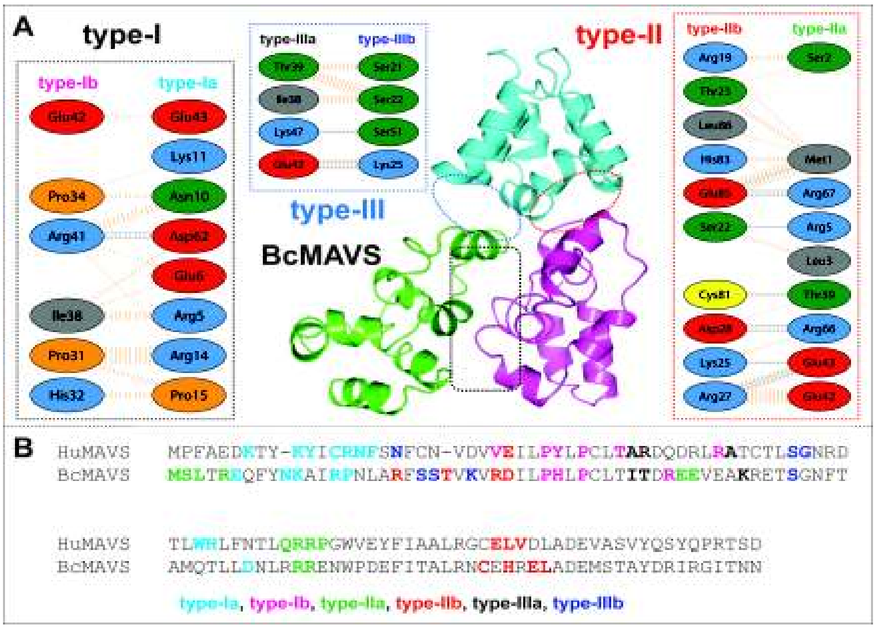


Fig. 131 Detailed molecular interaction determined by DIMPLOT program; (A) BcMAVS and HuMAVS. The interacting amino acid residues are colored based on the physicochemical parameters. The blue lines and orange dotted lines represent the H-bonds and hydrophobic contacts respectively. The interaction types (type- I, II, and III) are depicted in different color boxes. (B) Conserved Region of human and Blackcarps.

throughout the globe. To control the escalating infection of *E. tarda* in various species, it is essential to decode the mysterious mechanism behind the bacterial infection at transcript level. In this present study, we carried out a de novo *E. tarda* whole transcriptome sequencing using SOLiD sequencing platform. Assembly statistics of *E. tarda* dataset showed that the number of transcript contigs was 9657, out of which 6749 were GO annotated whereas 1528 were not assigned any GO terms. A KEGG enrichment study showed that the pathways that are directly linked with immune diseases like Rheumatoid arthritis (0.2%), tuberculosis (0.3%) endocytosis (0.6%) was considerably enriched. Protein-protein interaction study showed that most of the expressed proteins were involved in metabolic pathways, flagellar assembly, propanoate metabolism, Microbial metabolism in diverse environments, butanoate metabolism. The present study provides novel *E. tarda* transcriptome sequence data, allowing us to identify biologically significant genes and their functional relationship with fish diseases, and will be useful in recognizing the reliable therapeutic targets in near feature.

Structural bioinformatics insights into the CARD-CARD interaction mediated by the mitochondrial antiviral-signaling protein of black carp

The innate immune system offers the first line of defence against invading microbial pathogens through the recognition of conserved pathogen-associated molecular patterns (PAMPs) by pattern recognition receptors (PRRs). The host innate immune system through PRRs, the sensors for PAMPs, induces the production of cytokines. Among different families of PRRs, the retinoic acid inducible gene I (RIG-I)-like receptors (RLRs), and its mitochondrial adaptor *i.e.,* the mitochondrial antiviral-signaling (MAVS) protein, are crucial for RLR triggered interferon (IFN) antiviral immunity. Recent studies have shown that the N-terminal caspase recruitment domain (CARD) and transmembrane domain play a pivotal role in oligomerization of black carp MAVS (BcMAVS), crucial for the host innate immune response against viral invasion. In this study, we have used molecular modeling, docking, and molecular dynamics (MD) simulation approaches to shed molecular insights into the oligomerization mechanism of BcMAVSCARD. MD simulation and interaction analysis portrayed that the type-I surface patches of BcMAVSCARD make the major contribution to the interaction. Moreover, the evidence from surface patches and critical residues involved in the said interaction is found to be similar to that of the human counterpart and requires further investigation for legitimacy. Altogether, our study provided crucial information on oligomerization of BcMAVS CARDs and might be helpful for clarifying the innate immune response against pathogens and downstream signaling in fishes.

Computational characterization of epitopic region within the Outer Membrane Protein candidate in Flavobacterium columnare *for vaccine development*

The OMPs (outer membrane proteins) candidate of *Flavobacterium columnare* bacterial cell served a critical component for cellular invasion targeted to the eukaryotic cell and survival inside the macrophages. Therefore, OMPs are considered as the supreme element for the development of promising vaccine against to *F. columnare*. Applying advanced *in silico* approaches, the predicted 3-D model of targeted OMPs were characterized by the Swiss model server and validated through Procheck programs and ProSA (Protein Structure Analysis) web server. The protein sequences having B-cell binding sites were preferred from sequence alignment; afterwards the B cell epitopes prediction was prepared using the BCPred and AAP (Amino Acid Pairs) prediction algorithms modules of BCPreds. Consequently, the selected antigenic amino acids sequences (B-cell epitopic regions) were analyzed for T-cell epitopes determination (MHC I and MHC II alleles binding sequence) performing the ProPred 1 and ProPred server respectively. The epitopes (9 mer: IKKYEPAPV, YGPNYKWKF and YRGLNVGTS) within the OMPs binds to both of the MHC classes (MHC I and MHC II) and covered highest number of MHC alleles were characterized. OMPs of *F. columnare* being conserved across serotypes and highly immunogenic for their exposed epitopes on the cell

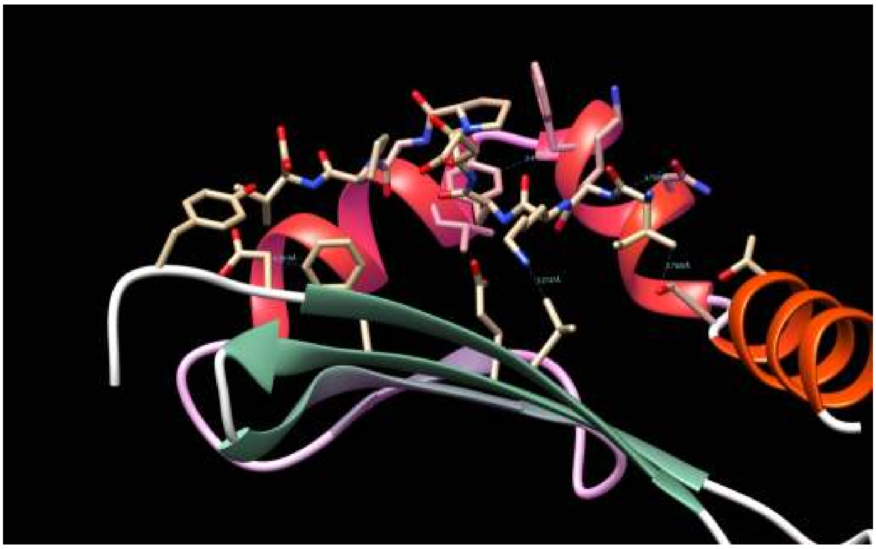


Fig. 132 The molecular docking model between *F. columnare* OMPs predicted epitopic regions and MHC class II histocompatibility antigen beta chain DAB2*04 of zebrafish.

surface was a potent candidate focus to vaccine development for combating the disease problems in commercial aquaculture. The portrayed epitopes might be beneficial for practical designing of abundant peptide-based vaccine development against the columnaris through boosting up the advantageous immune responses.

Structural insight into the peptidoglycan binding site of outer membrane protein A (OMP A) in Aeromonas hydrophila *using bioinformatics approach*

Outer membrane protein (OMP) and its sequences play an important role for preparing subunit vaccines. OMPs are responsible for maintaining the integrity and selectable permeability of bacterial membranes. As because, the OMPs of gram-negative bacteria are in lipids in contrast to gram-positive bacteria and hence act as a barrier to various external chemicals and enzyme that to damage the cell wall. The membranes of the protein are a bilayered structure consisting mainly of phospholipids, proteins and lipopolysaccharide which makes the protein highly immunogenic. In this study we performed molecular dynamics simulations of outer membrane protein. We explored the sequence-structure relationship of *Aeromonas hydrophila* through, a structural computational biology approach involving comparative modelling, protein-ligand docking and molecular dynamics (MD) simulations. Molecular mechanics based MM/PBSA binding free energy analysis displayed van der Waal energy (ΔGvwd) and Electrostatic energy (ΔGele) were the major contributors towards overall binding of free energy.

Deep insights into the mode of ATP-binding mechanism in Zebrafish cyclin-dependent protein kinase-like 1 (zCDKL1): A molecular dynamics approach

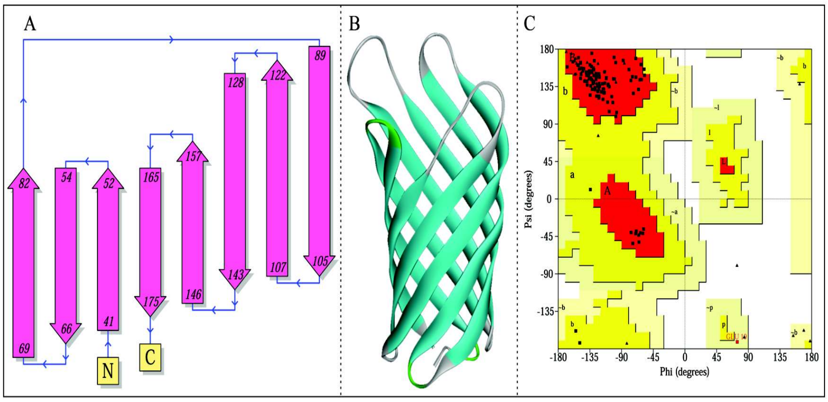


Fig. 133 The graphical representation of Secondary Structure Analysis of the protein Topology analysis of OMP A domain (B) Functional domain, 3D structure and structural analysis of OMP A (C) Ramachandran plot of the modeled protein of OMP A in *Aeromonas hydrophila*

In eukaryotes, the serine/threonine kinases (STKs) belonging to cyclin-dependent protein kinases (CDKs) play a significant role in control of cell division and curb transcription in response to several extra and intra-cellular signals indispensable for enzymatic activity. The zebrafish cyclin-dependent protein kinase-like 1 protein (zCDKL1) shares a high degree of sequence and structural similarity with mammalian orthologs and express in brain, ovary, testis, and low levels in other tissues. Regardless of its importance in the developmental process, the structure, function and mode of ATP recognition have not been investigated yet due to lack of experimental data. Henceforth, to gain atomistic insights in to the structural dynamics and mode of ATP binding, a series of computational techniques involving theoretical modeling, docking, molecular dynamics (MD) simulations and MM/PBSA binding free energies were employed. The modeled bi-lobed zCDKL1 shares a high degree of secondary structure topology with human orthologs where ATP prefers to lie in the central cavity of the bi-lobed catalytic domain enclosed by strong hydrogen bonding, electrostatic and hydrophobic contacts. Long range MD simulation portrayed that catalytic domain of zCDKL1 to be highly rigid in nature as compared to the complex (zCDKL1-ATP) form. Comparative analysis with its orthologs revealed that conserved amino acids *i.e.,* Ile10, Gly11, Glu12, Val18, Arg31, Phe80, Glu 130, Cys143 and Asp144 were crucial for ATP binding, which needs further investigation for legitimacy. MM/PBSA method revealed that van der Waals, electrostatic and polar solvation energy mostly contributes towards negative free energy. The implications of ATP binding mechanism inferred through these structural bioinformatics approaches will help in understanding the catalytic mechanisms of important STKs in eukaryotic system.

*Structural bioinformatics insights into ATP binding mechanism in zebrafish (*Danio rerio*) cyclin-dependent kinase-like 5 (zCDKL5) protein*

In mammalian systems, the conserved cyclin-dependent protein kinases (CDKs) control the process of cell division and curb the transcription mechanism in response to diverse signaling events that are essential for the catalytic activity. In zebrafish, zCDKL5 portrays differential expression profiling in several tissues and presumed to play a vital role in the neuronal development. In this study, the sequence-structure relationship and mode of ATP binding in zCDKL5 was unveiled through theoretical modeling, molecular docking, and MD simulations. Like human CDKs, the modeled zCDKL5 was found to be bipartite in nature, where, ATP binds to the central cavity of the catalytic domain through a strong network of H-bonding, electrostatic, and hydrophobic interactions. MD simulation portrayed that conserved residues, *viz,* Ile10, Gly11, Glu12, Val18, Val64, Glu81, Cys143, and Asp144 were indispensable for tight anchoring of ATP and contribute to the stability of the zCDKL5-ATP complex. MM/PBSA binding free energy analysis displayed that van der Waal energy (ΔGvwd) and Electrostatic energy (ΔGele) were the major contributors towards the overall binding free energy. Thus, comparative structural bioinformatics approach has shed new insights into the dynamics and ATP binding mechanism of zCDKL5. The results from the study will help to undertake further research on the role of phosphorylated CDKL5 in the onset of neurodevelopmental disorders caused by mutations in higher eukaryotic systems.

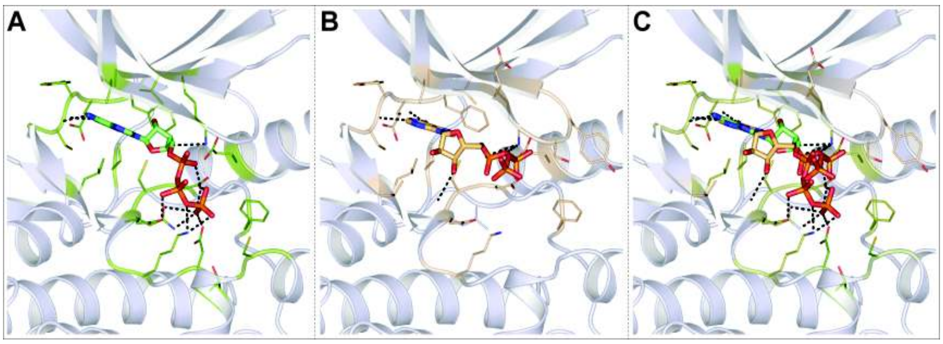


Fig. 134 Mode of ATP binding in zCDKL1. (A) The docked pose of ATP with zCDKL1 obtained from automated docking through AutoDock; (B) The molecular interaction of zCDKL1-ATP obtained through manual docking. (C) Structural position of the automated docked pose and manual docking portrayed using molecular visualization tool PyMOL. ATP molecule is shown as stick, protein as cartoon, interacting amino acids are depicted in line and polar contacts were presented in blackdotted lines.

Elucidating the molecular interaction of Zebrafish

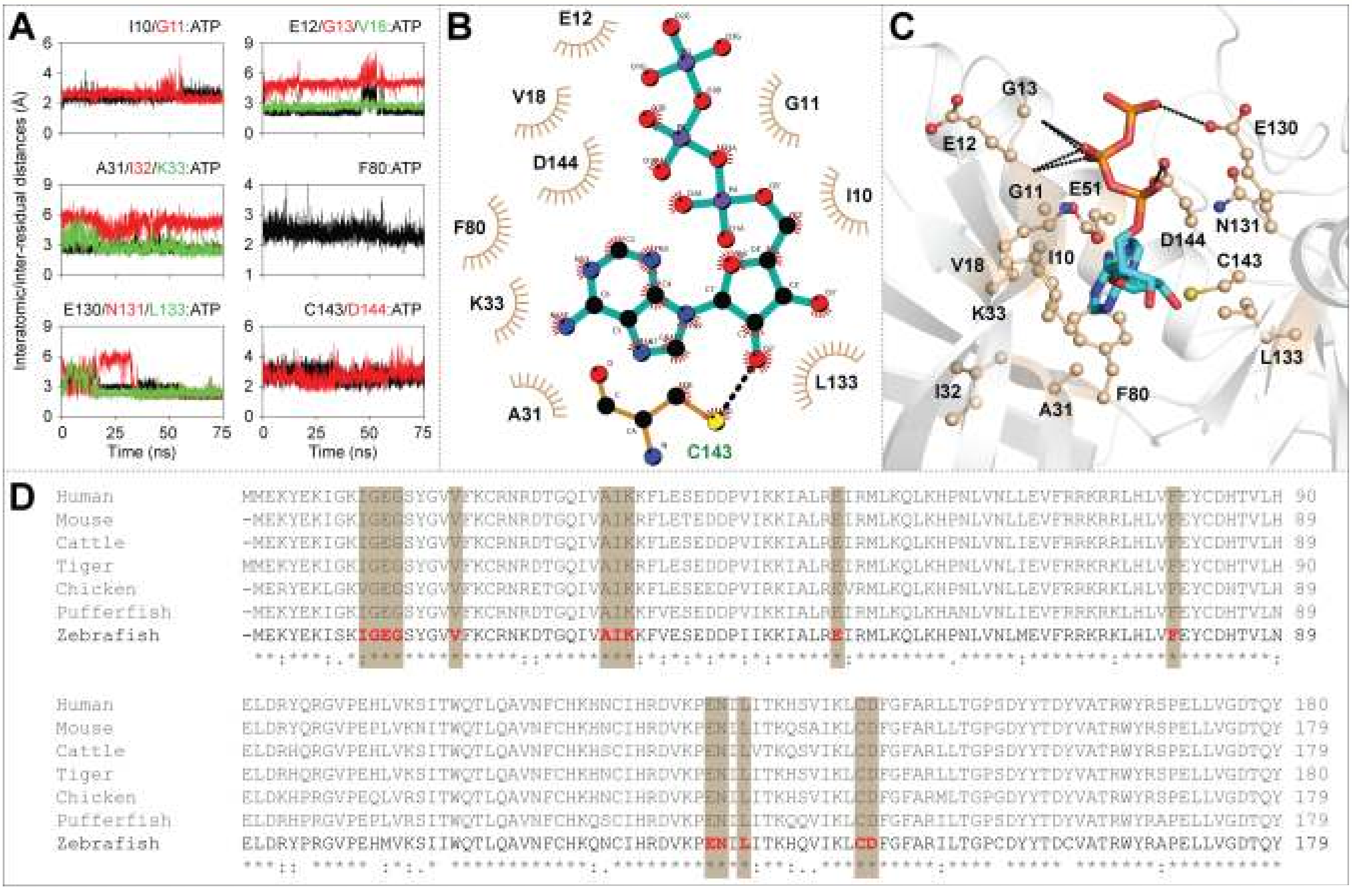


Fig. 135 Interaction analysis of ATP-zCDKL1 complex. (A) Inter-residual/inter-atomic distances of the key residues participating in molecular interaction ATP during 75 ns MD simulations. (B) The two-dimensional representation of zCDKL1- ATP interaction generated using the LigPlot+ program. (C) Interactions of ATP with the active site amino acids of zCDKL1 shown in PyMOL. The protein, ligand and hydrogen bonds are shown as cartoon, stick and dotted lines, respectively. (D) Multiple sequence alignment of CDKL1 of human, mouse, cattle, tiger, chicken, pufferfish and Zebrafish displaying the conserved amino acids responsible for ATP binding.

(Danio rerio) PGRP-2 receptor with DAP and LYS-type Peptidoglycans using in-silico approaches

Peptidoglycan recognition proteins (PGRPs) are the major constituent of innate immunity. Although PGRPs are structurally conserved through evolution their involvement in innate immunity are different in vertebrates and invertebrates. They are highly specific for the recognition and in some cases, hydrolyze bacterial peptidoglycans (PGNs). Zebrafish PGRPs have both peptidoglycans lytic amidase activity and broad-spectrum bactericidal activity, but far less is known about how these receptors recognize these microbial ligands. Such studies were severely hampered by the need to know zPGRP's structural and functional configuration. Henceforth, we inferred the three-dimensional architecture of the zPGRP2 at molecular scale through computational approach involving molecular modeling, docking and MD simulations of 50ns. So as to compensate these, 3D models of zPGRP2 were constructed and conformational and dynamic properties of zPGRP2 were studied. Docking information of microbial ligands such as MuramylPentapeptide-DAP (MPP-Dap), MuramylPentapeptide-LYS (MPP-Lys), Muramyl Tripeptide-DAP (MTP-Dap), Muramyl Tripeptide-Lys (MTP-Lys), MuramylTetrapeptide-DAP (MTr-Dap), MuramylTetrapeptide-LYS (MTr-Lys) and Tracheal Cytotoxin (TCT) in AutodockVina revealed β1, α2, α4, β4, and loops connecting β1?α2, α2?β2, β3?β4, and α4?α5 as the key interacting domains with the binding energy -4.5,-5.3,-5.5,-5.6,-5.3,-5.0,-5.1 for MTP-Dap, MTrP-Dap, MPP-Dap, MTP-Lys, MTrP-Lys, MPP-Lys and TCT respectively. We identified, few conserved critical amino acids i.e., His143, Ala89, Trp61, Ile35, Lys38, Asp60, His32, Arg144, Trp63, His31, Ala34, Asp106, His90 and Pro36 which are found to be crucial binding and provides stability to the complex. The plasticity of the PGRP binding site revealed by these microbial ligands suggests an intrinsic capacity of the innate immune system to rapidly evolve specificities to meet new microbial challenges in the future.

Antibiotic Resistant Gene (ARG) profiling of Yamuna river and Sundarbans delta using metagenomic approach

The direct discharge of urban sewage, hospital and pharmaceutical waste in the environment increase the antibiotic concentration which acts as a selection pressure for development of antibiotic resistant strains. To underline this major health concerns, a comprehensive profile of ARGs has been identified from the sediments of river Yamuna and soil samples from mangrove/non-mangrove of Sundarbans, using a metagenomic approach. A total of 139, 2 and 1 antibiotic resistance genes were identified from the sediments of river Yamuna, mangrove as well as non-mangrove soil of Sundarbans, respectively. On the other hand ARGs from the bacterial transcriptomics data has also been identified.

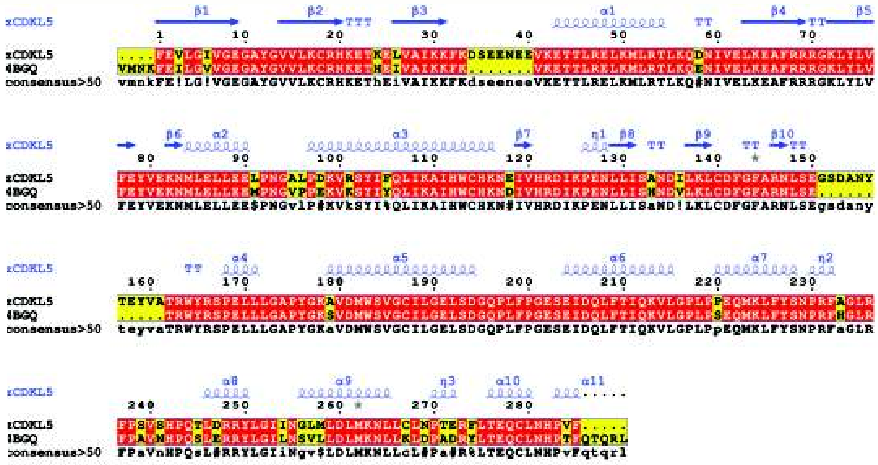


Fig. 136 Target-template alignment of zCDKL5 with the close structural homolog,that is, human CDKL5 kinase domain crystal structure (4BGQ) using Multalin and ESPript. The secondary structural elements were identified using ESPript. The α-helices, η-helices, β-sheets, and strict β-turns are denoted α, η, β, and TT, respectively. Similar amino acids are highlighted in boxes, and completely conserved residues are indicated by white lettering on a red background

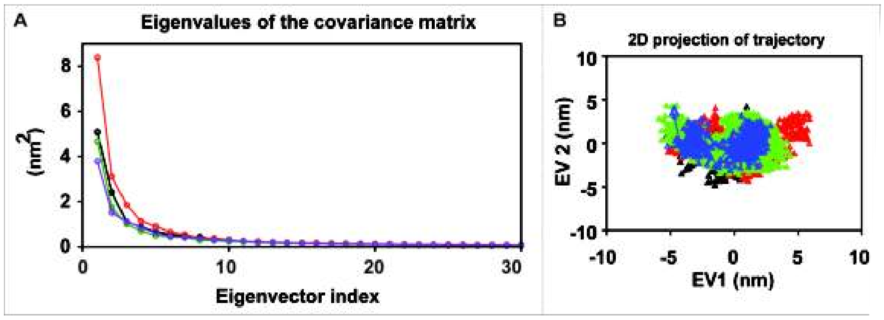


Fig. 137 PCA of zCDKL5 and ATP bound complexes (A) movement of main chain atoms on the basis of Eigenvalues in both apo and holo complexes and (B) MD trajectory in 2D projection

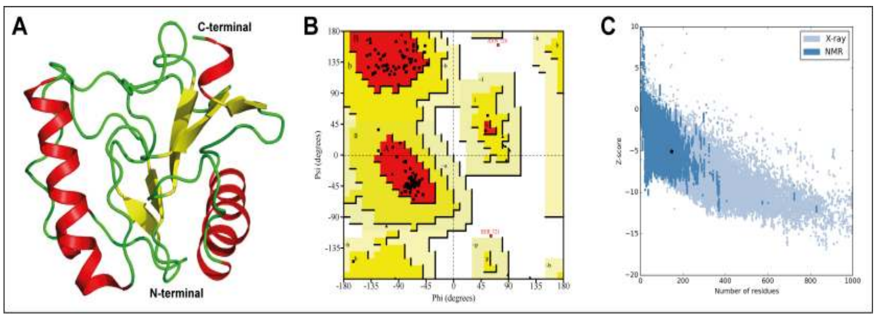


Fig. 138 (A) 3-Dimensional structure of PGRP2, (B) Ramachandran plot analysis of zPGRP2. Here, red region indicates favored region, yellow for allowed and light yellow shows generously allowed region and white for disallowed region. The phi and psi angles determine torsion angles. and (C) ProSA-web z-score analysis displaying the overall quality of the model

Table 12 Bioefficacy assessment of plant extracts against Argulus sp.

	LC_{50} (ppm)	95 % Fiducial limit		Calculated Chi square	Tabulated Chi square
		Lower Limit	Upper limit		
AH	3.12	1.10	8.80	1.77	7.81
SP	4.50	1.44	13.99	1.45	5.99

Alternative approaches for management of fish diseases

Development of antiparasitic herbal drug

Considering harmful effect of synthetic antiparasitic drugs in aquaculture system efforts have been made to develop ecofriendly plant based antiparasitic drugs from fruits of *Annona* sp. (AH) and *Sapindus* sp. (SP). Hexane extract of AH and methanol extract of SP were tested for their efficacy against *Argulus* sp. LC_{50} for the extract AH and SP was detected as 3.12 mg/L and 4.50 mg/L against *Argulus* sp.

Efficacy study of Terminalia arjuna *extracts against pathogenic bacteria and fungus*

With limited option of antimicrobials in preventive and therapeutic management of diseases in fish and concern of antibiotic resistance development there is an urgent need of substitute. With this aim, extracts of different parts (bark, fruit and leaf) of Terminalia arjuna were used for their efficacy against three different bacteria and fungus slight modification in disc diffusion method (CLSI, 2011). The references antibiotics disc as positive control such as Oxytetracycline (OTC), Streptomycin (SM) and Flucanazole (Flu) along with disc of negative control of respective solvents were embedded in the plate. The study showed antibacterial (8-23 mm zone), antifungal (12 mm) and anti-parasitic activities. The effective solvent extracts were used for final efficacy study. The results showed that the bacterial isolates have diverse pattern of efficacy, however, some of the bacterial isolates have very distinct inhibition zone i.e. ETML-3, VA-06, Ah-1 etc. The growth and survival revealed better values for fish fed with 1 % Arjuna bark extract as compared to the other feed treatments. For compound isolation the solvent system has been standardized.

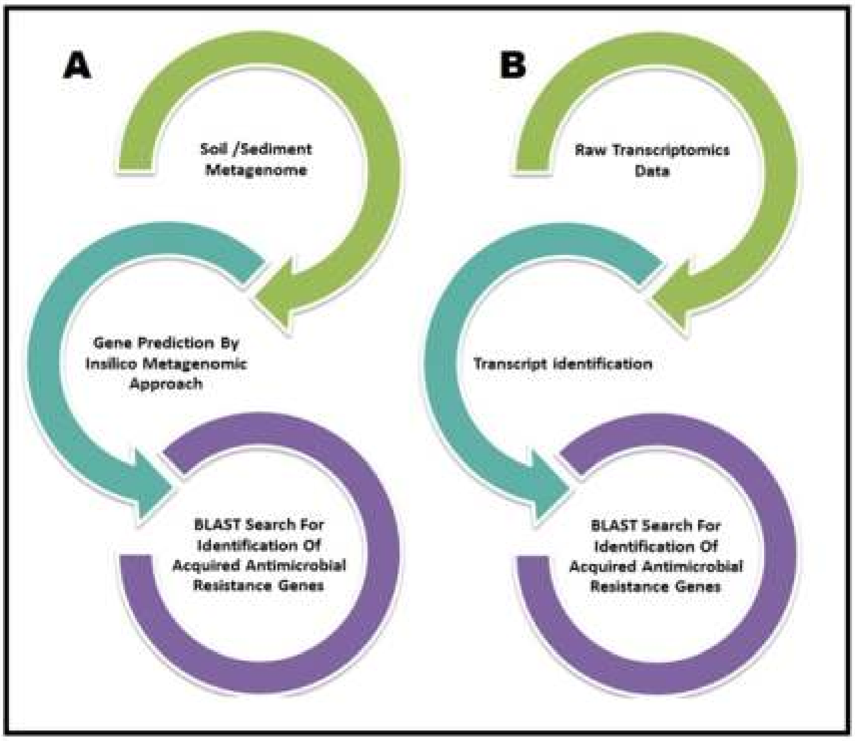


Fig. 139 ARG identification pipeline where "A" represent, pipeline for Metagenome dataset and "B" represent, pipeline for Transcriptomedataset.

A total of 14 fractions/combinations of the MeOH fractions of *Sonneratia apetala* with antibiotics were assayed against *A. veronii* isolated from diseased fishes of Moyna wetlands. Significant inhibition was obtained in initial trial. Isolation of bioactive compounds from the active component is in progress.

Plant essential oils as antibacterial against pathogenic Aeromonas sp.

In aquaculture, bacterial diseases caused by *Aeromonas* sp. with high antibiotic resistance are among the most common and troublesome. Application of herbs is emerging as a tool in controlling these diseases. Plant extracts besides disease control, favour various physiological activities in fish. In this study essential oils from *Cymbopogon citratus* and *C. nardus* (Poaceae family) were studied for their synergistic efficacy on oxytetracycline (OTC) against two resistant (Ah50; Acc. No. KJ609519 and Ah4; Acc. No. KJ588266) and one sensitive (Ah1; Acc. No. MG754418) strains of *Aeromonas hydrophila*. The oils exhibited dose dependant growth inhibition on the bacteria with MIC and MBC values ranging from 2.0-5.33 mg/ml and 4.0-8.0 mg/ml, respectively, *C. citratus* being more effective (Table 7). The oils when mixed with OTC at sub-MIC doses, few additive/ synergistic combinations were obtained which substantially reduced the effective dose of OTC (table 8). Study also indicated about the potential of the oils as antibiotic resistance modifying agents.

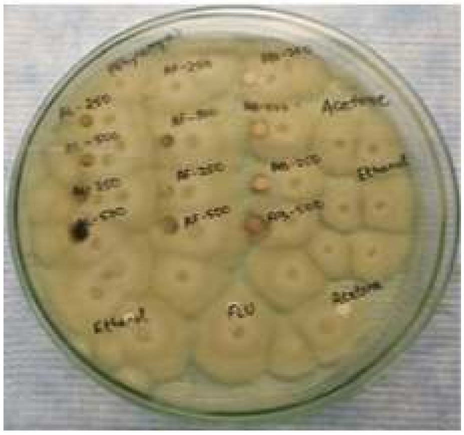


Fig. 140 Efficacy of ethanolic extracts of Arjuna bark and leaf against *Aphanomyces invadans*

Antioxidant activity of Arjuna plant extracts

The free radical scavenging activity (DPPH inhibition %) of different parts of Arjuna plant was tested. It revealed that fruit extract with distilled water showed maximum inhibition (47 - 66%), followed by ethanol fraction (22 - 64%), methanol (19 - 58%) and acetone (13 - 53%) fraction. The bark of Arjuna showed a different inhibition pattern i.e. ethanol fraction exhibits maximum inhibition (36 - 74%) followed by methanol (24 - 72%), acetone and distilled water (47 - 67%). The ethanol extract Arjuna leafs showed maximum inhibition (35 - 70 %) followed by methanol (25 - 68 %), acetone (17 - 44 %) and distilled water (15 - 35 %) extracts.

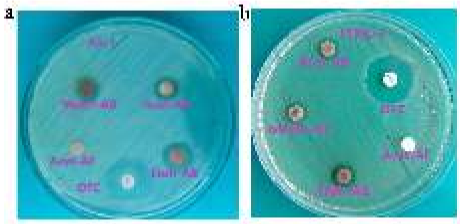


Fig. 140a. Antibiogram against potential fish pathogenic bacteria (*Aeromonas hydrophila* strain Ah-1 and *Edwardsiella tarda* strain ETML-3) at 10mg/ml of ethanolic Arjuna bark extract

Water soluble polysaccharide as fish immunostimulant

Water soluble polysaccharides (hydrocolloids) are known to act as prebiotics. These hydrocolloids were extracted from different plant sources to explore as immunostimulant in fish. Polysaccharides were fed to fish (*Oreochromis niloticus*) as oral drop @ 50 mg/kg body wt./day for 10 days. Both the treatment and control groups were maintained on normal diet. At 21st day, samples were collected for hematological, immunological and gut bacterial load analysis. Significant increase in Hb, RBC, WBC, Nitrite Assay and gut bacterial count was recorded. As a next step, feed containing polysaccharide (0.50 and 0.75 % of feed weight) has been prepared, and feeding trials has been initiated.

Nano products against ectoparasite Argulus bengalensis

Nanoemulsion formulation of an insecticide was developed through spontaneous emulsification technique and its bioefficacy was evaluated against fish ectoparasite *Argulus bengalensis*. The synthesis parameters of the nano-emulsion were standardised using

Table 13 MIC and MBC values of essential oils and oxytetracycline against *A. hydrophila* isolates (mean ± SEM), R1, R2 = resistant strains, S1 = sensitive strain; (-) indicates no growth

Bacterial isolate	Lemon oil		Citronella oil		Oxytetracycline	
	MIC (mg/ml)	MBC (mg/ml)	MIC (mg/ml)	MBC (mg/ml)	MIC (µg/ml)	MBC (µg /ml)
R1(*Ah*50)	3.33 ± 0.67	4.00 ± 0.00	4.00 ± 0.00	5.33 ± 1.33	-	-
R2 (*Ah*4)	2.67 ± 0.67	6.67 ± 1.33	5.33 ± 1.33	8.00 ± 0.00	-	-
S1(*Ah*1)	2.00 ± 0.00	4.00 ± 0.00	4.00 ± 0.00	6.67 ± 1.33	10.67 ±2.67	13.33±2.67

response surface methodology with an orthogonal design to get optimum nano-emulsion with lowest particle size (179.8 nm) and highest encapsulation efficiency (90.24 %). The loading of the insecticide in nano-micelle was further confirmed using FT-IR. The bioefficacy the optimised nano-emulsion was studied against *A. bengalensis* at embryonic stage. It was observed that treatment of nano-emulsion caused disruption of natural developmental stage of *A. bengalensis* egg at very low concentration (0.001 mg/L). The calculated LC_{90} (for prevention of 90% egg hatching) was found to be 1.395 mg/L for nano-emulsion as compared to 6.622 mg/L for conventional EC formulation.

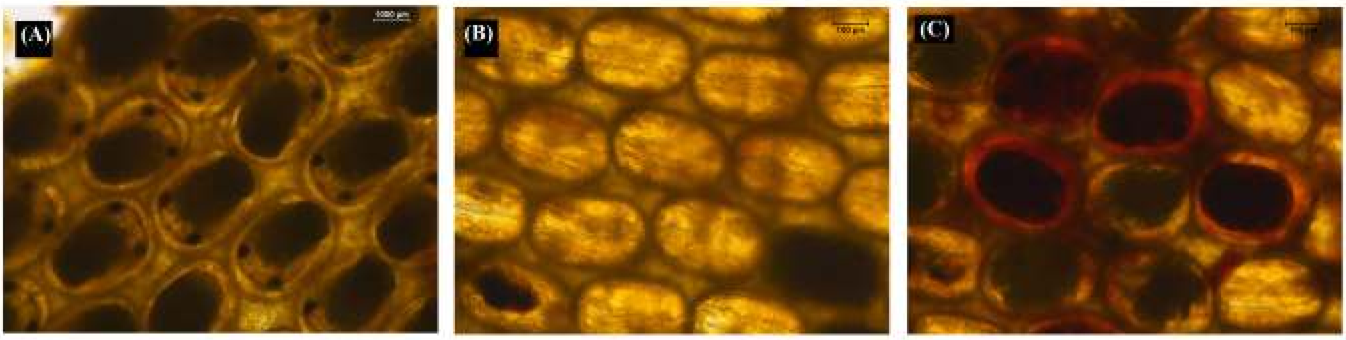


Fig. 141 Egg of *Argulus bengalensis* unhatched (A) and hatched (B); Effect of nano formulation at 0.1 mg/L(C).

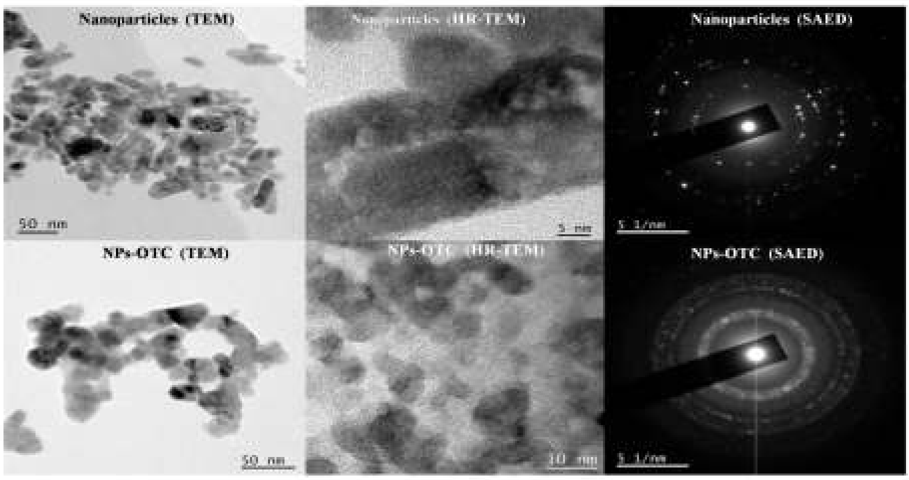


Fig. 142 TEM, HRTEM and SAED pattern of developed metal nanoparticles and OTC loaded metal oxide nanoparticles

Nano-antibiotics against resistant infectious bacterial strains

Nano-antibiotics were developed by encapsulating a recommended antibiotic (Oxytetracylcine hydrochloride) in metal oxide nanoparticles though a simple wet precipitation method. The synthesized nano-antibiotics showed wide zone of inhibition against OTC resistant infectious bacterial strains (*Aeromonas hydrophila* and *A. veronii*) at a very low dosages (30 µg). The development of nanodrugs for application in fisheries sector has the potential to revolutionize the disease management problem.

Distribution of microplastics in river Ganga

Small plastic debris is one the most significant emerging pollutant due to their extreme durability and synthetic nature, possessing tremendous threat to the aquatic environment. Though a considerable amount of literature exists with regard to microplastics in the marine environment, there is scarcity of information on microplastics, especially in India. In the present study, sediments of river Ganga at lower stretch were analyzed for distribution of meso and microplastics at seven different locations viz. Buxar, Patna, Bhagalpur, Nabadwip, Barrackpore, Godakhali and Fraserganj. All the sediments contained mesoplastics (> 5 mm) and microplastics (< 5 mm) with varying degree of mass fraction (11.48 to 63.79 ng/g sediments), numerical abundance (99.27- 409.86 items/kg) and morphotypes. Further analysis with infrared spectroscopy of mesoplastics showed a differential distribution of plastic nature (polyethylene, polypropylene, polyethylene terephthalate and polystyrene) based on the type of plastic garbage from sewage and gears used for fishing. This study exhibits the spatial distribution of meso and microplastics in the highly populated locations along river Ganga emphasizing the attention to be given to this emerging pollutant in the inland river system and their role as transporter of plastic fragments finally to the ocean.

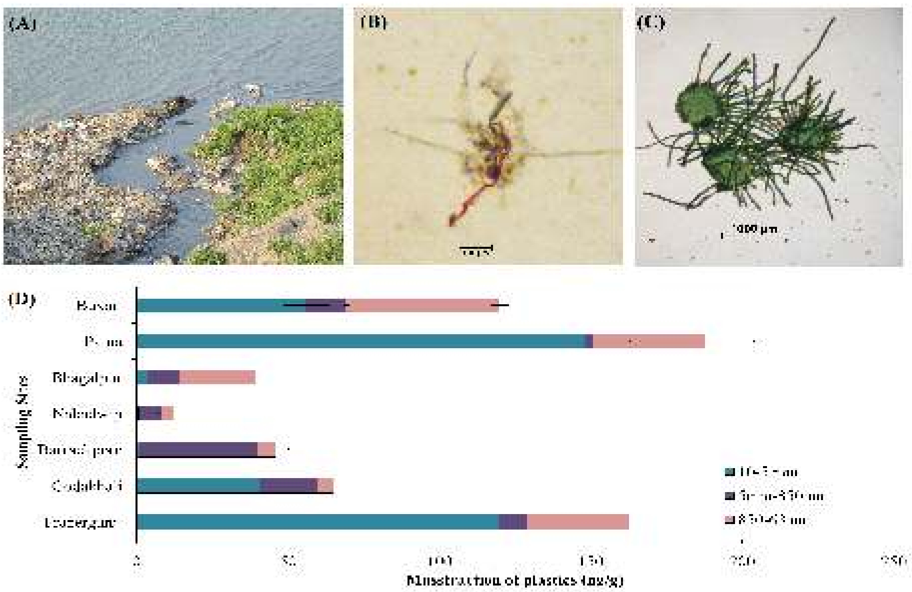


Fig. 143 Deposition of plastic in Ganga at Buxar (A); Extract microplastic in microscope (B,C); spatial distribution of meso and microplastics (mass fraction) in the selected sites of Ganga at lower stretch.

Project Title	:	**Aapplications of statistical tools for assessing Inland Fisheries Management**
Project Code	:	**FREM/17-20/15**
Project Personnel	:	Malay Naskar, M. Karthikeyan, S. K. Sahu, D. Karunakaran, D. N. Jha, A. K. Yadav, Chayna Jana and Rohan Kumar Raman

Spatial Databases

Spatial databases of (a) north Himalayan river system comprising data on 'water quality', 'site characteristics', 'fish species richness', 'phytoplankton richness', 'zooplankton richness', 'benthos richness' (b) Arunachal river network system comprising data on 'fish species richness', 'geo-physical parameters' have been generated in the form of standalone system. Those stand-alone spatial databases will be useful for researchers and policy-makers to view the spatial pattern of data, will enrich the data repository of ICAR-CIFRI, and will also be useful for model development.

Quantification of water and sediment quality determinants of Small Indigenous Fish (SIF)

A model-based approach has been devised to identify key determinants, specially the of water and sediment quality parameters, of abundance of SIFs in the Krishna River. The data used in the model have been generated through a survey conducted by ICAR-CIFRI (Das et. al, 2017). Abundance of Chanda nama, chosen as a candidate SIF, was designated as response variable; ten water quality and three sediment quality parameters were designated as explanatory variables for model-based inferences. Variable selection through Boruta (based on Random forest) algorithm has resulted in four parameters, viz. Specific Conductivity; DO, SiO_2; and Temperature; as the key determinants of SIF abundance of Krishna River. This information can be utilized further for river restoration programme.

Bivariate Poisson modelling framework for plankton

Bivariate Poisson regression modelling (BPRM) approach is used to estimate the effect of explanatory variables on two depended count response variables. It can provide a suitable tools to assess the aquatic ecosystem parameters where response data, such as species richness of fish, phytoplankton, zooplankton, are very often measured in count (i.e., in non-negative numbers) and are positively correlated. Further, in aquatic ecosystem, it is evident that the relationship between phytoplankton and zooplankton abundance is very much correlated with the water quality. So, to examine the correlation factors for phytoplankton and zooplankton richness in the river systems, secondary data on water quality, phytoplankton, and zooplankton richness of rivers Beas, Ganga, Ravi and Sutlaz of western Himalayan region (source: Johal et al., 2002) were used for model-based inferences. A total of 11 water quality parameters (e.g., water temperature (0C), DO (mg/L), specific conductivity (µS/cm), turbidity (NTU), total dissolved solids (mg/l), pH, chloride (mg/l), alkalinity (mg/l), hardness (mg/L), nitrate (mg/L) and phosphate (mg/L) along with plankton and zooplankton richness (no.) recorded at 42 sites of all the four rivers have been considered for model building. Factor analysis was used for the covariate selection and thereafter selected variables were incorporated into BPRM framework to predict phytoplankton and zooplankton richness.

AIC criteria (minimum best) was chosen as model selection criterion. Analysis showed a positive correlation (r = 0.36) between the plankton and zooplankton community for all the 41 river sites. Factor analysis suggested three important quality parameters viz. conductivity, dissolved oxygen and phosphate to explain 75% variability of water quality in the river system. Out of three identified water quality parameters, DO has been found to be the most influential covariate that induces correlation between phytoplankton and zooplankton richness, as observed through the BPRM modeling with minimum AIC value of 690.56. The advantage of using this model is that we have successfully quantified site-specific correlation between phytoplankton and zooplankton richness, which has not been reported in any previous study. It indicates that site-specific correlation between phytoplankton and zooplankton richness in the river Sutlej is relatively low than that in Ganga and Beas.

Bayesian geo-statistical modeling to identify fish species 'hot-spot' in river network

A new modeling approach has been applied to a secondary data to identify fish species 'hot-spot' in a river network system. The data have been collected and processed from published literature (Bagra et. al, 2009). There were 40 sites on 35 rivers from where geo-

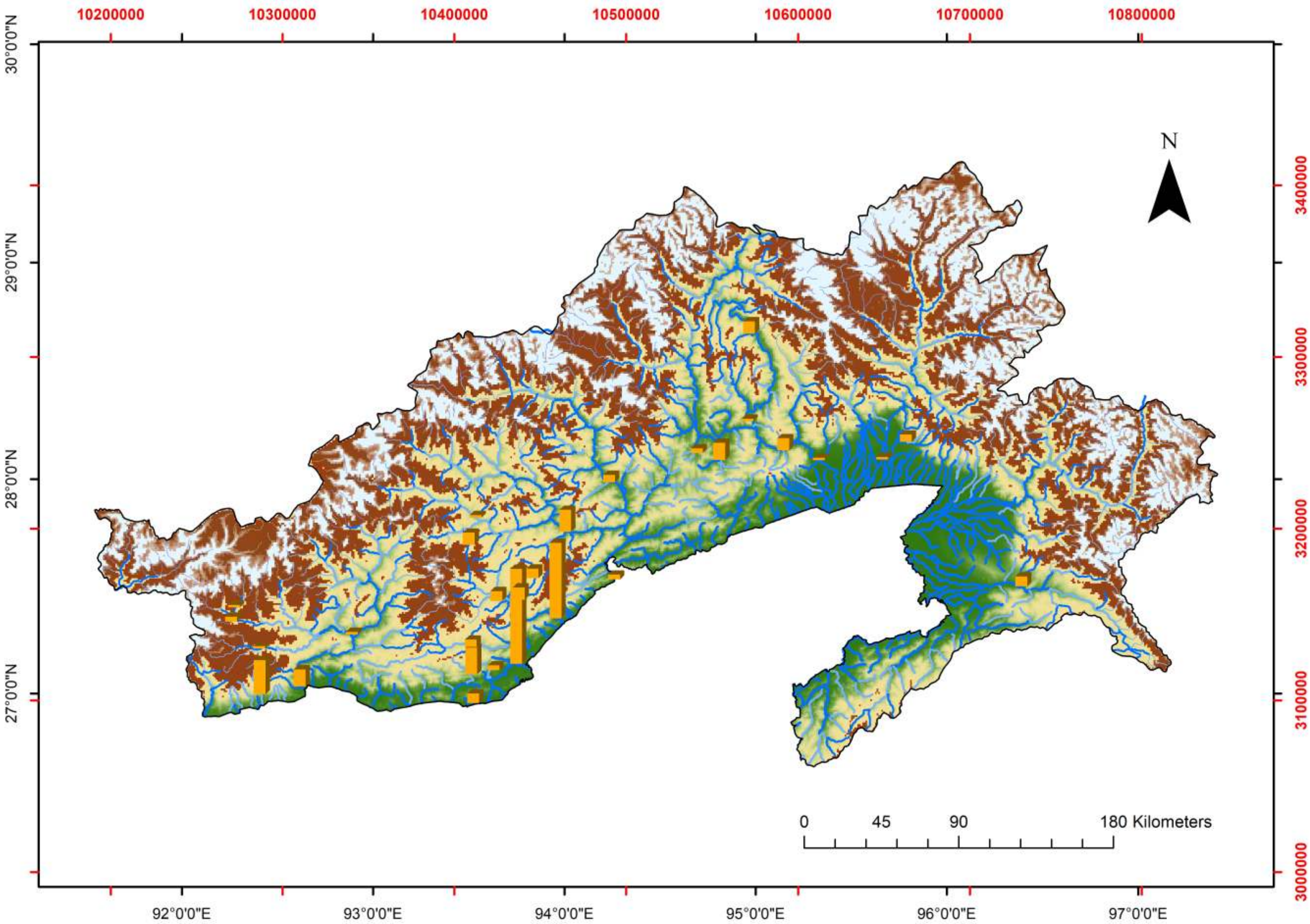


Fig. 144 GIS deployment of 'fish species richness' depicting the pattern of riverine network of Arunachal Pradesh

referenced fish species distribution data was recorded. We have further added value to the data by extracting information on sinuosity and elevation through RS image processing. Full Bayesian Poisson spatial (geo-statistical to be specific) regression model has been applied by designating fish species richness as response variable and longitude, latitude, elevation, number of streams and sinuosity as predictor variable. The results indicate that predictor variables have explained 55% variability in fish species richness. The relative importance of those predictors to explain variability in fish species are as follows sinuosity (negative) > longitude (negative) > elevation (negative) > number of stream (positive). Further, a predicted map of fish species richness has been generated from model output . The map indicates the prospective 'hot-spot' of fish species. This can be very useful for demarcation of protected area for biodiversity conservation.

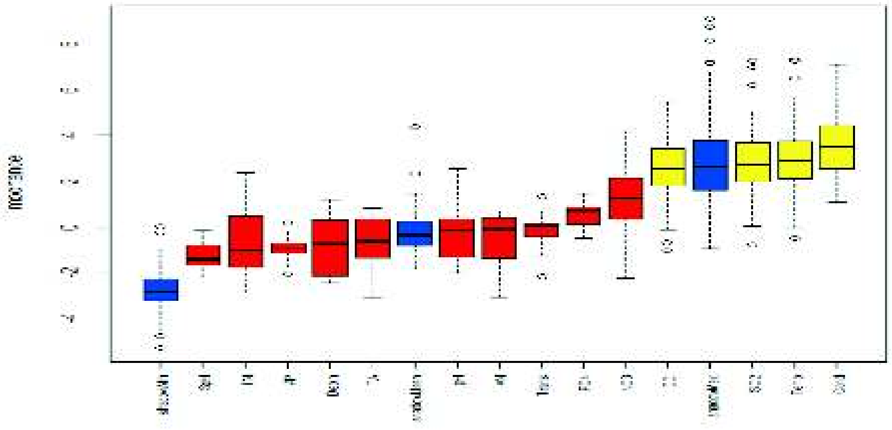


Fig. 145 Relative Importance of parameters for abundance of *Chanda nama*

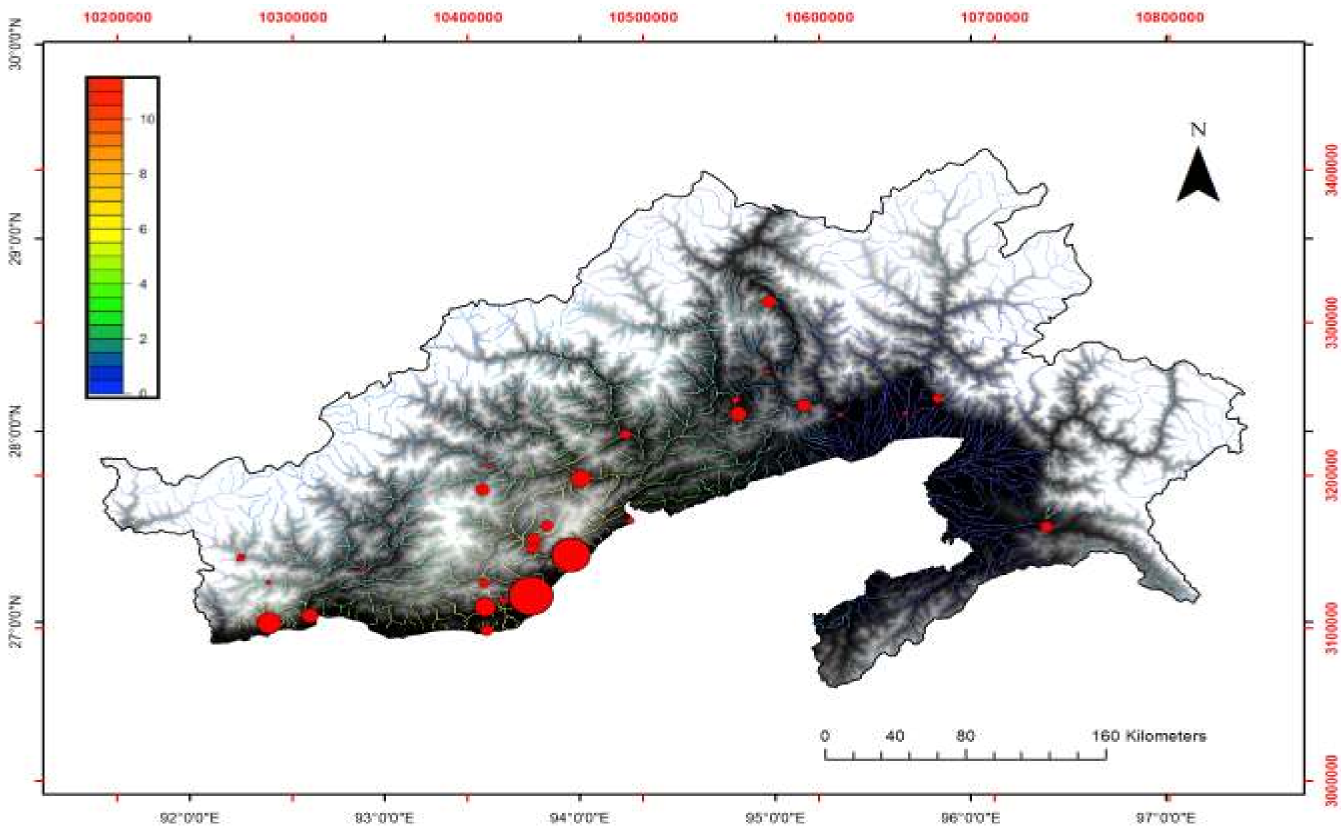


Fig. 146 Predictive map of fish species richness. Colour gradient from red to blue indicates high to low richness. Size of grey circles is proportional to the observed fish species richness.

Project Title	:	**Impact assessment of CIFRI technologies (cage and pen culture) and training**
Project No	:	**FSE/17-20/03**
Project Personnel	:	Arun Pandit, Ganesh Chandra, Aparna Roy, Anil K. Yadav, Piyashi Deb Roy, Simanku Bora and Sukanya Som
Associate(s)	:	Lokenath Chakrobarty

Impact of cage culture on fishers livelihood

Data for evaluation of the impact of cage culture on fishers livelihood was collected from the State Fisheries Department of Jharkhand and through field survey in Tenughat, Patratu, Tilaiya and Chandil reservoirs of Jharkhand. Jharkhand is one of the early adopters of cage culture in India and initiated cage fish farming in 2007 under NMPS scheme. The study revealed that, there were altogether 2,734 cages in-operation in 23 reservoirs of the state in 2015-16. A large majority (89%) of cages were GI made frame cages. The goal of the cage culture in the state was two-fold: i) to fulfill the protein requirements of the people at a low cost ii) and to create livelihood opportunities for the displaced farmers.

Fig. 147 Cage fabrication for installation in Patratu reservoir

In Chandil reservoir, it was found that around 100 displaced families undertook cage culture. The government provided subsidy to *Chandil Bandh Visthapit Matsyajibi Swabalambi Sahakari Samiti* (CBVMSSS), the fishing cooperative of the displaced farmers to buy cages for fish farming. The state Fisheries Department provided the technical support and training to the CBVMSSS. The income is shared between fishers and the society in 80-90:10-20 ratio. Cage culture is dominated by Pangas (*P. hypophthalmus*). Economic analysis showed that, fishermen earned a net return of about Rs. 50,000 per cage per cycle of Pangas production. The B:C ratio of cage culture in the reservoir was 1.24. The average fish production was around 3000 kg/cage/year.

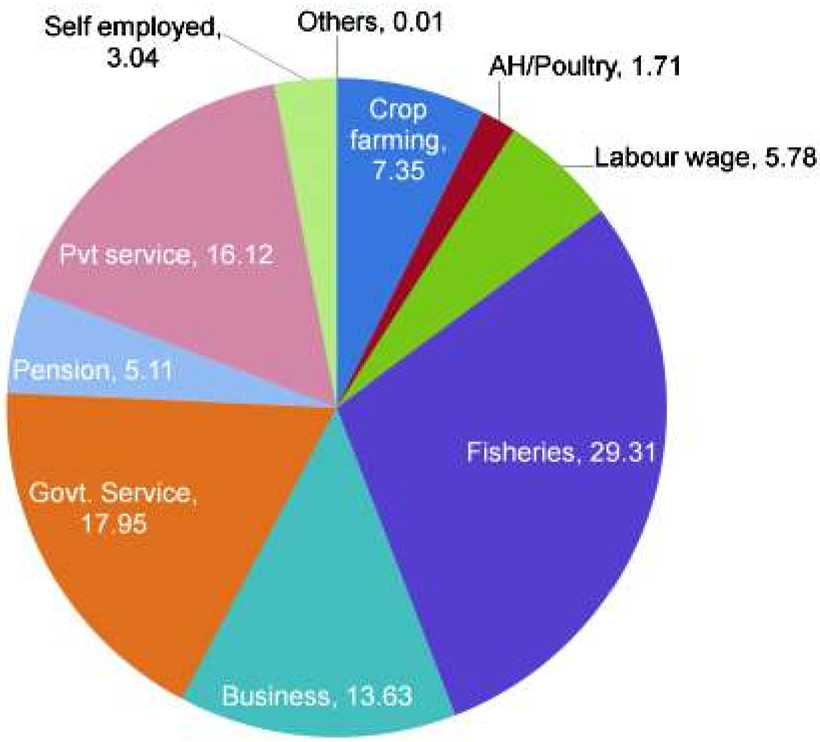


Fig. 148 Sources of livelihood of the fishers' households (before cage adoption)

Fig. 149 Bird’s eye view of CIFRI GI-Cage under fabrication

Table 14 Impact on high value asset possession and consequent changes after cage culture adoption

Asset	Cage fishers	
	Before cage	After cage
Pucca house	35.29	44.12
Own source of drinking water	30.88	33.82
Own toilet	45.59	70.59
Agri. land	63.24	61.76
Tractor/Power tiller	2.94	2.94
Electricity	77.94	91.18
Mobile phones	69.12	95.59
Computer/laptop	10.29	13.24
Colour TV	36.76	50.00
Fridge	13.24	19.12
Bi-cycle	63.24	64.71
Motorcycle	41.18	69.12

Study of basic socio-economic characteristics of the fishers households revealed that the average family size was around 5.5. The literacy rate of the respondents was also good. In general the socio-economic standards of the cage fishers are better than those of ordinary fishers. The monthly income was also significantly higher in the former group of fishers. On an average the number of economic activities was almost equal in both categories of fishers, however, the occupation migration was less in cage farmers households. The survey further revealed that, the cage farming contributes about 30% of their livelihood. The monthly income of the cage fishers has increased from Rs. 11,093 to Rs. 17,548 after adoption of cage farming. The occupation migration has reduced to 9% from 29% because of cage culture. The extent of agricultural land holding and livestock farming are also less in cage fishers. This is because cage farming alone consumes a significant time of fishers and sufficient income generated through cage farming gives them a comfortable livelihood.

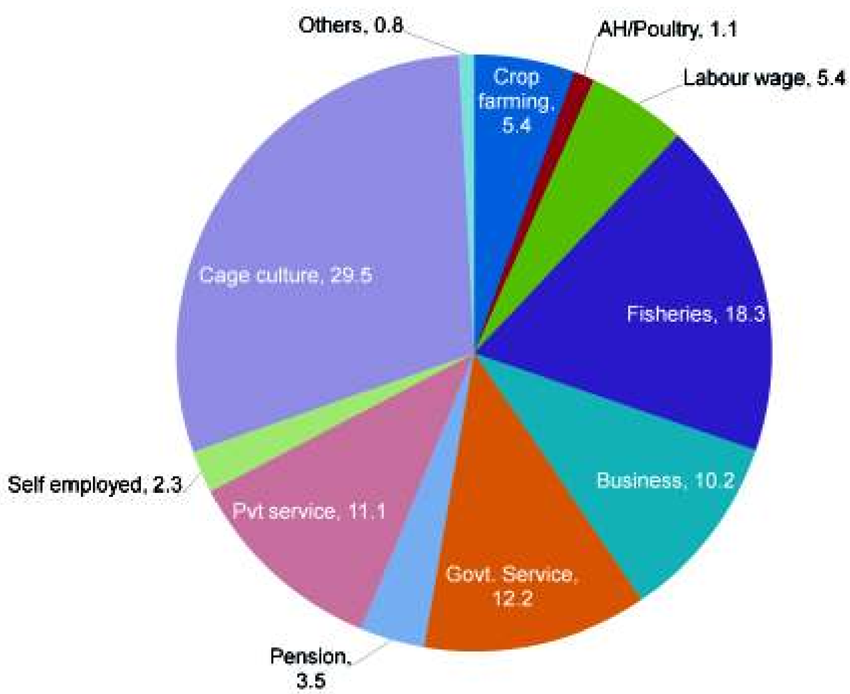


Fig. 150 Sources of livelihood of the fishers' households (after cage adoption)

It was also observed that, there are significant differences in asset possession after adoption of cage culture. Possession of pucca house, own toilet, electricity, colour TV were significantly higher after cage culture adoption.

Further, family expenses on fuel, education and households items have increased by around 97%, 76% and 39%, respectively. The expenses have also increased significantly towards other items such as Clothings, medical and household utilities.

Constraints in adoption of cage culture

The practising fishers' responses were recorded regarding the constraints faced by them in adopting the cage culture technology. It was found that, their major constraint was of high initial cost. Around Rs. 2.5-3.0 lakh is required in the first year to start one cage culture operation which is a large amount for an poor fisherman. High feed cost and low market of fish are other major constraints. Lack of guarantee of the fish seed, non availability of seed in time and disease / mortality were also mentioned by the fishers.

Impact of pen culture on wetland productivity and fishers income

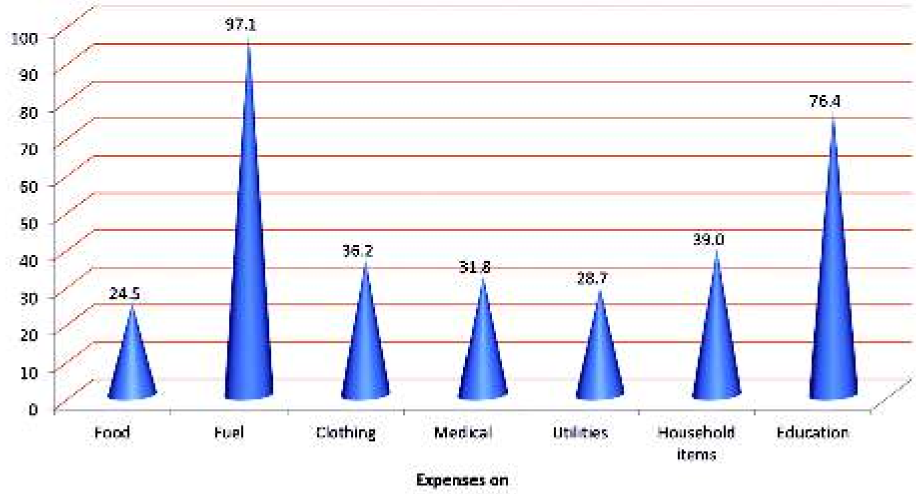


Fig. 151 Increase in routine expenses after adopting cage culture

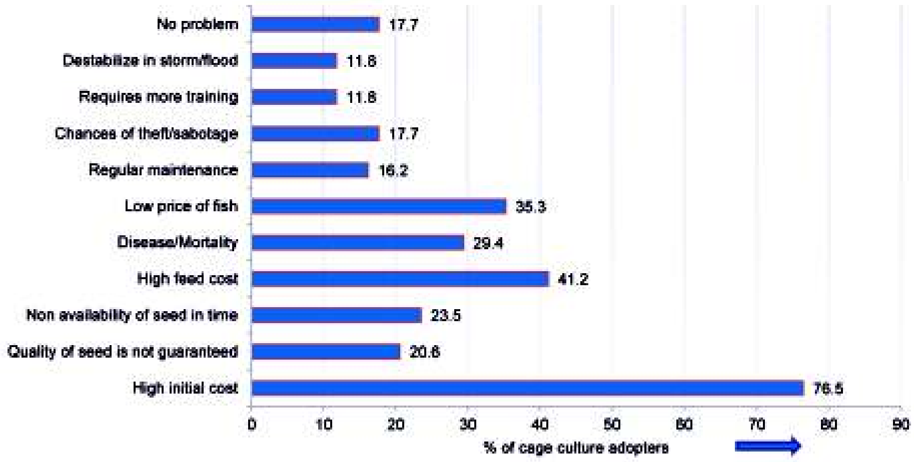


Fig. 152 Constraints in adoption of cage culture

The institute has been working on pen culture technology since early seventies. It has experimented with a wide variety of pen materials, candidate fish species, stocking densities and so on. Of late, the technology has been commercialized as “CIFRI PEN HDPE”. A study was carried out to analyse the impact of pen culture on fish yield in 22 beels of Assam. The institute had carried out pen aquaculture demonstrations in these beels during 2013-14 under NEH Programme. The study found that, the stocking of advanced fingerlings, produced *in-situ* through pen in the beel had considerable positive impact on fish yield. The average wetland production has significantly increased from 492 kg/ha/yr in 2012-13 to 1011 kg/ha/yr during 2016-17.

Another study was carried out at Takmu Pat, a part of Loktak lake in Manipur wherein ICAR-CIFRI, Barrackpore through its Regional Centre located at Guwahati conducted net pen enclosure culture of fish. In 2012,

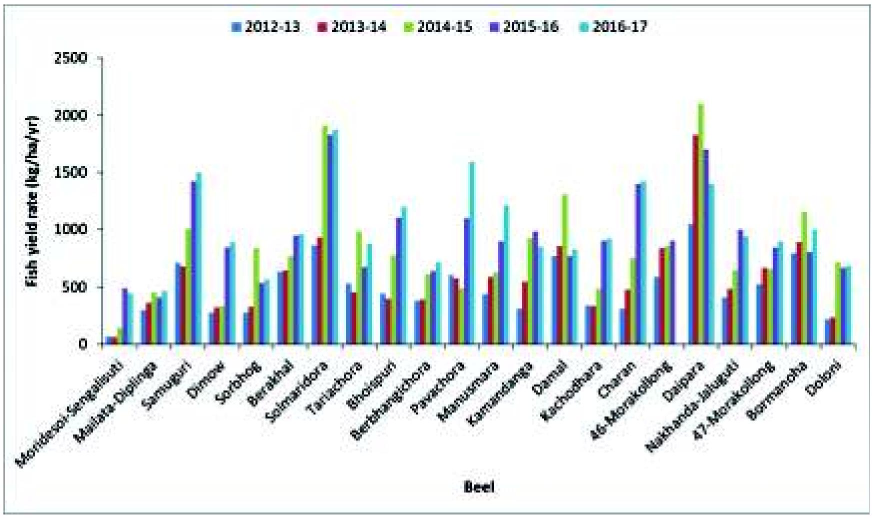


Fig. 153 Enhancement of fish productivity through pen culture in selected beels of Assam

the first pen culture demonstration was conducted, the results of which were encouraging. Subsequently, four such demonstrations were conducted in 2015 under NEH Component of CIFRI. Culture of Indian major carps (Catla, Rohu and Mrigal), exotic carps (Grass Carp, Silver Carp and Common Carp), Minor Carp (*L. gonius*) and Pengba (*Osteobrama belangeri*) in pens constructed in Takmu pat was highly successful.

Encouraged by success of those demonstrations, the Department of Fisheries, Govt. of Manipur took initiatives and conducted various enclosure culture programmes. At present 50 net pens, each of 0.5 ha are in operation by 50 local fishermen area at an annual lease value of Rs. 5000 from DoF, Manipur. The survey found that, 65.22% of the pen users were in the age group of 36-55 years and rests were above 56 years. This implies that, fisheries sector is not attracting the young people in the state. Among the respondent fishers families, male outnumbered the female with a male-female ratio of 1.14:1.00. About 34.78% fisher household have a family of size 2-4, 47.83% have family of size 5-6 and 17.39% having >7 members and average family size was worked out to be 5.3.

Literacy status of respondent households revealed that, 30% were primary, 53.33% were secondary and 16.67% were collegiate by formal education. The overall literacy rate was found to be 73.77% which is at par with the overall literacy rate of the state *i.e.* 76.94% as well as country 74.04% as per Census 2011. The respondent household income ranged from Rs. 12,500 to 25,660 per month with median income of Rs. 16,667 per month.

Study on income sources of respondent household and livelihood before and after pen culture revealed that, fisheries was the only income generating activity for almost all the respondent household before and after adoption of pen culture. They used to devote an average 2-3 hours per day for open fishing in wetland before pen culture with daily average fish catch of 1.5-3 kg, out of which 250-350 gram was used for home consumption. The major part of the catch was dominated by small indigenous fishes. After pen culture, an additional 3-4 hours is devoted for operation/ maintenance of pen. The paired-samples t-test was conducted to compare monthly routine expenses of respondent household before and after pen culture. There was a significant difference ($p<0.001$) in the monthly income before (Rs. 6183 ± 2711) and after pen culture adoption (Rs. 9250 ± 3318); Hence, pen culture has significant positive effect on fishers income.

Pen culture was carried out for table fish production. The candidate species considered for pen culture was grass carp yearlings since the para grass in wetland was used as feed. The species stocked in pen were grass carp (60-70%) and other carps (30-40%). No supplementary feeding was done. The stocking density ranged from 2500-3500 nos/0.5 ha. The fish production from pen ranged from 2600-4000 kg/ha.The benefit cost ratio was estimated to be 1.34-1.84 assuming that the pen materials will less for 2 years.

Impact of ICAR-CIFRI trainings imparted to farmers

Considering huge potential of the fisheries sector, Government of Bihar has put special emphasis on capacity building of the fishers/fish farmers. Accordingly 3261 fishers/ fish farmers from 37 districts of Bihar state were trained on inland fisheries management by ICAR-CIFRI during 2012-13 to 2018-19. Now, to measure the impact of those training programmes, data were collected from 400 trainees from six districts of Bihar using a semi structured interview schedule. The logistic regression analysis with socio-economic variables like main occupation, land holding, membership in organizations has positive and significant effect on the training effectiveness. The Training Effectiveness Index was 87.86% which comes under high effectiveness category. The results also revealed that 44.8% of the trainees were young aged which has positive effect on training effectiveness. About 53% of the farmers perceived that the training programme provided to them was highly satisfactory. The farmers also perceived that these trainings helped them to increase their knowledge and skill, enhance entrepreneurial ability and also motivate them to initiate new enterprises.

Socio-economic impact of trainings on the fishers

A case study was conducted by taking up the beneficiaries of Begusari District. A total of 138 fishers/ fish farmers from Begusarai districts were trained on various aspects of Inland Fisheries Management in last five years. Through personal interview the socio-impact of the trainings on the fishers/fish-farmers of Begusarai District were assessed and compared with the baseline socio-economic data. It was found that 7% more fishers

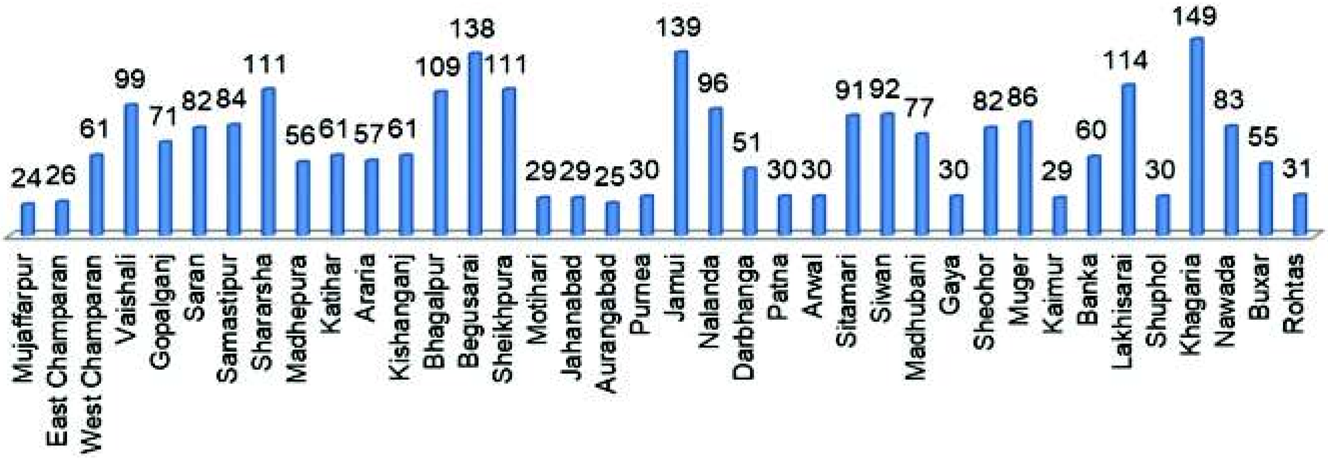


Fig. 154 District-wise distribution of farmers

Table 15 Impact of CIFRI trainings on the Socio-economics of the fishers of Begusarai District, Bihar (N=80)

Training benefits	Main Occupation Fishery	Average Income from fishery (Rs./yr)	Membership in organization	New pond construction
Before Training	23%	17,000	13%	0
After Training	31%	36,000	24%	4%

have now taken up fisheries as the main occupation after the training. The average income from fisheries has increased from Rs. 17,000/- to Rs. 36,000/- in a year. About 4% of the fishers have constructed their pond with help from Government subsidy.

Impact of Training imparted to Fishery Officials

Post-training assessment of overall quality of the training programme showed that 50% of the participants rated the training programme as excellent, while 34.62% perceived it as very good and 15.38% as good. All the participants perceived the training programme to be helpful for improving their job performances and 60% of them expressed willingness to conduct farmers' training on the same topic in future. 53.84% stated that, their expectations were fulfilled "to a great extent" and for rest of the trainees it was "to some extent". Further, significant positive association was found between the normalized scores of training need and fulfillment of expectation of the trainees with the help of correlation coefficient at 5% level of significance (r=0.632, P=0.000).

Significant correlation coefficient was also found between the normalized scores of expressed training needs of the topics and Rank Based Quotients (RBQs) of the perceived values of topics covered under the programme at 5% level of significance (r=0.808, p=0.003). This indicates accomplishment of the training needs of the trainees by the sessions taken under the programme. The findings of this study would be useful for conducting and improving similar type of model training courses in future.

Fig. 155 Grading of the training programme

Outreach Projects

Project Title : **Outreach Project on Fish Genetic Stock**

Project Code : OR/ER/08/09/02

Project Personnel : B. K. Behera, P. K. Parida, D. K. Meena, P. Das, A. Alam

Associate(s) : A. K. Jana

Sequencing of complete mitochondrial genome of Osteobrama belangeri *(Cyprinidae) and its comparison with other related Cypriniformes fish species*

The Osteobrama belangeri is a preferable medium sized carp in North eastern states of India. Whole Mitogenome information is key to biodiversity studies. Therefore, fish sample was collected from Loktak Lake ($24^{0}30^{/}19.82^{//}$N, $93^{0}46^{/}33.62^{//}$) Manipur, India and the whole mitogenome sequencing of *O. belangeri* was carried out. A total of 1,23,417 reads were obtained and compared with 19 number of fish mitogenome data. Mapped reads were de novo-assembled by Torrent Mapping Alignment Program (TMAP) using Torrent Suite software version 4.0 (Ion Torrent, Life Technologies, La Jolla, CA). The complete Mitogenome of *O. belangeri* is 16,609 bp (GenBank Accession No. MK749691) with 13 protein coding genes, 2 rRNA genes, 22 tRNA genes, and a 926-bp-long control region. The major number of genes was encoded on the H-strand except $tRNA^{Glu}$, $tRNA^{Gln}$, $tRNA^{Ala}$, $tRNA^{Tyr}$, $tRNA^{Pro}$, $tRNA^{Asn}$, $tRNA^{Cys}$, $tRNA^{Ser}$ and ND6 which were encoded on L strand and all 22 tRNAs were packed into a typical clover-leaf structure. The evolutionary history of *O. belangeri* was established with closely related 19 species of Cyprinidae using the Minimum Evolution method (Rzhetsky and Nei, 1992) and the optimize tree with a sum of total branch length (0.72897974) and the replicate trees in percentage, where associated Taxa clusters with branch length present above the branches. The minimum evolution phylogenetic tree was drawn by MEGA 6.0 (McAllister Ave, USA) (Tamura *et al*. 2011), using 19 related Cypriniformes fish species mitogenome from NCBI database. The *O. belangeri* is very close to the cluster of *Systomussarana sarana, S. orphoides, Barbus eburnunsis* and *Enteromius guirali* than other related Cypriniform fish species.

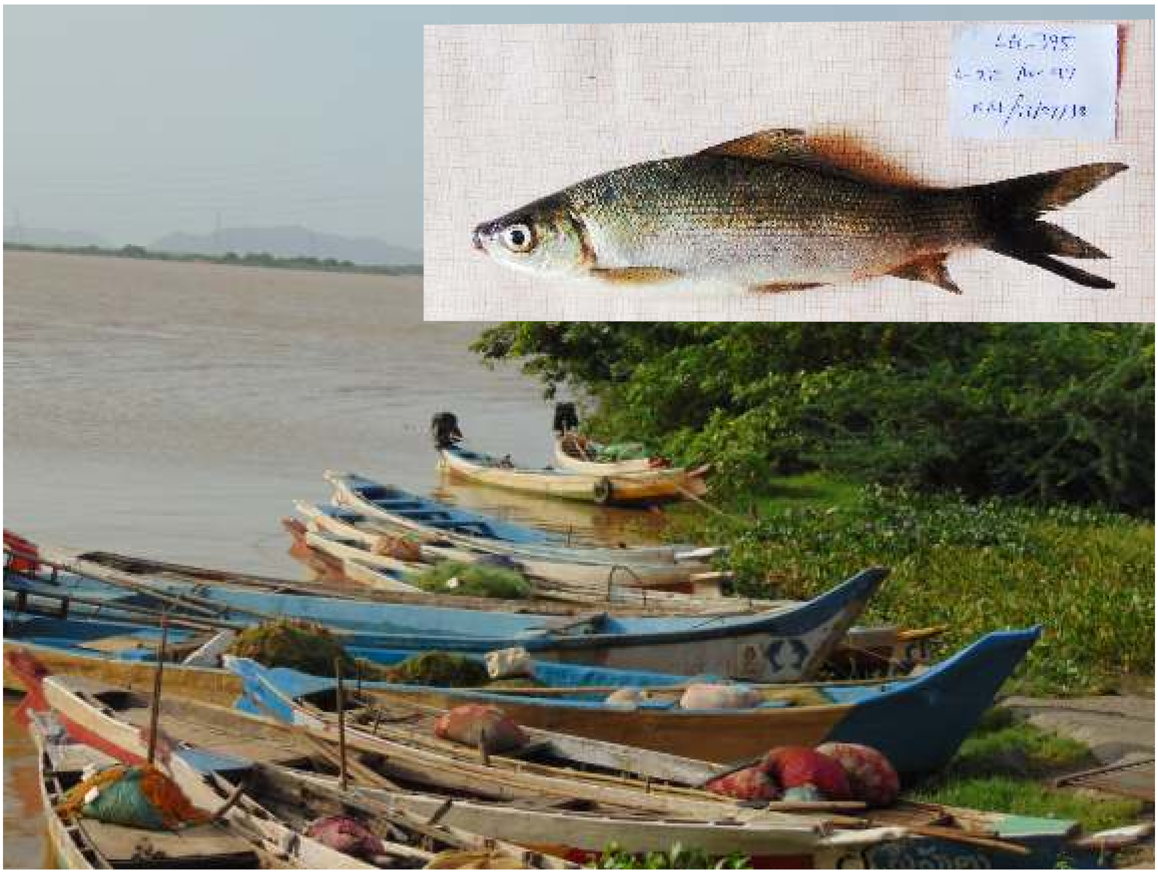


Fig. 156a. Sampling of *Labeo gonius* from river Krishna at Ibrahimpattnam

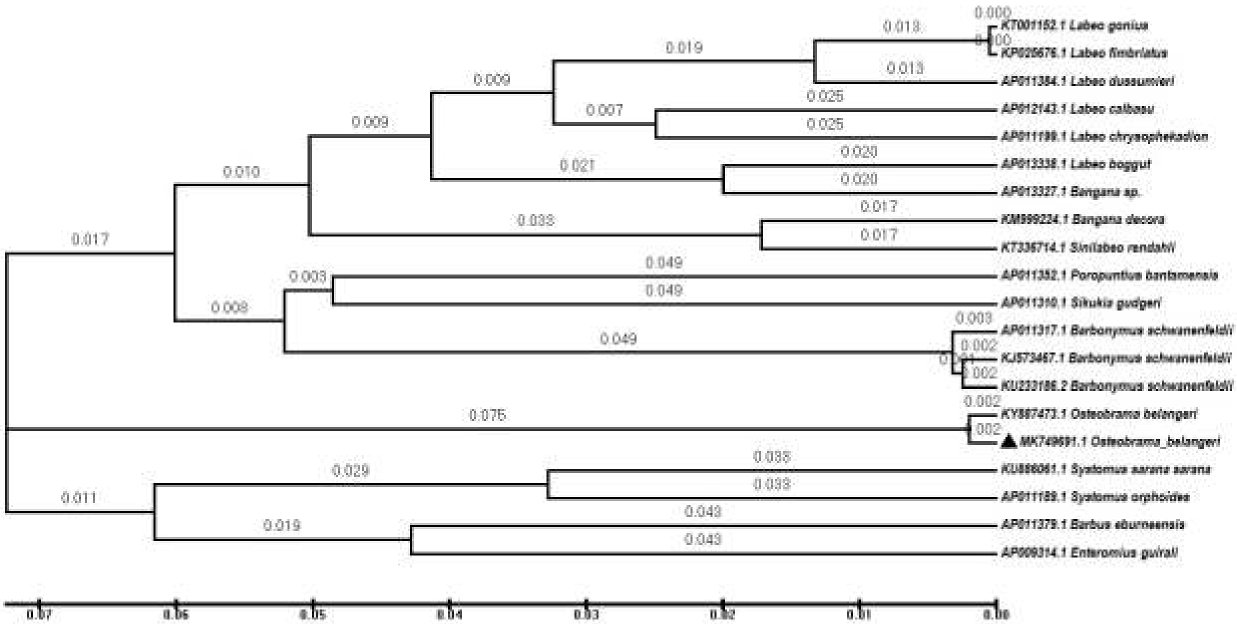


Fig.156b. Minimum evolution phylogenetic tree of Cypriniformes by taking 19 related fish mitogenome sequences (all parameters were used as default with gapopening penalty 15, gap extension penalty 6.66, and multiple alignment parameters set as gap opening penalty of 15, gap extension 6.66, DNA weight matrix IUB and transition weight 0.5 for alignment.

Network Projects

Project Title : **Antimicrobial Resistance (AMR) In Fisheries and aquaculture**

Project Personnel : A. K. Sahoo, and A. K. Bera

Antimicrobial resistance (AMR) has been identified as an important issue with serious health and economic implications. Under the ONE health approach programme, India has a global commitment to combat AMR. Realizing the importance, ICAR, New Delhi, in collaboration with FAO has initiated the AMR activities in Fisheries and Aquaculture with the objectives of a) determining the prevalence of antimicrobial resistance pattern in finfishes (carp/catfishes) in freshwater farms/cages/pens, b) determining the genotype of *Aeromonas* sp., *E. coli* and *Staphylococcus* sp. isolates and performing Antibiotic Sensitivity Test (AST) and c) determination of the risk factors associated with the emergence of antimicrobial resistance in freshwater. ICAR-CIFRI, Barrackpore has initiated these objectives in three districts Purba Bardhawan, N-24 Parganas and Howrah. A standard operating procedure (SoP) was prepared for *Aeromonas* sp., *E. coli* and *Staphylococcus* sp. isolates and biochemical tests were performed. A multiplex PCR for identification of *E. coli* was standardized. A total of 53 farms have been screened for these three bacterial isolates from the gill and gut of the fish (IMC). Antibiotic Sensitivity Test (AST) was performed through disc diffusion for 14 antibiotics against *Aeromonas* sp., 17 antibiotics against *E. coli* and 10 antibiotics against *Staphylococcus* sp. The results

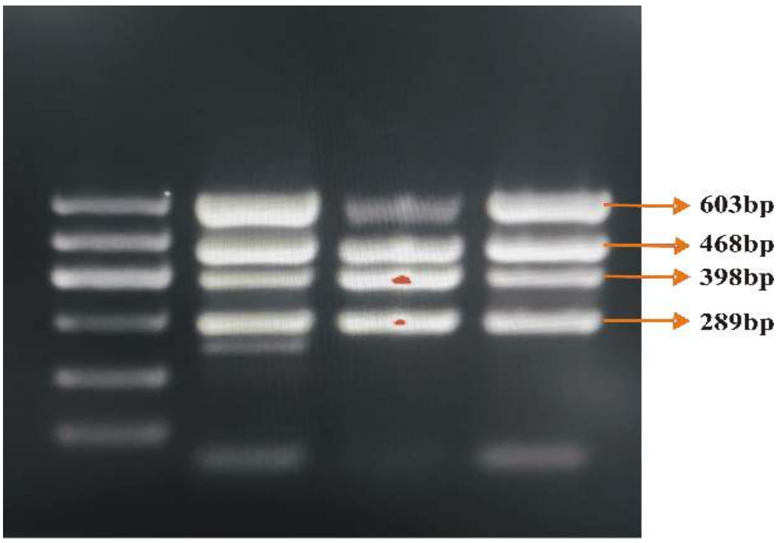


Fig.157 Multiplex PCR for identification of *E. coli*

revealed that the isolated *Aeromonas* sp. showed 96% resistance against Ampicillin/sulbactam, isolated *Staphylococcus* sp. showed 95% resistance against Benzyl penicillin and isolated *E.coli* showed 98% resistance against Amoxicillin (Fig.3) after analyzing the data using WHONET software.

Antimicrobial resistance pattern evaluated against *Aeromonas* sp., *Escherichia coli* and *Staphylococcus* sp. Showed 96% against Ampicillin/Sulbactum, 98% against Amoxicillin and 95% against Benzyle Penicillium.

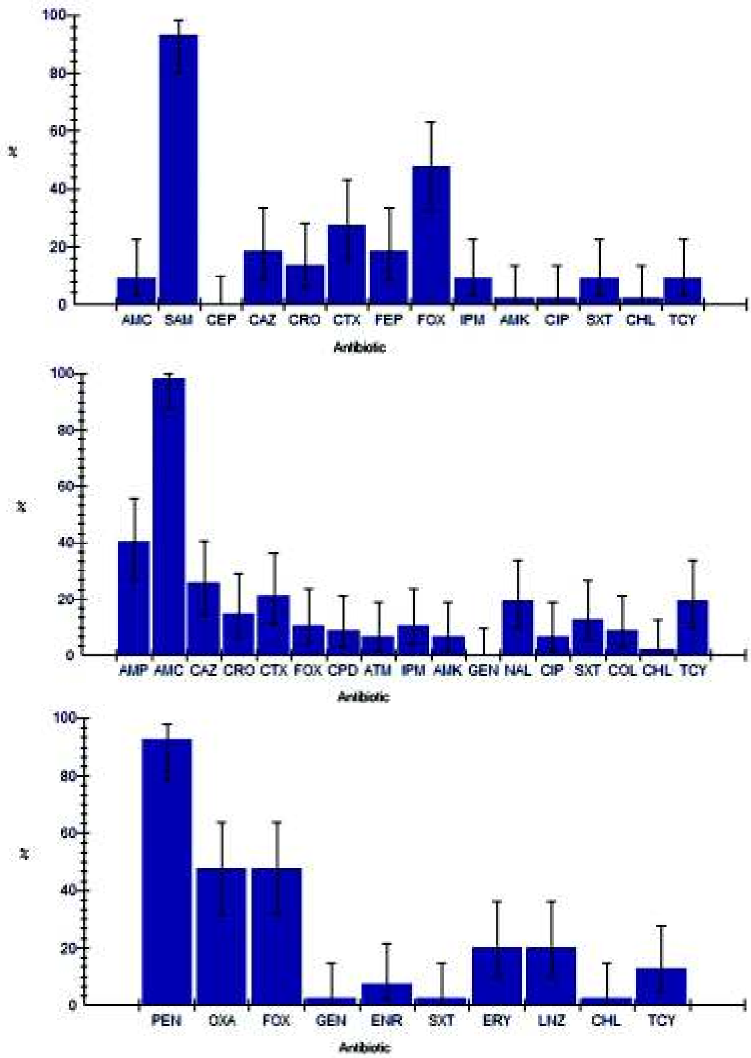


Fig.158 AST for (A) *Aeromonas* sp. (B) *E coli* (C) *Staphylococcus* sp. through disc diffusion

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

Project Personnel : A. Sinha, S. Yengkokpam and H. S. Swain

Live specimen of indigenous ornamental fishes like *Macrognathus pancalus* (Peacock eel), *M. aral* (Spiny eel), *Channa stewartii*, *Pethia manipurensis* were collected from West Bengal, Assam and Manipur for raising of brooders in captivity for induced breeding.

Fig. 159 Natural habitat of *Macrognathus* spp.

Fig. 160 *Macrognathus pancalus*

Fig. 161 *Macrognathus aral*

Specimen of *Macrognathus pancalus* (Peacock eel) and *M. aral* (Spiny eel) collected from two different places of West Bengal, *i.e.* Bongaon, North 24 Parganas district and Diamond Harbour, South 24 Parganas during October 2018 to February, 2019.

The natural habitat of Peacock eel and Spiny eel has been found to be in slow moving shallow water bodies throughout West Bengal. In captive condition they prefer to stay inside artificial hideout or inside the plant root or mud bottom. The preferable water temperature varies between 18-28°C. The suitable water quality parameters are:

Table 16 Suitable water quality parameters for *M. aral* and *M. pancalus*

Parameters	Range
pH	7.5-8.33
Alkalinity(mg/L)	136-185
TDS (mg/L)	1012
DO (mg/L)	9.77

Length-weight relationship curve of M. aral *and* M. pancalus

Morpho-taxonomy of 10 peacock eels and 10 spiny eels were done. Molecular taxonomy of peacock eel was also done to identify the species. Among the specimens studied, 31.25% were female and 68.75% male, giving a male: female sex ratio of 100 : 45. Reproductive study indicated that most of the fish (67%) were in immature stage while 33% were in maturing stage. The survival rate of spiny eel (55%) was better than that of the Peacock eel (46%). The weight gain of Spiny eel and peacock eel within 45 days was 2.0 g. and 3.5g respectively.

Table 17 Relationship between total length and weight of *M. aral* and *M. pancalus*

L-W Relationship	Equation	R^2
M. pancalus	Log W= -0.207+1.105L	0.635
M. aral	Log W= -0.802+1.615L	0.839

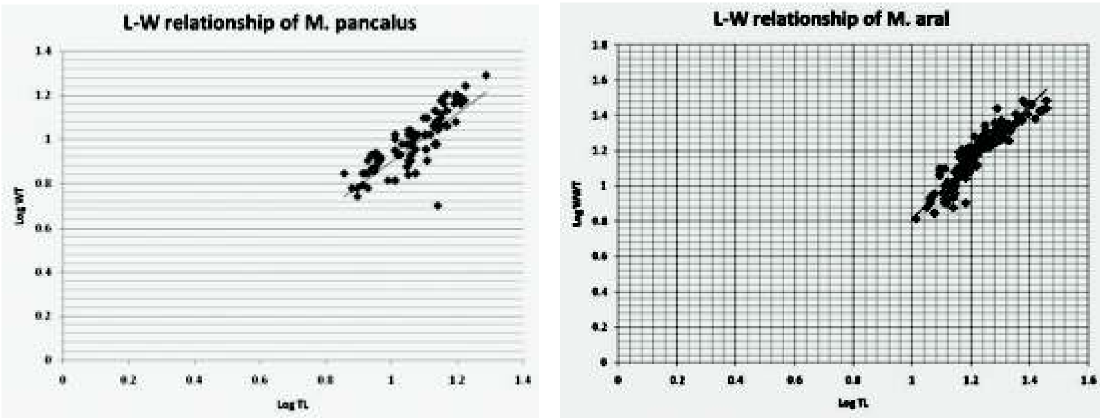


Fig. 162 Length-weight relationship of *M. aral* and *M. pancalus*

Trematode parasitic infestation was observed in peacock eel at low temperature. The abundance of the parasite varied from 5-22 Nos./fish. Oral dose of Praziquantel were used @ 2mg/100g of fish. Albendazole was also used for bath treatment @ 5mg/ml for 2-4 hours. Mortality was restricted within 4 days.

Specimens of *Channa stewartii* were collected from Jonai fish market, Dhemaji district of Assam during November, 2018 and February, 2019. The food analysis of *C. stewartii* showed carnivorous feeding habit consisting of fish, insects and semi-digested materials. The Specific Growth Rate (SGR) and Condition Factor (CF) of peacock eel were 2.75 and 0.34 respectively. In case of spiny eel the SGR was 2.00 and CF was 0.26. The natural habitat of *C. stewartii* in Poba reserve forest, Jonai, Dhemaji district, Assam indicated good water quality with high DO (7.44-8.34 mg/l), low free carbon dioxide, nearly neutral pH (6.82-6.99) and low TDS (0.1-0.9 mg/l). The soil type was coarse loamy, alluvial type.

Fig. 163 Indoor housing and breeding of *M. pancalus*

The natural habitat of *Pethia manipurensis* in Loktak lake, Bishnupur district, Manipur indicated good water quality with favourable temperature (22.5-23.8°C), clear water (Secchi disc visibility 85-95 cm), pH (6.6-6.8), optimal dissolved oxygen (6.5-7.0 mg/L), low free carbon dioxide and moderate total alkalinity (25-30 mg $CaCO_3$/L).

Fig. 164 *Channa stewartii* ready for breeding

Externally Funded Projects

Project Title : **All India network project on fish health**

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

Associates : C. Bandyopadhyay, N. C. Das and S. Sen

Evaluation of safety of oxytetracycline in Pangasianodon hypophthalmus

Safety of antibiotic Oxytetracycline (OTC) in *Pangasianodon hypophthalmus* was determined following 30 days oral administration of the antibiotic in 1-10 times the recommended dose. Serum alanine aminotransferase (ALT) level in treated fish was high, as compared to control, suggestive of hepatic damage: The level did not recover even after 10 days of withdrawal of the drug. Total bilirubin level and aspartate transaminase (AST) levels also increased in treated fish. Histopathological changes of liver, with high ALT level indicated moderate hepatic damage induced by OTC in treated fish. However, the pathological changes were reversible and the drug was safe for use in *P. hypophthalmus.*

Determination of withdrawal period of oxytetracycline in P. hypophthalmus

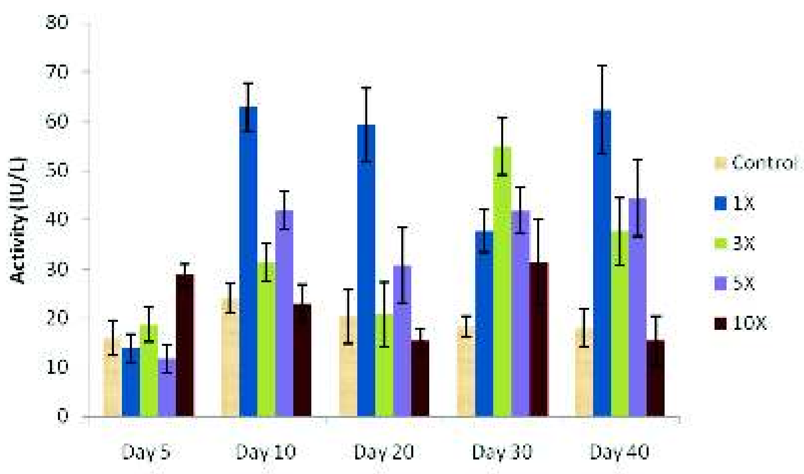


Fig. 165 Serum ALT level of fish treated with oxytetracycline

The objective of the study was to determine the withdrawal period of the antibiotic oxytetracycline for safety of the consumer. Fishes were daily fed with oxytetracycline @ 80mg/kg fish for 10 days followed by withdrawal. The residual concentration of the antibiotic in serum and different tissue/organs after drug withdrawal was measured in LC-MS/MS.

Study showed that, the antibiotic gets cleared from fish body within 14 days of withdrawal when the treated fish can be safely consumed.

Evaluation of safety of emamectin benzoate in P. hypophthalmus

Emamectin benzoate, a parasiticide approved for aquaculture use, was examined for its safety in *P. hypophthalmus*. Fish were administered the drug orally in 1-10 times of recommended dose for 21 days, followed by further observation. There was significant reduction in feed intake by treated fish that continued even after drug withdrawal. SerumALT level increased, suggestive of hepatotoxicity, in treated fish. Although the drug emamectin caused reduced feed intake and liver damage in high concentrations, it may be used in face of disease outbreak to reduce mortality loss.

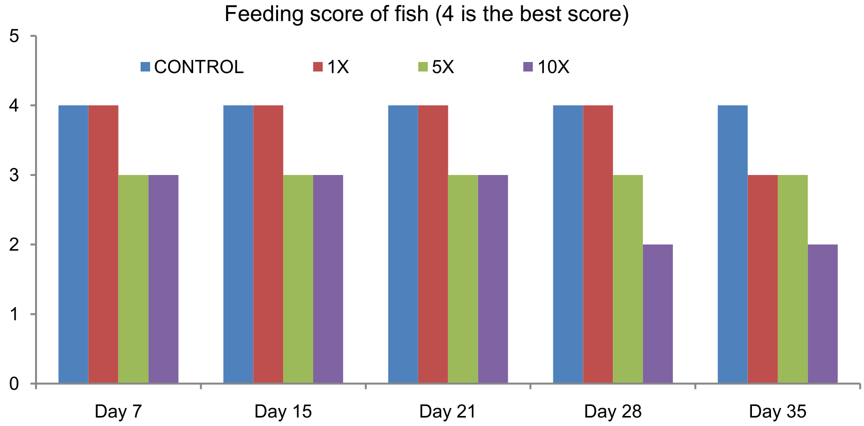


Fig.166 Feeding score of fish treated with emamectin benzoate

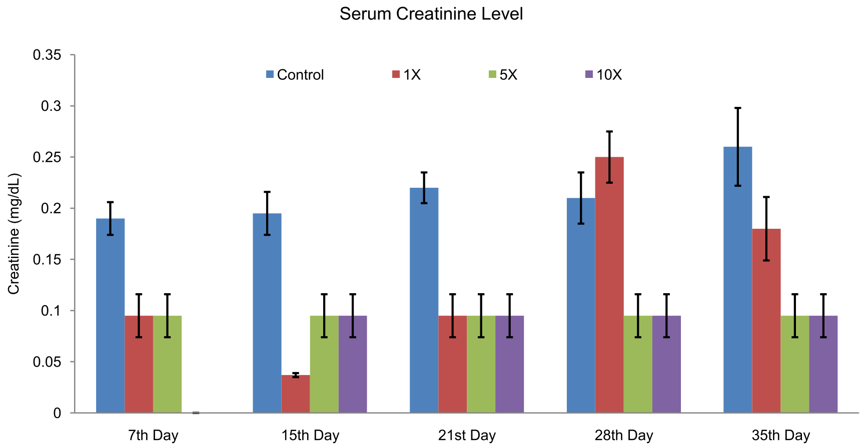


Fig. 167 Serum creatinine levels of fish treated with emamectin benzoate

Usage of drugs and chemicals in aquaculture systems of Assam

A survey was conducted following structured questionnaire in 132 aquaculture farms in Dhubri, Borpeta, Nagaon, Cachar, Karimganj, Hailakandi, Kamrup, Nalbari, Baksa and Darrong districts of Assam. The objective was to examine drug and chemical usage pattern including their consumption, in aquaculture system of Assam. The survey identified scale erosion, red disease, ulcer (EUS), tail and fin rot, argulosis, low DO, gas formation and bloom as the major problems in aquaculture in Assam. Assam fish farmers often used nutritional supplements and probiotics for enhancing fish growth. Sanitizers, water quality enhancers etc. are also substantially used in the state to correct low pH, gas accumulation in pond bottom. Average quantity of some of the common drugs and chemicals used to produce 1 tonne of fish were: Lime – 6 kg, $KMnO_4$ – 4.63 kg, CIFAX – 4.05L, Sokrena – 2.8L, Toximar – 48 kg, Clinar – 3.65 L, Cleantox – 24 kg, Aquabloom – 2.5L, Minplus – 30kg, etc.

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

Project Personnel : B. K. Das, V. R. Suresh, R. K. Manna, R. S. Shrivastava, D. N. Jha, Absar Alam, S. C. S. Das, J. Kumar, Manas H. M., Raju Baitha, T. N. Chanu, H. S. Swain and M. H. Ramteke

Associates : S. K. Paul, A. Roychowdhury, S. Mandal, L. Chakraborty, K. Shrivastava, S. Shrivastava and V. Kumar

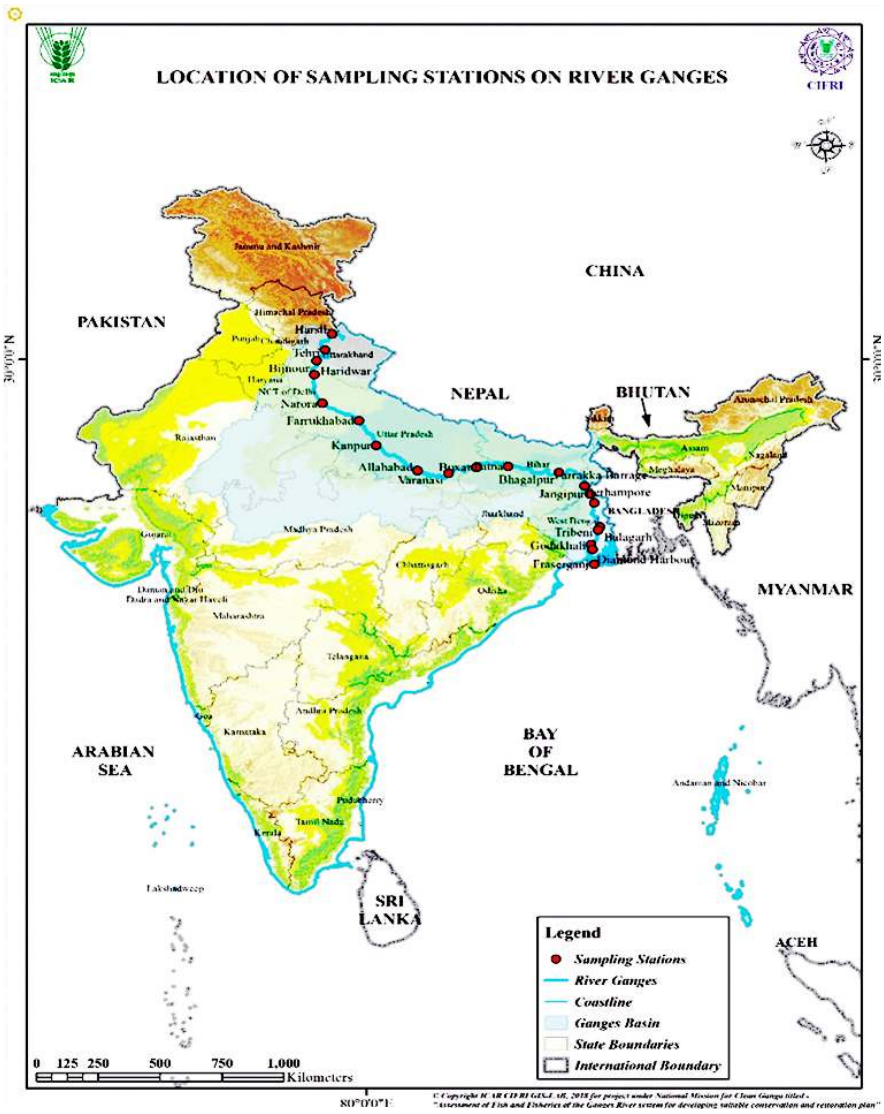


Fig. 168 Sampling stations on river Ganga

Quarterly field surveys were carried out at 20 selected stations of river Ganga for assessing ecology and fisheries of the river.

A total of 190 fish species belonging to 133 genera, 60 families and 17 orders were recorded from river Ganga from the upper stretch to lower estuarine stretch. Fish species distribution along the studied sites. Highest number of fish species has been recorded from upper stretch of river Ganga, namely, Bijnor (93species) and Narora (89 species). Significant number of fish species have been identified from Farakka (79 species) in the lower stretch. Among the estuarine stretch Fraserganj was found to be more diverse with 68 recorded fish species.

Exotic fishes from river Ganga

Seven exotic fish species, namely, *Hypophthalmichthys molitrix* (Silver carp), *Hypophthalmichthys nobilis* (Big head carp), *Ctenopharyngodon idella* (Grass carp), *Pterygoplichthys* *disjunctivus* (Vermiculated sailfin catfish), *Cyprinus carpio* (Common carp), *Clarias gariepinus* (African Magur) and *Oreochromis niloticus* (Nile tilapia) were recorded.

Indian Major Carp Landings at Allahabad

The total Indian Major Carp (IMC) landings from Allahabad stretch of Ganga River system during July 2016 to December 2018 has been estimated as 44.81 tonne. Among IMC's contribution from *Cirrhinus mrigala* (41.98 %) the highest, followed by *Labeo catla* (33.32 %), *L. rohita* (20.22 %) and *L. calbasu* (4.49%).

Dissolved Oxygen (DO) status of river Ganga

The river water has higer dissolved oxygen during Post-monsoon and low DO in Pre-monsoon. Allahabad and Varanasi recorded highest DO value, which may be due to the higher total chlorophyll owing to the slightly eutrophic condition in the stretch. In estuarine zone of the river the DO value decreases during Monsoon, may be due to higher turbidity.

Water pH status of river Ganga

The average water pH of the entire river is 8.06. (range:7.2-11.8). The Allahabad region showed slight increase in pH than other stations. In post-monsoon high pH value was observed probably due to higher photosynthesis in relatively calm water. During monsoon comparatively lower pH value was observed across the sampling sites.

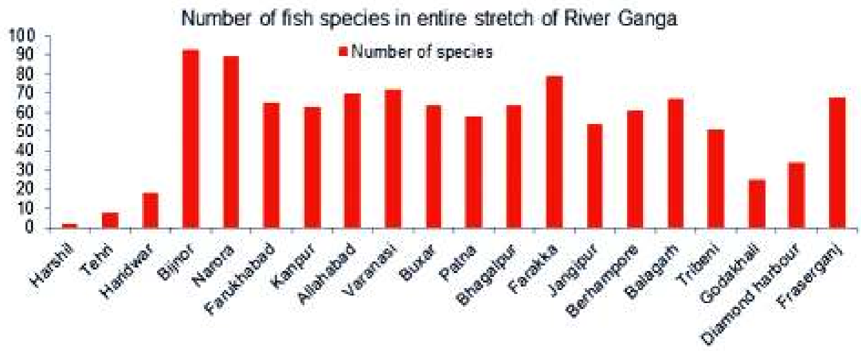


Fig. 169 Fish species distribution along the river Ganga

Table. 18 Species wise IMCs landings at Allahabad

IMCs	Quantity (t)	% Contribution
Labeo catla	14.93	33.32
Labeo rohita	9.06	20.22
Cirrhinus mrigala	18.81	41.98
Labeo calbasu	2.01	4.49

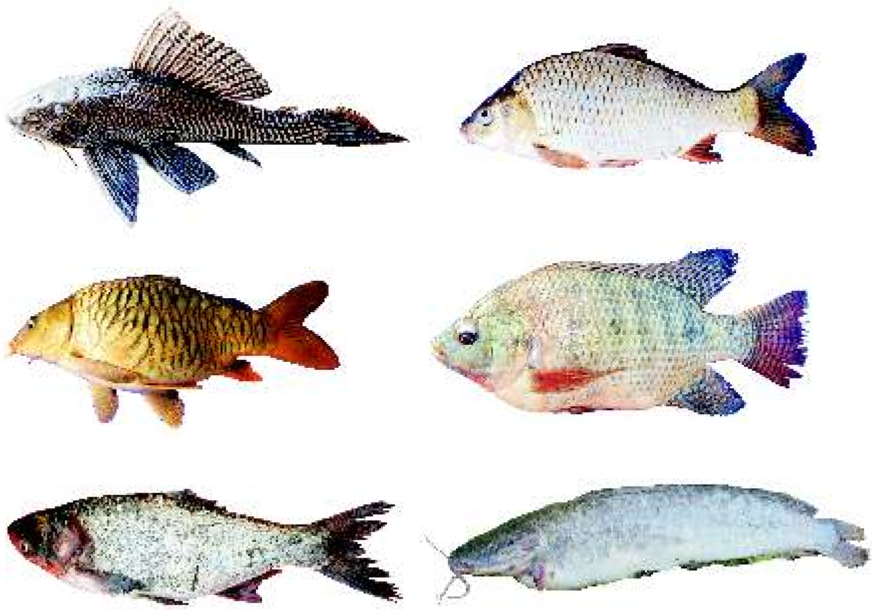


Fig. 170 Some of the exotic fish species recorded from river Ganga

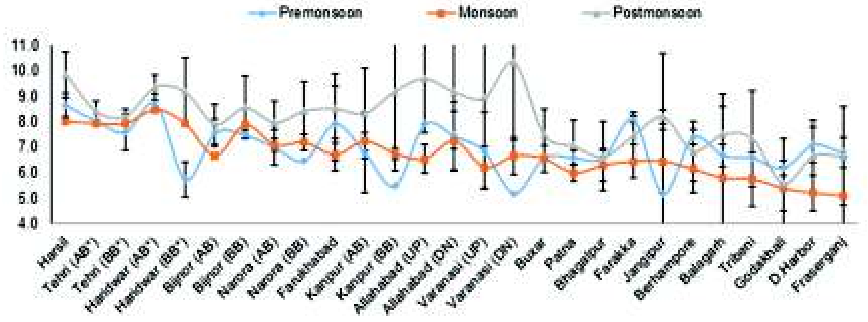


Fig. 171 Dissolved oxygen (mg/L) pattern in water of river Ganga (2018)

Plankton and periphyton status in river Ganga

A total of 87 genera of phytoplankton and 42 genera of zooplankton were recoded from the whole river. Among phytoplanktons, Bacillariophyceae (39 genera) was the most dominant, followed by Chlorophyceae (35 genera) and Myxophyceae (11 genera). Phytoplankton overwhelmingly dominated over zooplankton. Plankton abundance was found comparatively higher in stretches from Harsil to Varanasi of the river than Buxar to Fraserganj.

Pre-monsoon and post-monsoon months showed high plankton abundance at Kanpur (7634 units/l and 165 units/l respectively), possibly due to nutrient rich anthropogenic loading in the stretch. Monsoon months showed high density of plankton at Buxar with maximum abundance of *Microcystis* which may be toxic.

Periphyton abundance ranged between 3675 units/cm^2 at Fraserganj and 7220 units/cm^2 at Harshil. Higher abundance was observed in Kanpur which may be due to sluggish nature of river. Highest average Myxophyceae population was observed in Kanpur (11010 units/cm^2) indicating pollution as compared to other stretch. Overall, Bacillariophyceae accounted for the highest portion of biomass.

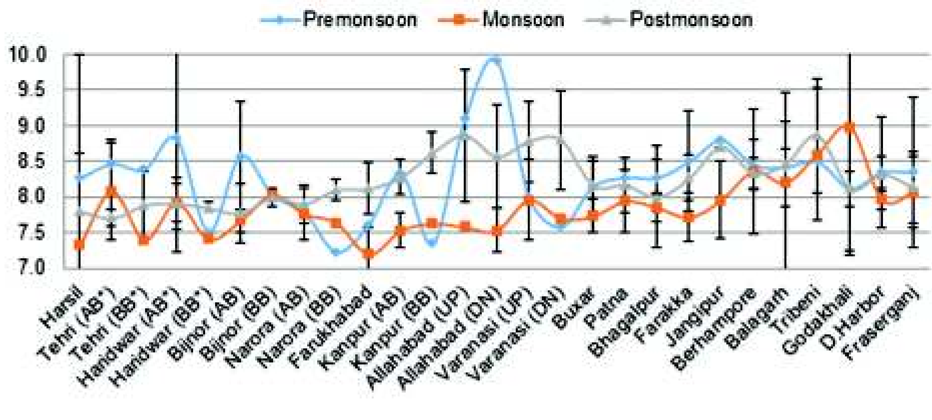


Fig 172 Water pH of river Ganga

Concentration of metals in river Ganga

The highest concentration of Zinc (0.032 mg/l) was observed in water at Farakka station, Manganese (0.228 mg/l) at Diamond Harbour; and Lead (0.074 mg/l), Cadmium (0.047 mg/l), Chromium (0.095 mg/l) and Copper (0.039 mg/l) at

Fraserganj. Cadmium concentration in other 10 sampling sites of Bihar and West Bengal were found below detection limits. Copper (0.18 µg/g) was detected in the flesh of *Rita rita* (a fish belonging to higher trophic level in the food chain). Zinc was found in the flesh of *Mystus cavasius* (55.42 µg/g), *Pethia conchonius* (39.321 µg/g), *Xenentodon cancila* (38.094 µg/g), *Odontamblyopus rubicundus* (22.53 µg/g), *R. rita* (2.178 µg/g). Manganese was found below detection limits among all the 14 fish species tested. Lead (5.439 µg/g) was detected in the flesh of *R. rita* but not in remaining 13 fish species. Cadmium was below detection limits in all the 14 fish species. Chromium was found in the flesh of *R. rita* (0.676 µg/g), *Setipinna phasa* (0.013 µg/g).

Importance of river Ganga on fisheries in wetlands

The study identified presence of 42 fish species belonging to 10 orders and 21 families from the open wetland whereas 24 fish species belonging to 05 orders and 09 families were recorded from the closed wetland. Seasonal fish diversity in these two wetlands was studied. Fish species richness (24 species) was comparatively low in closed wetland with dominance of IMCs (Indian Major Carps) and Chinese carps (more than 50%) over indigenous fish species due to stocking and loss of connectivity with parent river (Ganga River). It is also observed that, fish species richness is higher during monsoon season in both the wetlands. Cyprinidae dominated the fish community contributing about 36% and 46% in open and closed wetlands respectively.

Seed production (in-situ) of selected fish species and ranching for cleaning of river Ganga

Under NMCG project, out of six major species selected, *Cirrhinus mrigala* and *Labeo calbasu* mainly feed on detrital organic matter. About 44% of the gut content of *L. calbasu* is detrital organic matter; whereas in case of *Cirrhinus mrigala* it is about 40%. Restoration of fishery of IMC, Mahseer and trout will significantly remove the detrital organic load from the river and thus helping in making a 'cleaner Ganga'. With this objective, brooders of Indian Major Carps (IMC) were collected from river Ganga for in-situ production of seeds to be used for ranching. IMC wild brooders of 0.3 to 3 kg size were collected and stocked in a pond at Balagarh (Hooghly District, West Bengal). By adoption of Better Management Practices (BMP), the riverine brooders were matured in stocking pond by the month of July and breeding programme was conducted on 07th July, 2018. The fertilization rate was 98%. About 90 cups (appx. 50,000 spawns/cup) of spawns were produced after seventy two hours of fertilization. The IMC spawns produced were reared in a nursery pond at Balagarh up to advance fingerling stages which are being used for ranching in river Ganga. More than 12.85 lakhs of IMC fish seed have already been ranched at different stretches of river Ganga during 2018-19.

Fig 173 One of the ranching programmes in river Ganga

Table19 Fish ranching programmes conducted in 2018-19

Sl No.	Date	Place	No. of Seed released	Chief Guest(s) of the programme
1	27.03.2018	Fatehpur, Kausambi, Uttar Pradesh	10,000 IMC	Shri O. P. Ram, DDF, U. P.
2	05.09.2018	Barendrapara Ghat, Bally, Howrah, West Bengal	5,00,000 IMC	Swami Girishanandaji Maharaj, Manager, Ramkrishna Mission, Belur Math Swami Atmapriyanandaji Maharaj, V. C. Ramkrishna Mission Vivekananda Educational & Research Institute, Belur Math
3	02.10.2018	Barrackpore, West Bengal	2,80,000 IMC	Shri Navin Naik, Director, Neheru Yuva Kendra Sangathan
4	02.10.2018	Sangam, Allahabad	5,000 IMC	Dr. R. S. Srivastava, HoD, ICAR-CIFRI, Allahabad
5	06.11.2018	Mayapur, West Bengal	3,00,000 IMC	Shri Haridas Debnath, Savapati, Panchyat Samiti, Nabadwip
6	26.11.2018	Ramyaghat, Mirzapur	10,000 IMC	Dr. Varshi, DDF, Govt. of U.P.
7	04.12.2018	Sirsa, Allahabad	10,000 IMC	Shri M. N. Pathak, Ret. Principal
8	05.12.2018	Karaghat, Kausambi	20,000 IMC	Shri Sunil Singh, F.D.O., U.P.
9	08.02.2019	Sangam, Allahabad	15,000 IMC	Honb'le Minister Shri Nitin Gadkari
10	26.02.2019	Sangam, Allahabad	15,000 IMC	Honb'le MP Shri P. K. Patashani
11	15.03.2019	Barrackpore	10,000 IMC	Dr. A. G. Ponnaiah, Former Director, ICAR-CIBA, Chennai Dr. P. Pravakar, PI, NICRA,ICAR -CRIDA, Hyderabad
12	17.03.2019	Barrackpore	50,000 IMC	Dr. Vijayalaxmi Saxena, General President of Indian Science Congress Dr. Ashoke K. Saxena, Former General President of Indian Science Congress Dr. Subrata Mondal, Chief General Manager, NABARD
13	29.03.2019	Sangam Nose, Prayagraj Allahabad	15,000 IMC	QRT Members

Exhibitions and Mass awareness

A total of 15 mass awareness campaigns were conducted among the fishers of river Ganga in Uttar Pradesh and West Bengal. The Institute also participated in a nine day long exhibition hosted by a local Non Governmental Organization (Milan Tirtho Society) during 20th Dec to 29th December, 2018 at Kultoli, Sunderban (West Bengal). The exhibits in the 'National

Mission for Clean Ganga' pavilion showcased various ongoing activities of the institute under the project 'NAMAMI GANGE'. The pavilion has acquired fourth position among the several other Governmental pavilions in the event. CIFRI-NMCG project has participated in “Kumbh Mela 2019” at Prayagraj, Uttar Pradesh. The pavilion showcased the publications of NMCG and CIFRI activities for making the river Ganga clean. The pavilion was visited by Hon. Health Minister of U.P., Mr. Sidharth Nath Singh, Mrs. Kanchan Gadkari (wife of Nitin Gadkari) and various other dignitaries.

Project Title : **Hilsa fisheries improvement in river Ganga**

Project Personnel : B. K. Das, A. K. Sahoo, D. K. Meena, H. S. Swain

Associate : A. R. Choudhury

The main objective of the action plan for 'Hilsa fisheries improvement programme in river Ganga' is to increase the natural stock of hilsa (*Tenualosa ilisha*) in river Ganga upstream of Farraka barrage through ranching of wild collected hilsa seed/juveniles. In this regard, first hilsa ranching station was established on the right bank of river Ganga at upstream of Farakka barrage on 24th January, 2019. The ranching station was selected after thorough investigation with focus on availability of hilsa in the downstream of Farakka barrage and transportation. The main focus of the ranching station is to test the suitability of hilsa to acclimatize under controlled conditions. As per the action plan on hilsa fisheries improvement in the upstream of Farakka barrage of river Ganga, 151 hilsa fishes with an average length of 468 mm and with an average weight of 259 gm were ranched during the period of December 2018 to March 2019. Hilsa awareness program was organized in the villages upstream of Farakka barrage in West Bengal (Farakka barrage Bus dipot, Hatat colony, Deer Forest) and Jharkhand (Ganeshpur, Raipada Road Jharkhand,

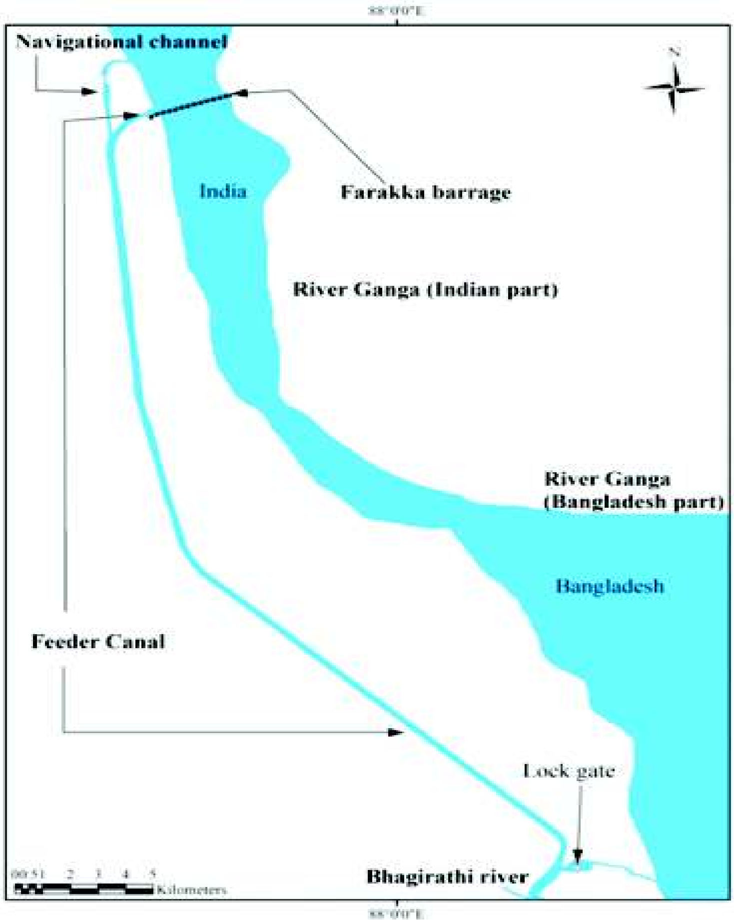


Fig 174 Sketch of River Ganga with Farakka barrage that obstructs hilsa migration

Fig. 175a. Inauguration of hilsa ranching station above Farakka barrage

Neemsahar Road and Radhanagar). The awareness program dealt with 'Hilsa conservation for future' and 'Hilsa Life Story'. More than 1000 fishermen were educated on the hilsa conservation in river Ganga for future through the active awareness program using audio-visual aids and distribution of folder and leaflets. Folders on “Hilsa Life Story” and Leaflet on “Hilsa Conservation for future” in English and Bengali were published and distributed on the foundation day in order to create awareness among the fishermen. Through the awareness programme, fishermen expressed that they were surprised by the capture of hilsa at different stations above the Farakka barrage. The result indicated that the hilsa ranched at Farakka during December (2018) were caught at Sahebganj (Jharkhand), which is 78 km upstream of Farakka barrage. A series of hilsa awareness campaigns have been organised in different villages adjacent to river Ganga, particularly upstream of Farkka barrage, on the activities of hilsa ranching programme and conservation of hilsa for enhancing hilsa fisheries in the middle stretch of the river Ganga.

Fig. 175b. Hilsa adult just before ranching in the upstream of Farakka Barrage

Fig. 175c. Awareness programme on hilsa at Sultanganj

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

Project Personnel : U. K. Sarkar, S. K. Nag, M. Naskar, B. K. Bhattacharjya, P. Panikkar, A. Pandit, D. Debnath, S. Yengkokpam, S. D. Sarkar, T. T. Paul, K. Kumari, G. Karnatak, Mishal P., Lianthuamluaia and T. N. Chanu

Successful climate resilient pen system (CRPS) demonstrations with conservation aspect of vulnerable indigenous fishes along with resilient fish species to combat climatic variances were carried out in different floodplain wetlands of West Bengal, Assam and in the backwaters (Vembanad Lake) of Kerala.

Fig.176 Pen installed in Mathura wetland

Sufficiently reinforced and structurally superior net pen enclosures using highly tensile netting material were installed in selected wetlands in 3 states. The pen height was about 11 feet to contain the stocked fishes even during peak monsoon. Provisions were kept to fence the gaps with netting material during monsoon to prevent escape of stocked fishes. In West Bengal, production of 380kg/100m^2/120 days and 160kg/100m^2/90 days with survival of 82% and 78% were achieved in Bhomra and Mathura wetlands respectively. In Mathura wetland *Labeo bata* and *Systomus sarana* grew from 2.72 g to 15 g and from 2.12 g to 9 g in 90 days. Adults of *Gudusia chapra* (9.5 g) *grew to*

Fig.177 Pen installed in Assam

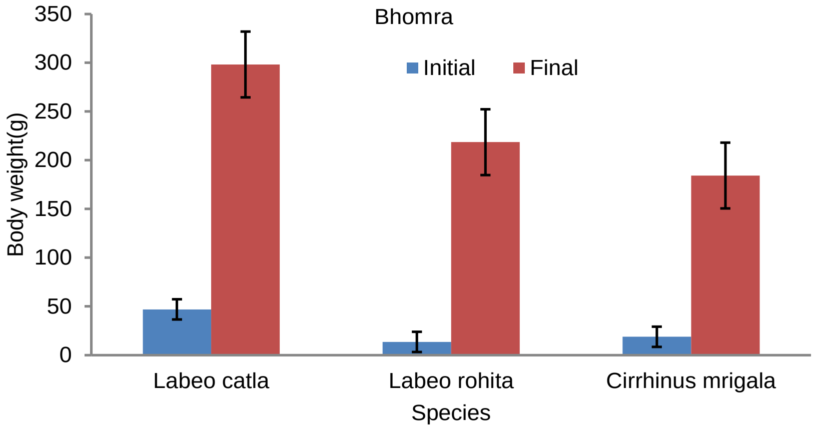


Fig.178 Growth performance of IMC in pens at Bhomra wetland

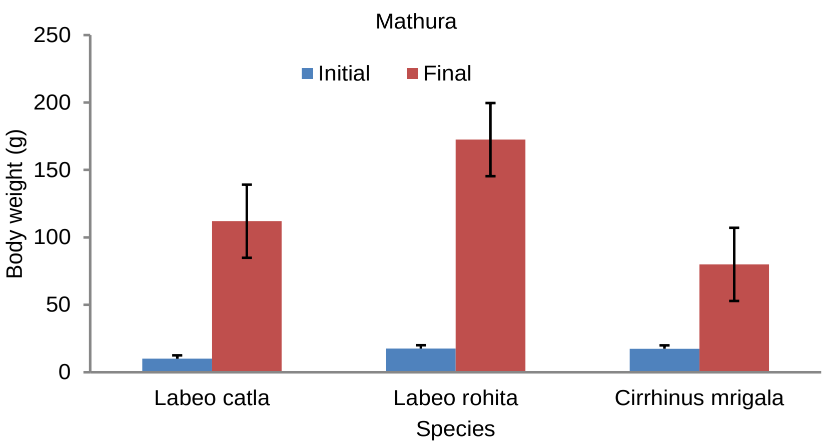


Fig.179 Growth performance of IMC in pens at Mathura wetland

Fig.180 Sampling in pen

14.5 g in 90 days. The young ones of average size 3.8 cm and 0.57 g were also observed in pens indicating natural spawning inside the pen. Demonstration of CRPS has been initiated at Nayachara beel of Cooch Behar district with IMC and other indigenous species *Ompok bimaculatus* and *Mystus cavasius*.

In Assam, after five months of rearing in pens, *C. mrigala* showed highest weight gain (1346.94% initial weight (IW): 30 g, final weight (FW): 432g), followed by *L. catla* (813.33%; IW: 33g, FW: 304g) and *L. rohita* (330.14%; IW: 107g, FW: 462g). Natural spawning of the SIFs was observed in the pens indicating that the SIFs can breed in small enclosures as well as can combat the recent changes in climate scenario.

In Vembanad lake (Kerala) small and large sized black clam (*Villorita cyprinoids*) were stocked at the rate of 5000 nos/m^2 and 2000 nos/m^2 respectively. The annual growth rate of clams in terms of length and weight was 14.23 mm/year and 47.98 g/year respectively with total annual production of 2 tonnes. The pen culture withstood the adverse impact of devastating flood during July-August (2018). This initiative benefitted fifty fishers of "Black Clam Industrial Co-operative society", Thycattussery.

Carbon sequestration in wetlands

Primary carbon (C) capture study from three wetlands i.e. Bhomra, Mathura and Jhagrasisa of West Bengal from different sediment depths showed highest C content at the depth of 15-30 cm (9.01%) and 0-15 cm (8.14%) in Mathura and Bhomra wetland respectively. In contrary C content in Jhagrasisa was lower at depth of 0-15 cm (2.79%).

Identification of climate change related stress resilient /tolerant fish species

The consequences of climate change on reproductive phenology and spawning success of fishes were determined by using threshold value of gonado somatic index (GSI) and pre-spawning fitness ($K_{spawn50}$) for generating species-specific baseline information along with favorable range of identified climatic and ecological variables. $K_{spawn50}$ of some vulnerable commercially important fishes such as female *Mystus tengara* (1.13-1.21 units), *M. cavasius* (0.846-0.945 units), *Eutropiichthys vacha* (0.716-0.799 units) and *Channa punctata* (4.14 units) were estimated.

Impact of environmental variables on phytoplankton community

Temporal heterogeneity of different size groups of phytoplankton (nano and micro plankton) abundance was assessed in Bhomra beel (seasonally flooded and weed infested), an anthropogenically stressed wetland. Study revealed a comparative reduction in size fraction (%) of nano and micro phytoplankton in monsoon season owing to high flood pulse. The availability of overall phytoplankton community is found to be the highest during post monsoon followed by pre-monsoon and monsoon period.

Diversity of methanotrophs and methanogens in wetland

Preliminary diversity analysis of methanotrophs and methanogens was done in East Kolkata (sewage fed) wetland, Bhomra (floodplain)

Fig.181 SIFs (mola) harvested from pen of Assam

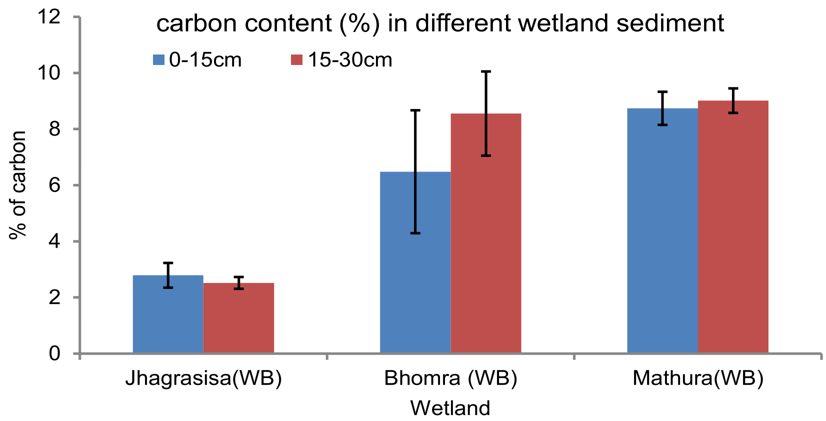


Fig.182 Carbon sequestration in wetlands of West Bengal

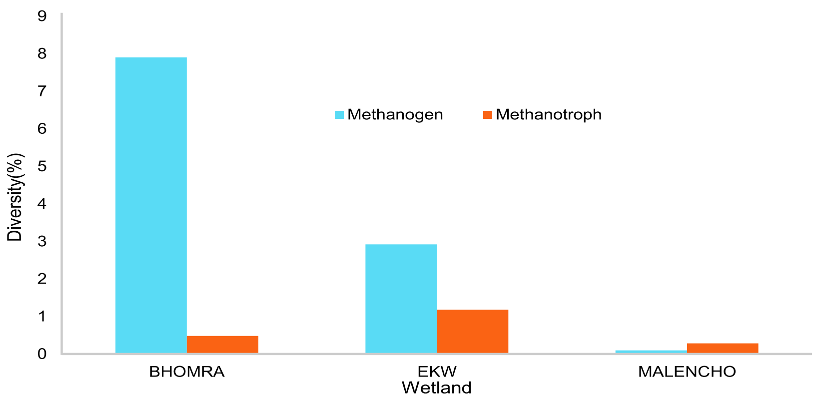


Fig.183 Methanogen and Methanotroph diversity in different wetlands

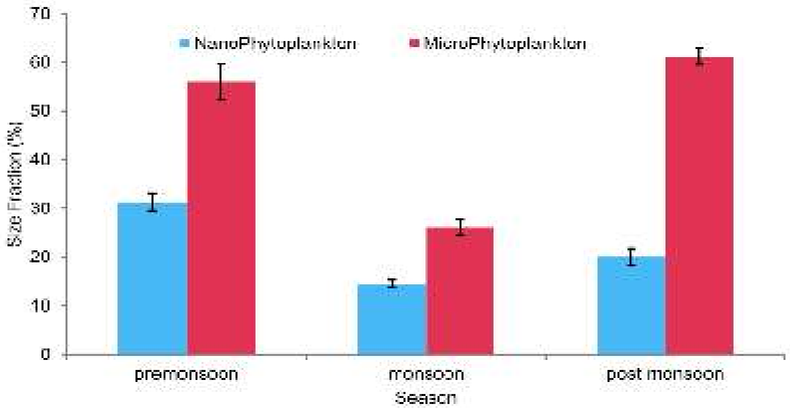


Fig.184 Inter-relationships between enviro-climatic parameters and phytoplankton

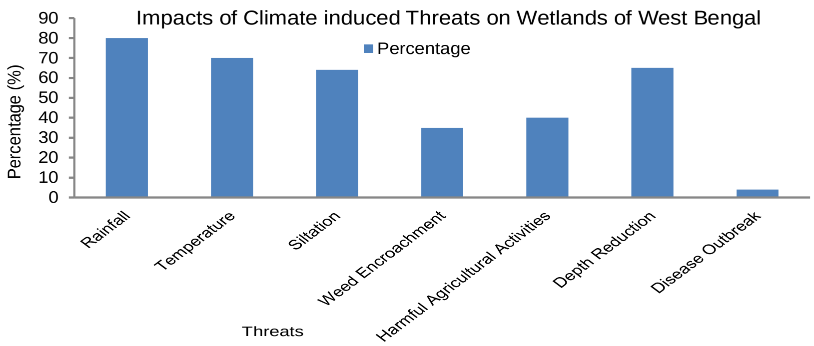


Fig.185 Reduction in fish diversity in the studied wetlands of West Bengal

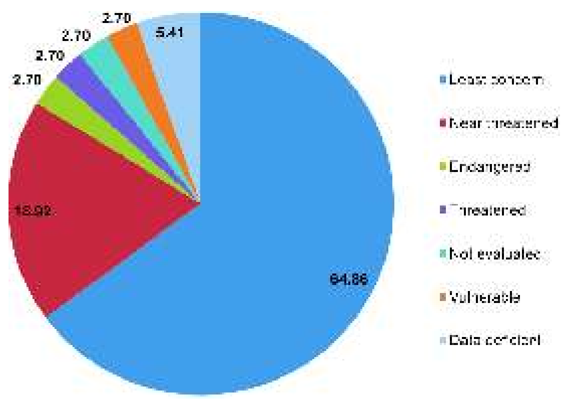


Fig.186 Conservation status of fish species as per IUCN Red List

wetland and Malencho (coastal) wetland. Methanogens were more dominant than methanotrops in Bhomra and East Kolkata wetland, whereas methanotroph diversity was more in Malencho wetland.

Vulnerability assessment of wetland fisheries to climate change in states of West Bengal, Assam and Kerala by using previously developed framework

Owing to scarcity of time series data on climatic variables and biological diversity of floodplain wetlands of India, the present study presents an alternative approach-specifically based on stakeholders' perception - of vulnerability assessment of wetland fisheries to climate change. As per the study, erratic rainfall (80%) is the major factor altering the reproductive phenology of fishes, followed by rise in temperature (70%), depth reduction (65%), siltation (64%), unscientific farming practices (40%), weed infestation (35%) and disease outbreak (4%).

In wetlands of Assam, indigenous fish species such as *Chitala chitala, Wallago attu and Monopterus cuchia* have drasatically declined while *Ompok pabda, Mastacembelus armatus, Channa marulius, Botia dario, Ailia coila and Systomus sarana* are becoming endangered due to loss of riverine connection, weed infestation and excessive siltation.

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

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

Development of formalin detection kit 'CIFLIN'

'CIFLIN' a kit for detection of formaldehyde in fish tissue, was developed under this project. It can qualitatively test and detect adulteration of formalin in fish within 5-7 min from 0.1 g fish tissue. Lower limit of detection of formaldehyde in fish tissues is 25 ppm. Trade mark has been obtained for CIFLIN kit.

Fig.187 Formalin detection kit CIFLIN

Study of effects of formaldehyde in animal models (Rat, Rattus norvegicus*) in proteogenomics platform*

Food contaminated with formaldehyde is gradually coming up as a major source of formaldehydecexposure. In this context, we investigated the impact of formaldehyde in rat (*Rattus norvegicus*) fed through oral route under proteogenomics platform. Proteomic analysis of the liver tissue of rat (*Rattus nervogicus*) by label free quantification identified 4765 proteins or protein subunits. Out of these, 621 proteins/protein subunits were found to have differential abundance : 277 increased in abundance and 344 decreased in abundance in the liver of formaldehyde treated rat. Similarly, in transcriptomics analysis, significant up-regulation of 308 transcripts and down regulation of 228 transcripts was observed. Gene ontology analysis showed that binding, catalysis, signal transducer activities were affected by formaldehyde. Pathway analysis revealed that formaldehyde exposure activated PI3K-AKT pathway, which inhibits caspase activity, assisting cells to survive.

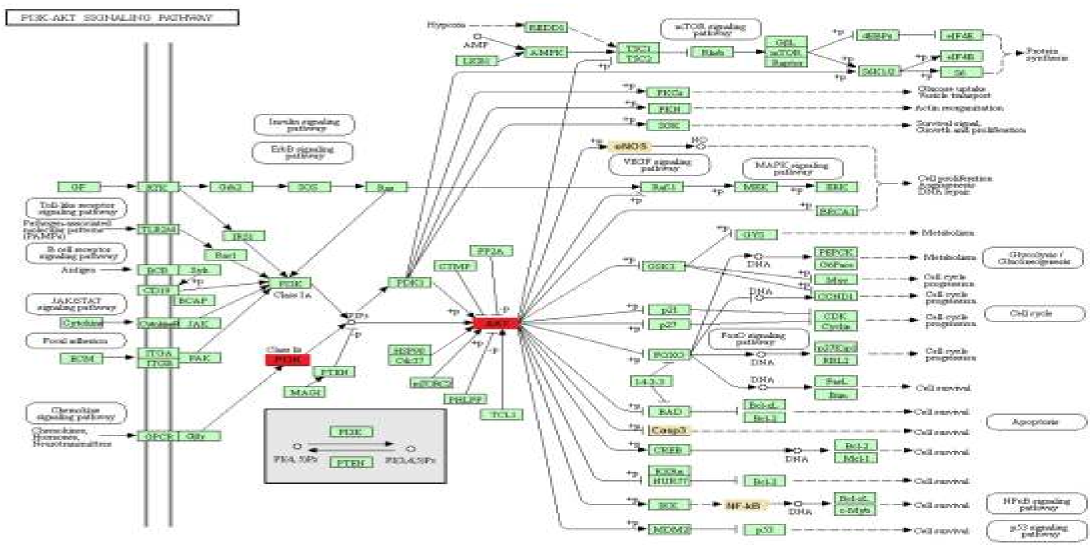


Fig. 188 Differentially expressed genes in PI3-AKT pathway in liver of rat fed formaldehyde orally. (■ up-regulated and ■ down-regulated)

Programme Title : Wetland fisheries development projects of Bihar under CSS blue revolution

Project Title :

1. **Fisheries development in Rulhi wetland of Bihar through stakeholders' participatory fisheries management model (Co-management) in a sustainable manner- An Innovative project**

2. **Fisheries development in Sirsa wetland of Bihar through *in-situ* fish seed rearing and fisheries enhancement techniques for tapping fish production potential- An Innovative project**

3. **Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholders participation for capacity building and improved livelihood - An Innovative project**

4. **Fisheries development in Majharia maun of Bihar through refinement of site specific fisheries enhancement technology- An Innovative project**

Project Personnel : B. K. Das, M. A. Hassan, G. Chandra, K. M. Sandhya, S. Kumari, P. Mishal, Lianthuamluaia, G. Karnatak, R. Baitha and H. S. Swain

Implementation of fisheries enhancement programme

Based on the need of the each selected wetland, species enhancement and stocking enhancement activities were implemented following standard norms. Selection of fish species and their stocking were based on the ecosystem characteristics of each wetland. Stocking enhancement activity with advanced fingerlings of IMC, common carps and grass carps (Weight: 25-50g; Length: 12-23cm) was undertaken in a staggered manner at a time interval of 50-60 days. So far, 2869 Kg, 3865 Kg, 4684 Kg, and 4720 Kg seed (including advanced fingerling for open wetland area and fry/fingerling for cage, pen and pond) have been stocked in Sirsa (area : 80 ha), Rulhi (area : 82 ha), Kararia (area : 100 ha) and Majharia (area : 100 ha) wetlands, respectively. The seed stocked in open wetland gradually will start reaching harvestable size by April-May onwards and then the fishermen will reap the benefit of stocking enhancement programme.

Production of advanced fingerling in pen

The pre fabricated “CIFRI pen HDPE” were procured and installed in the marginal area of Sirsa, Kararia and Majaharia *maun* for production of advanced fingerling when fry stages of seeds were available during July-September. The pens were stocked with seed of both Indian major carp and two exotic carp species, namely, common carp, *Cyprinus carpio* and grass carp, *Ctenopharyngodon idella*. Fish seeds grew very fast, especially grass carp in Majharia wetland. A total of 750 Kg of advanced fingerlings were produced in Majharia *maun*. In Rulhi and Kararia wetland similar results were obtained. However, it was noticed that in wetlands, such as Majharia and Kararia *maun* where large catfish, specially *Wallago attu* and exotic predatory catfish, *Clarias gariepinus* is present, pens were physically damaged. In such cases, to avoid damage, the pen has to be protected by deploying another protecting layer of net outside the pen wall.

Fig. 189 Pen installed in Majharia *maun*

Seed/fish production in cages

The CIFRI GI Cages were installed in Sirsa, Rulhi and Majharia *maun* at suitable site where water depth was more than 5 meter. The standard dimensions of cage frame remained unchanged while dimensions of hapa were duly modified to suit wetland ecosystem. Major carp seed was stocked in cages as a measure of contingent source of stocking material in the open wetland during post flood situation. The seed grew well in cages in Sirsa and about 210 Kg of advanced fingerlings were produced after 62 days of rearing, which were later released in the open wetland. In Majharia *maun* a total of 242 Kg of advanced fingerling were recorded and released in the wetland. In order to ensure income supplement of fishers, a fast growing catfish species, *Pangasianodon hypophthalmus*, having consumer acceptability in the region were stocked in Sirsa *maun*. A total of 2210 Kg of catfish was harvested after 115

Fig. 190 Catching large size predatory fish before fish seeds stocking in wetlands

Fig. 191 Seed stocking in pen

Fig. 192 Excavation of nursery pond in Rulhi wetland in progress

Fig. 193 Seed monitoring in nursery pond

days of rearing and sold at the rate Rs.90-110 /Kg in the local market indicating its culture potential in the area.

Pond construction

The excavation of nursery ponds has been partially completed. Out of 3 ha pond approved for Majharia maun, 1 ha pond comprising three nursery ponds have been completed. While in Kararia maun, out of 2 ha approved pond area, 0.7 ha comprising 3 nursery ponds have been completed.

Production of advanced fingerling in pond

Fry/ early fingerling of selected species of carps weighing 400-500 Kg were stocked in each newly constructed nursery pond in Majharia and Kararia *maun* during November-December. While in Rulhi *maun*, as the nursery pond was not ready, the fry/early fingerlings were stocked in a private pond. At regular intervals growth of seed was monitored in these ponds. The seeds that have reached stockable size of more than 120 mm were harvested and stocked in open wetland.

Training

The beneficiary fishers (35 Nos.) have undergone exposure visit cum training on fisheries management in wetlands of Bihar at CIFRI, Barrackpore during 18-22 June, 2018.

Farmers' participation in the World Fisheries Day at Patna

A total of 84 fishers from Sirsa, Rulhi, Majharia and Kararia maun participated in the World Fisheries Day celebration held at Gyan Bhavan, Patna during 22 October, 2018. Honourable Minister of

Agriculture Sri Radha Mohan Singh, Honourable Deputy C.M. of Bihar, Sri Sushil Modi and Honourable Tourism Minister, Sri Pramod Kumar visited the stall and appreciated the activities undertaken at Motihari.

In order to showcase the project activities and achievements made under the four fisheries development projects in Sirsa, Rulhi, Majharia and Kararia maun, 8 banners (both in Hindi and English) were prepared and exhibited in the pavilion of World Fisheries Day 2018 held at Patna.

Fig.194 Posters on Kararia & Majharia maun

Project Title : **Fisheries development in Kothia *maun* of Bihar**

Project Personnel : B. K. Das, Ganesh Chandra and Raju Baitha

Fig.195 Fish harvest conducted in March 2019

Implementation of fisheries enhancement programme

Based on the need of the wetland, species enhancement and stocking enhancement activitie were implemented following scientifically proven norms developed by ICAR-CIFRI. Selection of fish species and their stocking density was based on the ecosystem characteristics prevailing at Kothia *maun*. Stock enhancement activity with advanced fingerlings (weight : 25-50g) was undertaken twice at 90 days interval along with stocking of pens and cages with fish seed of 1-2 gm size. So far, 3,395 kg biomass of seed (including advanced fingerling for open wetland area and fry/fingerling for

Fig.196 Fish harvest conducted during March 2019 in presence of Honourable Minister of Agriculture & Farmers Welfare, Government of India, Sri Radha Mohan Singh

cage and pen) has been stocked in the wetland was. The seed stocked in open wetland gradually will start reaching harvestable size by May 2019 onwards and then the fishermen will reap the benefit of stocking enhancement programme. However, in March and April 2019 has partially harvested 669.30 kg of fish (weight ranging from 0.5-1.8 kg).

Production of advanced fingerling in pen

The pre-fabricated "CIFRI HDPE pens" (area-1.5 ha) were installed in the marginal area of Kothia *maun* for production of advanced fingerling to ensure year round fish seed availability at site for stocking in *maun*.

The pens were stocked with seed of Indian major carp (*Labeo catla, Labeo rohita* and *Cirrhinus mrigala*) and one exotic carp species, *Ctenopharyngodon idella*. Seed production in pen is found to be very useful technology in wetland. Among seeds of various species stocked, grass carp had shown excellent growth rate. A total of 121 Kg of advanced fingerlings were produced from Kothia *maun* (pen) in 20 days upon stocking of 100 kg. Later on, advance fingerlings of these species were stocked in to open *maun* to avoid losses from severe winter kill.

Seed/Fish production in cages

The "CIFRI GI Cage" (6 Nos) were installed in Kothia *maun* and 100 kg seeds of Catla, Rohu and Mrigal were stocked in 6 cages, but with poor survival and mass mortality due to biting winter.

Pond construction

The excavation of 4 nursery ponds (1 ha each) has been completed. The

Fig.197 Installation of "CIFRI HDPE pen" (a), fish seed stocking (b) and monitoring (c)

Fig.198 (A) Installation of “CIFRI GI Cage” and (B) stocking of fish seeds

Fig.199 Nursery pond preparation

Fig.200 On field Awareness and skill development of fishers at Kothia maun; a) Inauguration of the programme by Block Development Officer, b) Class room teaching & learning process, c) & d) Field teaching and learning process, e) Group photograph on valedictory day of training

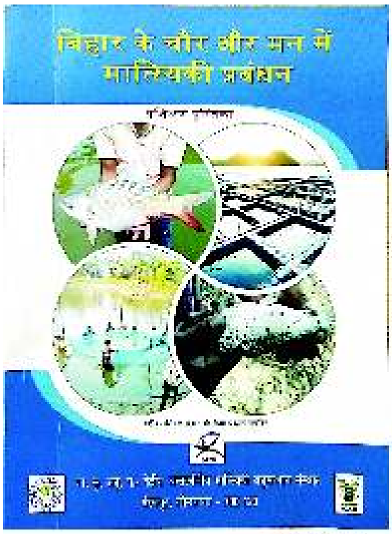


Fig 201 Training manual on Bihar Wetland Fisheries Development

दैनिक भास्कर

14-Feb-2019
मोतीहारी Page 3

मछुआरों का तीन दिवसीय प्रशिक्षण शुरू

भास्कर न्यूज़ | तेतरिया

प्रखंड क्षेत्र के कोठिया मन के समीप राष्ट्रीय मात्स्यिकी विकास बोर्ड के तत्वावधान में भाकृ अनुप केंद्रीय अंतः स्थलीय मात्स्यिकी अनुसंधान संस्थान, बैरकपुर, कोलकाता की टीम मछुआरों को प्रशिक्षण दे रही है। तीन दिवसीय मछुआरों का प्रशिक्षण शिविर का उद्घाटन प्रखंड विकास पदाधिकारी चंद्र भूषण कुमार ने किया। शिविर में 50 मछुआरों को प्रशिक्षित किया जा रहा है। प्रशिक्षण में पहले दिन प्रशिक्षक राजू बैठा, सुमन कुमारी, एसए हसन एवं गणेश चंद ने मछुआरों को केज कल्चर एवं पेन कल्चर का प्रशिक्षण दिया। इस प्रशिक्षण का लाभ उठाकर मछुआरे अपनी आमदनी बढ़ा सकते हैं। मौके पर मत्स्यजीवी संघ के प्रखंड अध्यक्ष राम नारायण सहनी, शिवबालक सहनी, कृष्ण देव सहनी, परमहंस निषाद, उपेंद्र सहनी, जय किशोर सहनी आदि मौजूद थे।

मछुआरों को प्रशिक्षण देते अधिकारी।

Fig. 202 Print media coverage of the training programme

Fig 203 ICAR-CIFRI scientists were interacting with Director of Fisheries, Govt. of Bihar

ponds are under pre-stocking management and will be producing sufficient numbers of advance fingerlings of carp to stock the open *maun* in 2019.

Communities and stakeholders empowerment through capacity building

Awareness and skill development of 50 fishers of Kothia *maun* through three days training program on "*Bihar ke Chaur aur maun me matsyiki prabandhan*" at Kothia, Motihari, Bihar from 13-15 February 2019.

Farmers participated in the "World Fisheries Day" at Patna

A total of 25 fishers were part of 84 contingent of fishers from Kothia *maun* to participate in the "World Fisheries Day" held at Gyan Bhavan, Patna during 22 October 2018.

Fig. 204 Visit of distinguished officers at project site

Project Title : **National surveillance program for aquatic animal diseases**

Project Personnel : B. K. Behera, B. K. Das, B. K. Bhattacharya, P. K. Parida, P. Das, S. Bhowmick

Associate : A. K. Jana

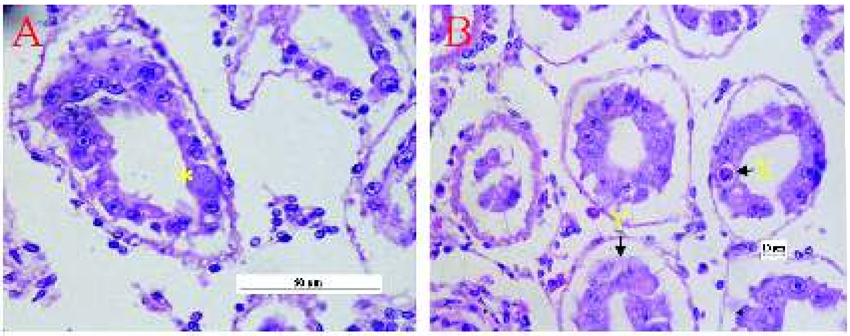


Fig. 205 Histopathology of EHP in *L. vannamei* showing A: developmental stages / spores in the tubular epithelial cells (*) (H & E; 600 X). B: basophilic inclusions (X) and granular bodies and completely detached tubule and enlarged haemal sinus in the hepatopancreatic tissue (Y) (H &E; 400 X)

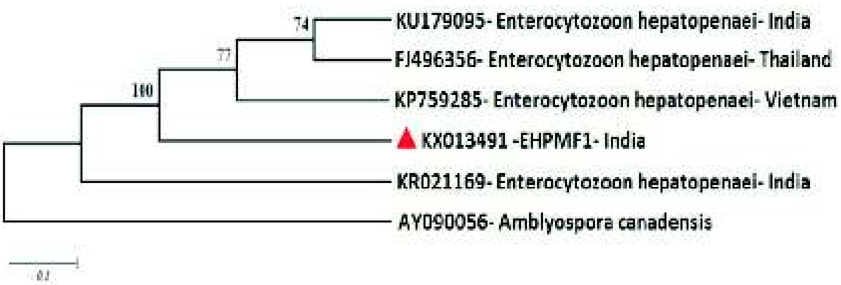


Fig. 206 Phylogenetic tree analysis of *E. hepatopenaei* based on ssu rRNA nucleotide sequences. Phylogenetic tree was generated using Maximum-likelihood method by the MEGA 6 software. The numbers next to the branches indicate percentage values for 1000 bootstrap replicates. Bootstrap values are shown at the nodes. The nucleotide sequence of EHPMF1 identified in this study which is submitted to NCBI is indicated by the shaded triangle.

Identification of Microsporidian Parasite, Enterocytozoon hepatopenaei *in cultured Pacific White Shrimp,* Litopenaeus vannamei *(Boone, 1931) in West Bengal*

Enterocytozoon hepatopenaei (EHP) is an emerging microsporidian pathogen in shrimp aquaculture. EHP could be detected from slow growing shrimps as well as in some cases from White Faeces Syndrome affected animals. *Litopenaeus vannamei* samples collected from East Midnapur district (N=119), North 24 Parganas (N=50) and South 24 Parganas (N=50) district of West Bengal were screened for identification of EHP in cultured *L. vannamei* in West Bengal. Histological examination of hepatopancreas of the infected animals showed, eosinophilic to basophilic inclusions in the epithelial cells with moderate necrotic tubular detachment from the basal membrane. From the shrimp hepatopancreatic samples, DNA was extracted and PCR amplified by using two different sets of primers targeting the SSU rRNA and 18S rRNA genes. Based on the BLASTP, the sequence of SSU rRNA gene (KX013491) of the collected sample showed 100% homology with EHP SSU rRNA gene sequences submitted in NCBI from different countries *viz.* Vietnam (KP759285), Thailand (FJ496356) and India (KU179095).The 18S rRNA gene sequence was submitted to NCBI GenBank (KU851962). Further, all the field samples were found to be EHP +ve by using a new second generation primer targeting the Spore Wall Protein gene (SWP) of EHP (KY483639). Overall prevalence rate of EHP in the cultured *L. vannamei* farm in West Bengal was estimated to be 84.9%, which was highest in comparison to earlier reports in India.

Genetic diversity and multiple antibiotic resistance index study of bacterial pathogen, Klebsiella pneumoniae *strains isolated from diseased Indian Major Carps*

Diseased fish samples showing hemorrhages and reddish lesions were collected from different freshwater fish farms located at 3 different districts of West Bengal, India (Burdwan, North 24 Parganas and Nadia). Primarily *Klebsiella pneumoniae* were identified through *Klebsiella* specific media and biochemical tests. PCR analysis of 16S-23S internal transcribed spacer (PCR ribotyping) was carried out to study the species variation within different *Klebsiella pneumoniae* isolates. For all the isolates, a conserved PCR ribotype pattern was observed which differed from other bacterial species. Phylogenetic study showed the high degree of homology with diverse source of other strains. The multiple antibiotic resistance (MAR) values of the present study for the isolates were found to be 0.468. Based on 16S rRNA gene sequence analysis revealed the genetic diversity of *Klebsiella pneumoniae* isolated from different diseased fish farms of West Bengal. All the strains were found to be hyper-mucoviscous and multidrug resistant thus making it pathogenic towards the host organisms.

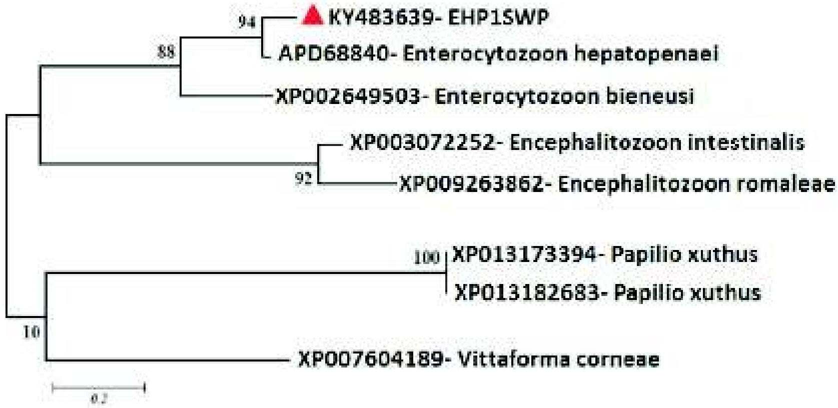


Fig. 207 Phylogenetic tree analysis of *E. hepatopenaei* based on Spore Wall Protein gene [EHP1SWP] sequences. Phylogenetic tree was generated using Maximum-likelihood method by the MEGA 6 software. The numbers next to the branches indicate percentage values for 1000 bootstrap replicates. Bootstrap values are shown at the nodes. The sequence of EHP1SWP identified in this study submitted to NCBI is indicated by the shaded triangle.

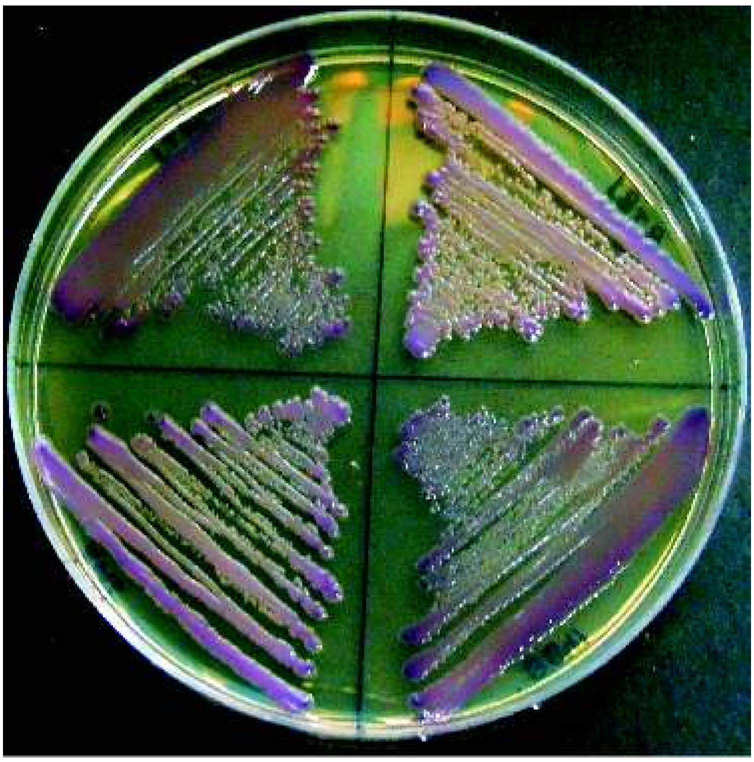


Fig.208 Appearance of *Klebsiella pneumoniae* as purple-magenta (mucoid) colonies on HiCrome Klebsiella Selective Agar Base.

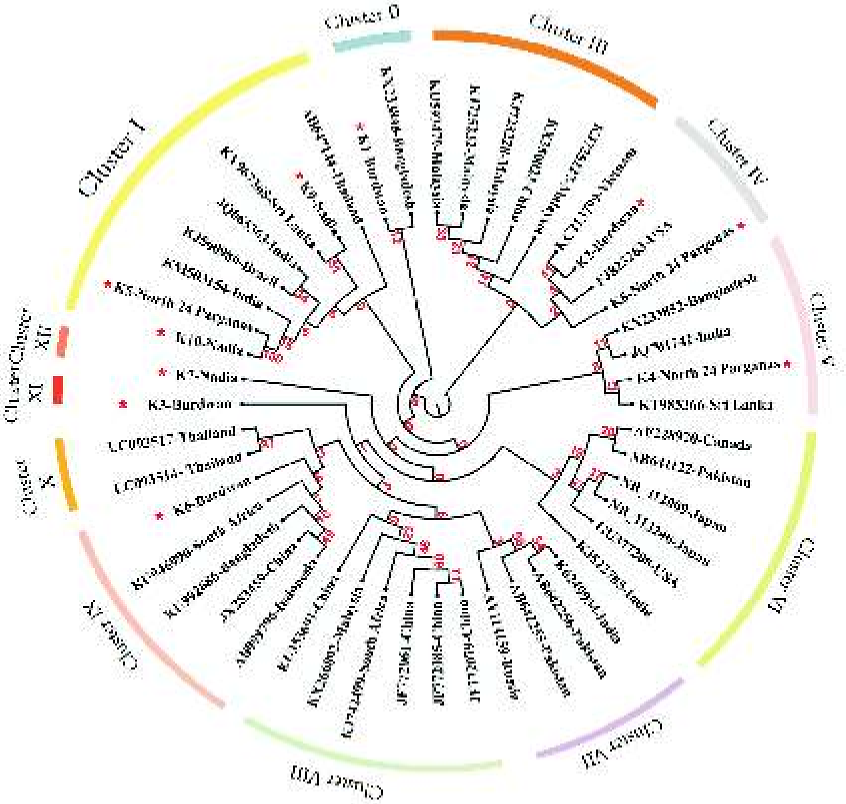


Fig. 209 Phylogenetic relationship of *Klebsiella pneumoniae* strains used in this study (*) with *Klebsiella pneumoniae* strains reported from different part of the world using Maximum-likelihood method by the CLC genomic Workbench Software . The numbers next to the branches indicate percentage values for 1000 bootstrap replicates. Bootstrap values are shown at the nodes.

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

Project Personnel : B. K. Behera, B. K. Das, P. K. Parida, D. J. Sarkar and R. K. Raman

Associate : A. K. Jana

Environmental sediment samples were collected from nine different sites along the river Ganga, *viz.*, Ganga Barrage (N 26^{0} 30.858$^{/}$ E 80^{0} 19.114$^{/}$), Jajmau (N 26^{0} 25.301$^{/}$ E 80^{0} 25.282$^{/}$), Jana Village (N 26^{0} 24.495$^{/}$ E 80^{0} 26.904$^{/}$) near Kanpur, Uttar Pradesh, Farakka Barrage (N 24^{0} 47.804$^{/}$ E 87^{0} 55.417$^{/}$), Dhulian (N 24^{0} 47.804$^{/}$ E 87^{0} 55.417$^{/}$), Lalbagh (N 29^{0} 11.087$^{/}$ E 88^{0} 16.079$^{/}$) in West Bengal and three different sites of river Yamuna, viz., Wazaribad (N 28^{0} 42.39$^{/}$ E 77^{0} 13.57$^{/}$), Okhla barrage (N 28^{0} 32.51$^{/}$ E 77^{0} 18.30$^{/}$), Faizupur Khaddar (N 28^{0} 18.43$^{/}$ E 77^{0} 27.52$^{/}$) near New Delhi, India. Metagenomic sequencing was carried out for the nine river sediment samples. The bacterial and fungal communities were characterized in terms of relative abundance, taxonomic diversity from the sediments of the river Ganga and Yamuna. 92 species of bioremediation bacteria belong to 45 genera have been identified using taxonomical classification system, Kaiju. Proteobacteria was found to be the most dominant bacterial flora, followed by Actinobacteria, Firmicutes and Deinococcus-Thermus. Rhodococcus species (*Rhodococcus erythropoliis* and *Rhodococcus qingshengii*) were found in significantly higher quantity in Farakka compare to Yamuna locations ($p \leq 0.05$) of river Ganga. *Cupriavidus necator*, *Cupriavidus taiwanensis* and *Paraburkholderia xenovorans* were also observed in significantly higher quantities in stretches near Farakka. *Aspergillus versicolor* and *Fusarium solani* were observed in significantly higher quantities at New Delhi stretches of river Yamuna compared to the river Ganga. Interestingly, protein domain analysis of identified bioremediation bacteria revealed several protein domains including urea ABC transporter, UrtA, UrtD, UrtE, zinc/cadmium/mercury/lead-transporting ATPase which opined to play pivotal role in bioremediation in the polluted environments. Further, the protein domains involved in pesticide biodegradation, *viz.*, P450 and short-chain dehydrogenases/reductases (SDR) and more were discovered in river sediment metagenomics data. Our report for the first time shows the richness of microbial diversity in the major riverine ecosystems (Ganga and Yamuna) in India highlighting bioremediation applications for inland aquatic environmental management.

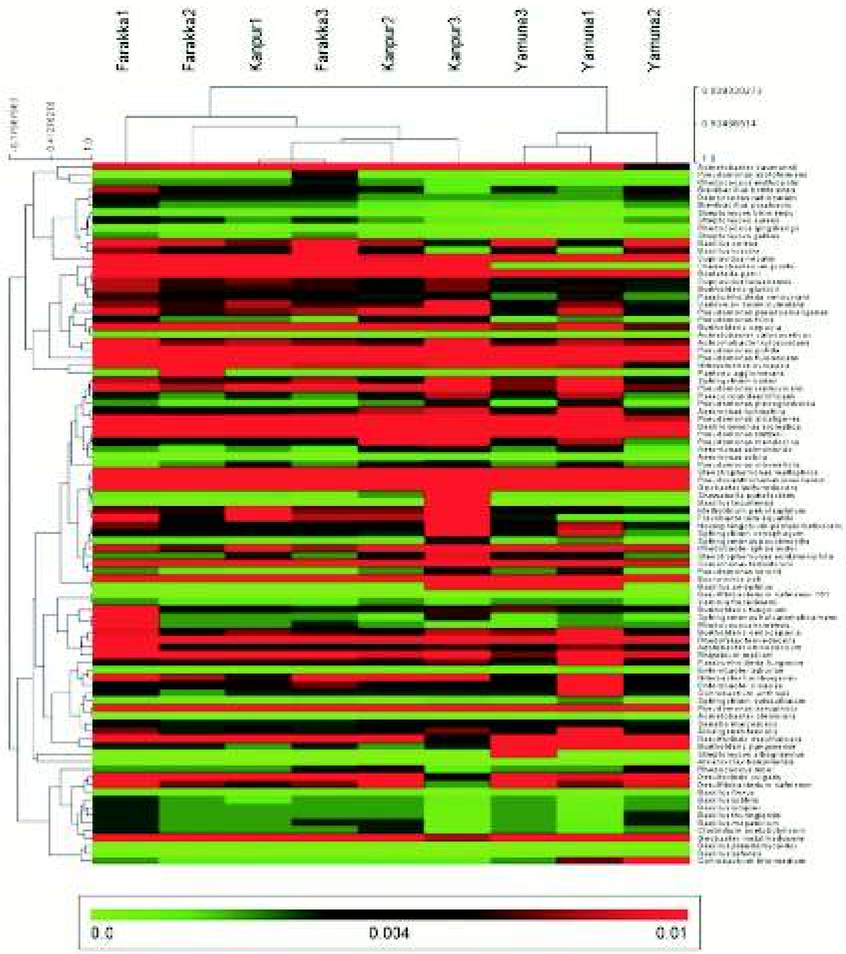


Fig.210a. Heatmap of relative species abundance of identified bioremediation bacteria from nine different sediment metagenomes. Heatmap showing 92 species of bacteria with significant differences (Student's t-test, $p \leq 0.01$) of relative abundances among the nine sampling site.

Fig.210b. Assessing water quality of river Yamuna at Okhla

Project Title : **National Agricultural Innovation Fund (NAIF) Component-1 ITMU**

Project Personnel : Ganesh Chandra

Trademarks

ICAR-Central Inland Fisheries Research Institute has successfully registered trademarks of four technologies namely CAGEGROW® CIFRI GI CAGE® CIFRI PEN HDPE® CIFLIN® in the name of “Indian Council of Agriculture Research” in the Trade Mark Registry of Government of India, Mumbai.

Trademark No. 3625921 CAGEGROW® (Certificate No. 1843046 sealed on 25 April 2018) was published in Trademark Journal No: 1827 in December 2017 and valid up to August 2027. CAGEGROW® is registered under the trademark Class 31, as fish feed, Animal feed.

प्रारूप आरजी - 2
Form RG - 2

भारत सरकार
Government of India
व्यापार चिन्ह रजिस्ट्री
Trade Marks Registry
व्यापार चिन्ह अधिनियम, 1999
Trade Marks Act, 1999
व्यापार चिन्ह के रजिस्ट्रीकरण का प्रमाणपत्र, धारा 23 (2), नियम 56 (1)
Certificate of Registration of Trade Mark, Section 23 (2), Rule 56 (1)

क्रमांक No. 1843046

Trade Mark No. 3625921 Date 01/09/2017 J. No. 1827

Certified that Trade Mark / a representation is annexed hereto, has been registered in the name(s) of :-
INDIAN COUNCIL OF AGRICULTURAL RESEARCH, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700120, An Indian Research Institute, (Government Department)

In Class 31 Under No. 3625921 as of the date 01 September 2017 in respect of

Fish Feed, Animal Feed.

CAGEGROW

Sealed at my direction, this 25th day of April, 2018

व्यापार चिन्ह रजिस्ट्री
Trade Marks Registry MUMBAI

व्यापार चिन्ह रजिस्ट्रार
Registrar of Trademarks

Registration is for 10 years from the date of application and may then be renewed for a period of 10 years and also at the expiration of each period of 10 years.
This certificate is not for use in legal proceedings or for obtaining Registration abroad.
Note: Upon any change of ownership of this Trademark, or change in address, of the principal place of business or address for service in India a request should AT ONCE be made to register the change.

प्रारूप आरजी - 2
Form RG - 2

भारत सरकार
Government of India
व्यापार चिन्ह रजिस्ट्री
Trade Marks Registry
व्यापार चिन्ह अधिनियम, 1999
Trade Marks Act, 1999
व्यापार चिन्ह के रजिस्ट्रीकरण का प्रमाणपत्र, धारा 23 (2), नियम 56 (1)
Certificate of Registration of Trade Mark, Section 23 (2), Rule 56 (1)

क्रमांक No. 2085292

Trade Mark No. 3852537 Date 05/06/2018 J. No. 1866

Certified that Trade Mark / a representation is annexed hereto, has been registered in the name(s) of :-
INDIAN COUNCIL OF AGRICULTURAL RESEARCH, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700120., An Indian Research Institute, (Government Department)

In Class 22 Under No. 3852537 as of the date 05 June 2018 in respect of

Net pens for fish farming;fishing nets

CIFRI GI CAGE

Sealed at my direction, this 27th day of January, 2019

व्यापार चिन्ह रजिस्ट्री
Trade Marks Registry MUMBAI

व्यापार चिन्ह रजिस्ट्रार
Registrar of Trademarks

Registration is for 10 years from the date of application and may then be renewed for a period of 10 years and also at the expiration of each period of 10 years.
This certificate is not for use in legal proceedings or for obtaining Registration abroad.
Note: Upon any change of ownership of this Trademark, or change in address, of the principal place of business or address for service in India a request should AT ONCE be made to register the change.

Trademark No. 3852537 CIFRI GI CAGE® (Certificate No. 2085292 sealed on 27 January 2019) was published in Trademark Journal No: 1866 and valid up to June, 2028. CIFRI GI CAGE® is registered under the trademark Class 22, as Net pens for fish farming; fishing nets.

Trademark No. 3852538 CIFRI PEN HDPE® (Certificate No. 2085291 sealed on 27 January 2019) was published in Trademark Journal No: 1866 and valid up to June, 2028. CIFRI PEN HDPE® is registered under the trademark Class 22, as Net pens for fish farming; fishing nets.

Trademark no. 3852539 CIFLIN® (Certificate No. 2045488 sealed on 8 December 2018) were registered under trademark Journal No. 1859 valid up to June 2028. CIFLIN® is registered under the trademark Class 1, as Chemical used for detecting formaldehyde adulteration of fish.

CIFRI GI CAGE, CIFRI PEN HDPE and CAGEGROW have been commercialized in the year 2017-18 and 2018-19.

Patent

Patent application on “Vertical Slab Gel Electrophoresis apparatus” has been filed in the name of Indian council of Agricultural Research” filed on 22 September 2019 to Indian Patent Office, Kolkata. The application number is 38954/2018-KOL, 201831035743.

MOU signed

The Institute has signed with different State Fisheries Departments and other developmental agencies for fisheries development and ecosystem assessment.

Table 20 MoU signed with different State departments and other agencies

Sl. No.	MOU	Purpose
1.	MOU signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Government of Odisha, consultancy project on “DPR preparation for the development of Tamparas situated in Ganjam district for commercial unit of aquaculture and culture based fisheries” signed on 11 April 2018 at Cuttack, Odisha	Consultancy
2.	MOU signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Government of Odisha, consultancy project on “DPR preparation for the development of aquaculture cluster in periphery of Chilika in Khorda District” signed on 11 April 2018 at Cuttack, Odisha	Consultancy
3.	MOU signed between ICAR-CIFRI, Barrackpore and MP Fisheries Fe deration Limited, Bhopal, MP for consultancy project on “Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar Reservoir” on 23 May 2018 at Barrackpore, West Bengal.	Consultancy
4.	MOU signed between ICAR -CIFRI, Barrackpore and MP Fisheries Federation Limited, Bhopal, MP for consultancy project on “Status of fish diversity, abundance and population dynamics of Tilapia in Halali reservoir, Madhya Pradesh for sustainable fisheries management” on 23 May 2018 at Barrackpore, West Bengal.	Consultancy
5.	MOU signed between ICAR-CIFRI, Barrackpore and Project implementation Unit -2 Kalpasar Department, Government of Gujarat, Gujarat for consultancy project on “Assessment and Impact study on bio -diversity, eco-hydrology, fish population dynamics and livelihood of fishers in Narmada river with special focus on downstream of Sardar Sarovar Dam and Bhadbhut Reservoir” on 17 July 2018 at Vadodara, Gujarat.	Consultancy
6.	MOU signed between ICAR-CIFRI, Barrackpore and Coal ash Institute of India, Kolkata for consultancy project on “Assessment of impact of fly ash leakage on biaotic and abiotic components of river Ganges due to force majeure of loaded barges ” on 22 February 2019 at Barrackpore, West Bengal.	Consultancy
7.	MOU signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Government of Odisha, for installation of 110 CIFRI GI Cage under the state plan scheme “Infrastructure for Cage culture” in different waterbodies of Odisha signed on 19 July 2018 at Cuttack, Odisha	Sale and Installation of CIFRI Technology
8.	MOU signed between ICAR-CIFRI, Barrackpore and Department of Fisheries, Government of Odisha, for installation of 110.8 ha CIFRI Pen HDPE under the different schemes in different waterbodies of Odisha signed on 12 November 2018 at Cuttack, Odisha	Sale and Installation of CIFRI Technology

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

Project Personnel : B. K. Bhattacharjya, S. Yengkokpam, D. Debnath and P. DebRoy

Project partners

1. Director of Fisheries, Directorate of Fisheries, Govt. of Manipur, Lamphelpat, Imphal - 795005, Manipur.
2. Director of Fisheries, Directorate of Fisheries, Govt. of Meghalaya, Clive Colony, Shillong – 793003, Meghalaya.
3. Director of Fisheries, Directorate of Fisheries, Govt. of Arunachal Pradesh, Itanagar.

Fig. 211 Eminent fisheries scientists and officers including Dr. J. K. Jena, DDG (Fisheries and Animal Sciences), ICAR, New Delhi; Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore, Kolkata; Prof. R. N. Goswami, Dean, CVSc (AAU), Khanapara; Dr. S. Rajkhowa, Director, NRC on Pig, Rani; Dr. B. K. Bhattacharjya, Head (Acting), ICAR-CIFRI Regional Centre, Guwahati; Shri H. Biramani Singh, Director of Fisheries, Govt. of Manipur; Shri J. K. Samal, Deputy General Manager, NABARD, Guwahati during the inception workshop on 24.08.18 at the College of Veterinary Science (AAU), Khanapara).

Fig. 212. ICAR-CIFRI HDPE pens installed in Takmu pat of Bishnupur district, Manipur

An inception workshop of the project was organized on 24.08.18 at the College of Veterinary Science (AAU), Khanapara prior to formal implementation of the project. Stakeholders including project partners from Manipur, Arunachal Pradesh and Meghalaya took part in the workshop

Study on socio-economic condition of the wetland fishers of Takmu pat, Bishnupur district, Manipur was carried out. Primary data collected from wetland fishers (51 nos.) of Takmu pat, showed that cent percent fishers belonged to below poverty line category. 88.23% of wetland fishers were original fisher-folk but 20% took fishing as profession. Their average annual income was INR 1 lakh with major expenditure on education (52%,) followed by mobile bill (16%) and clothing (9%) and 5% on food, 3% on cooking, 3% on social expenses, 2% on festival expensed, 6% on medical expenses, 1% on transportation and 3% on purchased of household needs. Only 21.57% of the respondents had agricultural land and 58.82% had ring bunds for fish culture. About 4% of fishers were indebted with credit and only 9.8% fishers were having savings mainly in local non-formal organizations called 'Marup'. Engel's coefficient (50%) indicated poor living condition of the fishers of Takmu pat, Loktak Lake.

Information on region-specific harvest practices/ models (3 nos.) was collected from fishers of Takmu pat. Bamboo box-trap, a fishing gear made from seasoned split bamboos, a unique method of preparing earthen sinkers for use in the foot-rope of gill nets and drag nets and “Nga-A Yaiba”, a traditionally processed dried fish product was

Fig. 213 Haul of *Labeo bata*

documented from the survey area. Field visits were under taken to document fishing methods practiced by wetland fishers of Bishnupur district, Manipur. Major fishing gears for harvesting fish from wetlands were lift net (locally called *nupi-il*), dip nets (*il-jao*), gill nets (*laang*), long-lines (*khoisang thakpa*), encircling nets (*Moirang laang*) and drag nets (*moonamba*). Some other occasionally practiced fishing methods/gears include scoop net (*longthrai*), plunge cover-basket (*long-oop*), spear fishing (*long*) and pole-line (*khoi choppa*). Trap fishing methods documented from the study area employed three types of traps, *viz.,* bamboo basket/basket trap (*taijeps*), tubular trap (*kabo-lu*) and conical trap (*sora-lu*).

An on-field training programme on 'Pen aquaculture technology in floodplain wetlands of Manipur' under NMHs project was conducted at Sendra, Loktak, Bishnupur district on February 19, 2019. The purpose of the training programme was to train fishers on various aspect of pen aquaculture technology that has immense potential for improving income and livelihoods of thousands of wetland fishers residing around Loktak. A total of 50 fishers participated in the training programme. Five ICAR-CIFRI HDPE pens (each measuring 0.1 ha) were installed in Takmu lake (pat) of Bishnupur district, Manipur. Fifteen thousand fingerlings of Indian major, minor and exotic carps were stocked @ 3 nos./m^2 in five pens under the NMHS project during March 13-15, 2019.

Fish feed (CIFRI CAGEGROW) of different diameter pellet size (viz. Starter, Grower and Finisher feed) was used for feeding the stocked fishes in pens. The study is in progress.

Rapid survey was made to examine physico-chemical characteristics of wetlands of Meghalaya before fisheries enhancements. Water quality parameters indicated favourable conditions for fish rearing in Boro, Katuli and Kumligaon beels. Water had near neutral pH (6.6-7.4), high DO (7.2-9.6 ppm), low to moderate alkalinity (22-47 ppm) and transparency of 28-70 cm. The soil was clayey-loam in nature.

Project Title : **Nutrient profiling of fishes of Loktak Lake in Manipur, a high altitude lake with organic fauna and potential scope for GI tagging (under DBT NER Twinning)**

Project Personnel : B. P. Mohanty (with M. Samarendra Singh, Thambal Marik College, Oinam, Manipur)

Nutrient composition of fish varies with species, zoogeography, age, sex, climate, etc. Loktak Lake, the largest freshwater lake in Northeast India at Moirang, in the Bishnupur District of Manipur, is a high altitude lake situated at 24°33'N and 93°47'E, 790 m ASL and rich in unique endemic, organic flora and fauna. Loktak has a unique aquatic ecosystem owing to its higher altitude, low temperature and organic soil and vegetation. Owing to this, the fish food organisms are likely to be different and this could contribute to differential body composition of fish fauna, thereby making it unique as human nutrient, possibly different than the same species from planes. This project targets to study the nutritional composition of fish with the objective to identify such specific nutrient richness, if any, with possible scope for GI tagging.

Fig. 214 Loktak Lake, Moirang, Manipur. Study site for nutrient profiling of important food fishes

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

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

In order to enhance fish production from reservoirs for livelihood and nutritional security in Telangana, production of stocking material and table fish were being demonstrated in modular cages installed in Palair reservoir located in Khammam district. Species diversification was attempted in CIFRI GI model cages by stocking *Labeo rohita, L. catla, Pangasianodon hypophthalmus, L. rohita* (Jayanti variety) and prawn *Macrobrachium* sp. *After* 150 days of culture the species yielded average weights of 52.65 ± 5.558 g, 33.41 ± 4.608 g, 178.25 ± 10.089 g, 78.14 ± 5.729 g and 21.46 ± 2.517 g, respectively. The better growth performance and survival indicates that the fish species such as Jayanti rohu and freshwater prawn can be used as potential candidates for species diversification in cage culture.

Seasonal samplings were carried out to study the fish diversity, assemblage structure and seasonal dynamics of fish abundance and also to explore the changes in assemblage due to cage culture in Palair reservoir, Telangana. During the study, a total of 33 fish species belonging to 14 families were recorded from Palair reservoir including two exotic species, *viz*., Tilapia (*Oreochromis niloticus*) and Pangas (*Pangasionodon hypophthalmus*). Tilapia formed a major share of fishers' catches along with stocked Indian major carps. The important native fishes contributing to reservoir fisheries were *Etroplus suratensis, E. maculatus, Sperata seenghala, Glossogobius giuris, Notopterus notopterus, Wallago attu* and *Osteobrama cotio.* The fish assemblage analysis indicated a richer abundance of fishes near operational cage culture system in the reservoir, which indicates that the cage influences on the surrounding natural ecosystem and its fish communities.

Fig. 215 Growth monitoring of Jayanti rohu

Project Title : Collaborative research project with WorldFish Centre under Window-3 Program on small scale fisheries

Project Personnel : B. K. Das, B. P. Mohanty, B. K. Bhattacharya, A. K. Das, B. K. Behera, A. Pandit, A. K. Sahoo, A. Roy, G. Karnataka, P. K. Parida, S. Borah

Under the collaborative research project, Dr. A. K. Das (Principal Scientist) and Dr. P. K. Parida (Scientist) of ICAR-CIFRI visited WorldFish, Bangladesh for the exposure on Small Scale Fisheries during 22 to 28 October, 2018. The team had an interaction with the WorldFish team at Dhaka; ECOFISH Project team at Chandpur; Dr. Masud H Khan, CSO, BFRI and his team at Chandpur; Fisheries officers at Rajsahi and Dr. A.S. Md. Rashedul Haque DG, Fisheries department Bangladesh at Dhaka on small scale fisheries development.

Fig. 216 Growth monitoring of *Macrobrachium* sp.

Fig. 217 *Etroplus maculatus* harvested from Palair reservoir

Dr. B. K. Das, Director, ICAR-CIFRI attended ICAR-WorldFish Research Strategy Workshop from 26-27 November 2018 at WorldFish centre Head Quarter, Penang, Malaysia. He has presented the project outline and detailed workdone in small scale fisheries by ICAR-CIFRI. In the workshop detail project planning on small scale fisheries was prepared.

Dr. A. Roy participated in 'MuSIC' Workshop at World Fish, Penang. Multi-stakeholders' Information and Communication (MuSIC) Workshop was organized during 18-23rd February, 2019 to promote 'Voluntary guidelines for securing sustainable Small-Scale Fisheries' in Asian countries. Fishery Researchers from Government Institutions; NGOs activists working closely with fishing communities and Development Journalists (Print, TV, Radio, Online Journals etc.).

Fig. 218 Participation of CIFRI Scientists in WorldFish meeting on small scale fisheries

Fig. 219 Participation of CIFRI Scientists in MuSIC Workshop at WorldFish

The objectives of the workshop were

- Greater awareness and understanding within researcher, NGO activists and media personnel about relevance of small-scale fisheries in India as well as in Asia in the context of food security, wholesome nutrition and the SSF Guidelines.

- Sharing of research and activities of WorldFish among participants which can be utilized in respective professional fields.

- A step towards creating a pan-Asian alliance for information sharing and communication aimed at more informed policy and action on small-scale fisheries issues.

Project Title	:	**Determination of environmental flows for non-lean/non monsoon months for Teesta IV Hydropower project, Sikkim**
Project Personnel	:	B. K. Das, A. K. Sahoo, H. S. Swain and P. K. Parida
Associates	:	S. Prasad and S. K. Majumdar

Teesta IV Hydropower project envisages a power generation capacity of 520 MW comprising construction of a power dam on river Teesta with appurtenant headrace tunnels and a underground powerhouse. An investigation was carried out to estimate environmental flows for the non-lean/non monsoon months based on the availability of fish species. During these period, juveniles of *Schizothorax* sp. were abundant preferring water depth of 0.6-0.8m and velocity of 0.8-1.0m/s. Hydrographs of consecutive four years (2015-2018) for the non-lean non-monsoon period was plotted to understand the annual change. Keeping this habitat, hydrodynamic modeling has been carried out in the river stretch between Teesta-IV dam and tail race tunnel (TRT) outlet using HEC-RAS software. River

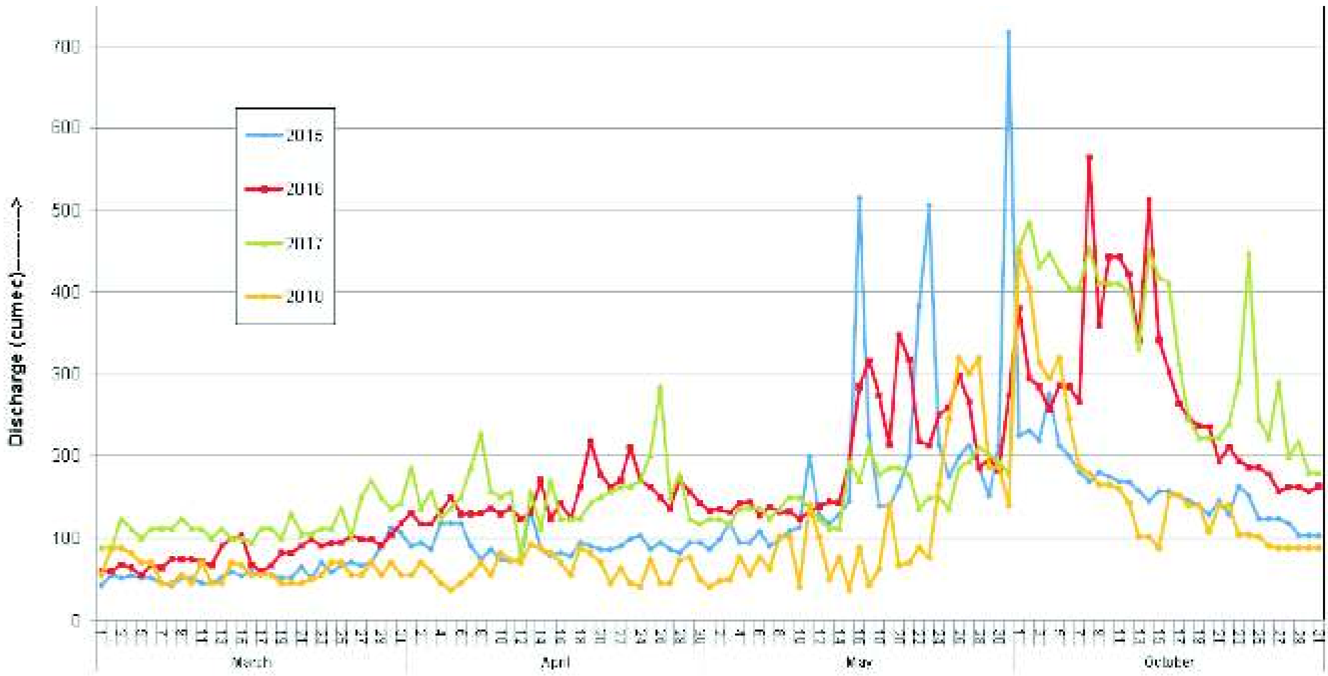


Fig.220 Hydrograph of Teesta river at Sankalang G/D site based on daily discharge data during 2015-2018

cross-sections at an interval of 500 m between dam and TRT outlet have been used in this study. The flow, depths and velocities at all locations along the reach were worked out for different discharges which ranged from 15 cumec to 19 cumec considering two scenarios, *viz.,* contribution of flows without intermediate catchments and contribution of flows with intermediate catchments. In both the cases it was observed that a discharge of 15-19 cumec will fulfill the average depth of 1.2 m and velocity of 1.2m/s in the stretch between dam to power house.

Project Title : Study on assessment of efficacy of fish pass /fish ladders in Teesta Low Dam-III and Teesta Low Dam-IV power stations, West Bengal

Project Personnel : B. K. Das, A. K. Sahoo, D. K. Meena, T. N. Chanu and R. K. Raman,

Associates : A. R. Choudhury and S. Prasad

Study on assessment of efficacy of fish pass/fish ladders in Teesta Low Dam-III and IV Power Stations (TLDP III and IV), West Bengal in river Teesta was carried out through monitoring of migratory fish species in fish pass by using fish traps, video recording and tagging studies with Floy T-anchor. Fish traps of varying shapes have been used at different time periods, *viz.,* early morning, night and daytime to understand the suitable period of migration. In addition to locally available fish species, migratory fishes such as, the Chocolate Mahseer, *Neolissochilus hexagonolepis* and the snow trout, *Schizothorax richardsonii* were observed in large quantities in the fish pass during pre-monsoon (Jan/Feb). To understand the efficacy of fish pass, tagging experiments were carried out during the months of August and October representing the monsoon and post-monsoon seasons, respectively as the period is considered to be favourable for the downstream migration of brood fish. A total of 64 individuals of *N. hexagonolepis* with length ranging from 79-558 mm were successfully tagged at sites representing upstream and downstream of TLDP III and IV. Awareness was created among the local fishermen, officials from the Department of Fisheries, recreational fishers and general public through meetings, posters, hoardings and wall stickers before and after tagging studies to provide the information on tagged fishes. The overall recovery of tagged fishes was estimated to be 6.25% within a month of post tagging.

Fig. 221 Tagging of fish to study efficacy of fish pass

Project Title	:	**Impact assessment of hydro ecological changes on fisheries and socio economy of fisheries downstream of Sardar Sarovar Dam (SSD) in Narmada Basin'**
Project Personnel	:	B. K. Das, G. Chandra, H. Chowdhury, B. K. Behera, Sajina A. M., S. P. Kamble, W. A. Meetei and Vaisakh G.,
Associates	:	A. Sengupta, S.Prasad, S. Saha, R. K. Sah, J. K. Solanki, B. K. Sahoo and B. Gondaliya

River Narmada, the "lifeline" of millions of people in Central India, is one of the largest west flowing rivers of the country. Physico-chemical characteristics of River Narmada downstream of SSD have been studied at stretch between Kevadia to Ambetha during the period April (2018)-March (2019) at ten selected stations, *viz.,* Kevadia, Garudeswar, Poicha, Sisodara, Jhanor, Bharuch, Sakkarpura, Bhadbhut, Mahegam and Ambetha. Water temperature fluctuates from 25.93±3.71 to 29±6.11 ºC. Transparency was lowest at Sakkarpura (10±6.92 cm) and highest at in Garudeswar (95.33±49.69 cm). In the upper stretch, dissolved oxygen (DO) ranged from (8±1.44ppm) at Jhanor to (8.8±4.01ppm) at Kevadia and in the lower stretch it ranged from 6.66±1.84 ppm at Bharuch to 6.83±0.45 ppm at Mahegam. Overall observed average DO in the river was found suitable for the living organisms.

Sediment characteristics

Fig. 222a.Fishing operation in Narmada river downstream of SardarSarovar Dam

The soil along the studied stretch was sandy in nature. Sand content of the sampling sites varied from 82.5-97%, 75-95% and 63-94% during pre-monsoon, monsoon and post-monsoon seasons respectively. Sand content gradually increased as the river approaches the sea recording highest sand content at Ambetha. In the upper stretch of the river up to Jhanor, sand content was less than 90%. At the estuarine stretch from Bharuch to Ambetha (except Sakkarpura) the recorded sand content was more than 90%. Sand content was low at Sakkarpura due to deposition of industrial effluents by the JMDC canal which meets the river at this point. Silt content in the river soil ranged from 1.7-9.8%, 1-13% and 3-25% during pre-monsoon, monsoon and post-monsoon seasons respectively. In general, silt content gradually decreased as the river towards the river mouth. Highest clay content was recorded at Garudeshwar (10.7%) and lowest was at Ambetha (1.3%) during pre-monsoon season. During monsoon, clay content varied from 6%

(Ambetha)-12% (Jhanor) whereas, in post-monsoon it was recorded from 5% (Ambetha)-20% (Sisodara).

Plankton diversity and density

The productivity of any aquatic ecosystem is mainly controlled by the phytoplankton population dynamics and the dynamic structure of these communities directly reflects the health of aquatic ecosystems. A total of 42 phytoplankton taxa, belonging to four groups/classes were recorded during the study period. The highest diversity was recorded at Zone I (riverine freshwater stretch Kevadia, Poicha & Sisodara) where the phytoplankton community comprised of 31 species with representatives from all the four groups/classes. The recorded diversity at Zones II (tidal freshwater stretch-Jhanor) and III (estuarine stretch-Bharuch, Shakkarpura, Bhadbhut, Mehegam & Ambetha) were 10 and 28 respectively. Zone I represented a phytoplankton community dominated by green algae (13 species) and diatoms (12 species). The phytoplankton community in Zones II and III were dominated by diatoms, a character common to estuarine waters. Among the major groups, diatoms were the most dominant (20 species), followed by green algae (15 species), Cyanobacteria (5 species) and Euglenophyceae (2 species). The seasonal variation in phytoplankton density followed a uniform pattern in all the three zones with density reaching its minimum in monsoon .

Phytoplankton density is lowest during monsoon due to dilution of populations by the freshwater influx (both riverine and land run-off) as well as the turbid water conditions which restrict the light penetration. In Zone I, phytoplankton density becomes highest during winter (1264 units/litre) as the calm weather conditions allow the nutrient-laden riverine sediments to settle down thereby increasing the euphotic zone resulting in increased primary production. But in Zones II and III, the phytoplankton density was highest during pre-monsoon due to high salinity and greater light intensity prevalent during the season which favours the abundance of many diatom species of marine origin (such as *Coscinodiscus* sp., *Biddulphia* sp., *Skeletonema costatum* and *Ditylum brightwelli*) which dominate the phytoplankton community during pre-monsoon.

Macro benthic community

A total of 15 benthic macro invertebrate species were observed during the pre-monsoon sampling downstream of SSD. *Bithynia pulchella* was found to be the most abundant species among benthic community followed by *Bellamya bengalensis* and *Melanoides tuberculata*.

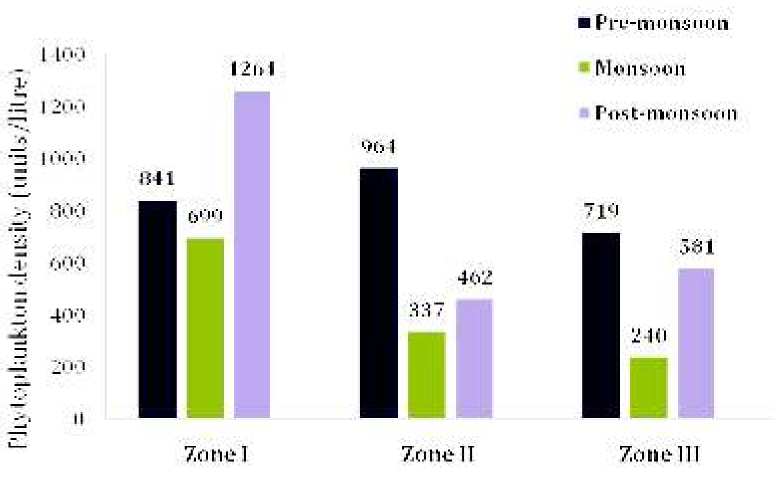


Fig. 222b. Seasonal variation in phytoplankton density along different zones

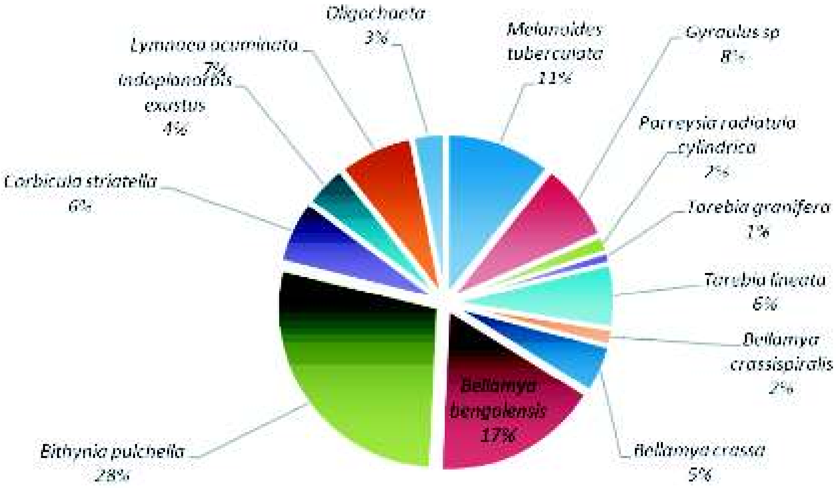


Fig. 223 Composition of benthic macro-invertebrates in River Narmada during pre-monsoon season

In terms of diversity, Garudeshwar recorded the highest diversity (Shannon diversity index) with a value of 1.884 while the lowest diversity was observed at Poicha.

Fish and shell fish diversity

A total of 71 fish species belonging to 29 families were recorded from the stretch of river Narmada downstream of SSD. Cyprinidae (carps) was the most speciose family with 12 species, followed by Bagridae (6 species), Mugilidae (6 species) and Gobiidae (5 species). Among the recorded fish species only three species *viz., Wallago attu, Ompok pabda* and *O. bimaculatus*, are categorised as Near threatened (NT) according the IUCN Red List of Threatened Species. As per the NBFGR categorisation (2013), *O. pabda* and *Tor tor* have been listed as Vulnerable (VU).

In Zone I, the fish community was exclusively comprised of freshwater species. At Jhanor (Zone II), the biota experiences tidal fluctuations without the influence of salinity since there is sufficient freshwater flow to maintain salinities less than 1 ppt. This tidal freshwater zone is considered as an integral part of the estuarine system with specific community structure and important sites of physical, chemical and biological processes. Fish community in Zone II is a heterogeneous assemblage of species under different estuarine usage functional guild, *viz*., freshwater species (12 species), anadromous (1 species; *T. ilisha*), marine migrants (7 species) and true estuarine/brackish species (1 species; *Scatophagus argus*). Zone III typify the true estuarine/brackish stretch where the salinities remain well above 1 ppt throughout the year. The prevalence of brackish water conditions have enabled the stenohaline marine species to migrate in into Zone III which is reflected in the catch structure of fishing gears operational along the area. Among the 37 fish species recorded from Zone III, 27 species are primarily marine. Two species (*Parambassis lala* and *P. ranga*) of freshwater stragglers were also collected during the study which might have been accidentally introduced to the estuarine zone due to monsoonal riverine influx. The mullet, *Rhinomugil corsula* and the goby, *Glossogobius giuris*, were recorded from all the three sampling zones irrespective of the sampling seasons. This can be attributed to their habitat preference which range from upper riverine freshwater reaches to brackish waters in the lower estuarine reaches leading to the establishment of a stable population throughout the river-estuary continuum.

Project Title	:	**Investigation on ecological status, conservation and enhancement of fisheries in Gujarat part of Sardar Sarovar Reservoir**
Project Personnel	:	B. K. Das, A. K. Das, G. Chandra, C. M. Roshith,S. P. Kamble, W. A. Meetei, Vaisakh G. and Vikas Kumar
Assocites	:	S. Das, R. K. Sah, J. K. Solanki, S. K. Banik and N. Vadel

Trophic status of Sardar Sarovar Reservoir (SSR)

The Trophic State Index (TSI) was estimated for each sampling locations in different seasons to assess the trophic status of the reservoir. Three variables, chlorophyll-a, Secchi depth and total phosphorus independently used for estimated Carlson index values. Based on pre-monsoon results, Hapeshwar (CTSIV 64.57) and Vadgam (CTSIV 61.35) are categorized as Eutrophic, with anoxic hypolimnia, blue-green algae dominancy, algal scums and macrophyte problems. Based on monsoon results, the reservoir (all six sampling stations) categorized as Mesotrophic showing water moderately clear, but there is increasing probability of anoxia during the summer. Based on post-monsoon results, Hapeshwar (49.79) and Farkada (48.82) sampling stations categorized as Mesotrophic showing moderately clear water but increasing with probability of anoxia during the summer. Turkheda (54.76) and

Fig. 224 Fishing operation in Sardar Sarovar Reservoir

Dhumna (59.03) were categorized as Eutrophic. Gadher (61.95) and Vadgam (65.63) were also categorized as Eutrophic and these sites have dominance of blue-green algae, algal scum probable, extensive macrophyte problems.

Plankton dynamics

The planktonic community structure in the Gujarat part of the Sardar Sarovar reservoir is represented by 44 is better species belonging to 8 groups of phytoplankton and zooplankton. A total of 33 species of phytoplankton was observed in the reservoir during the study period. Cyanophyceae, Chlorophyceae, Bacillariophyceae and Dinophyceae were the four phytoplankton groups occurring in the reservoir. *Aulacosiera* sp*.* was the most abundant phytoplankton species and was recorded during post-monsoon season. Among the four phytoplankton group, bacillariophyceae was the most dominant group in terms of biomass (83%); while chlorophyceae was the most diverse group in terms of species diversity with nineteen species. Among phytoplanktons, *Ulothrix* sp. was dominant during pre-monsoon; *Staurastrum* sp*.* during monsoon and *Aulacosiera* sp*.* during the post-monsoon season. The density of phytoplankton was within the range of 98 to 5078 units/litre. The zooplankton community comprised of 11 species belonging to four major groups *viz.,* Copepoda, Cladoceran, Rotifera and Protozoa were recorded. Rotifera was the dominant group both in terms of species diversity and biomass. The density of zooplankton during the period ranges from 20 to 254 numbers/litre. Among zooplanktons *Keratella* sp. was dominant during the pre-monsoon and monsoon season with a peak density of 289 numbers/litre, while *Brachinous* sp. was dominant during the post-monsoon season. The total plankton density of the reservoir ranged from 191 to 5103 numbers per litre during the sampling period.

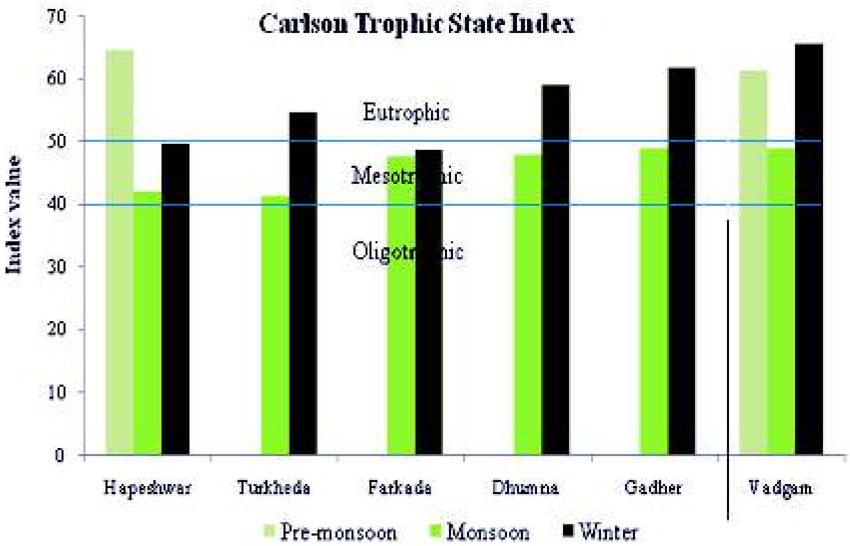


Fig. 225 Seasonal variation in trophic status at different sampling stations in SSR

Fish Diversity and catch composition

A total of 29 fish species belonging to 12 families were recorded from the Sardar Sarovar reservoir in the sampling surveys during 2018-19. Cyprinidae was the dominant family in terms of species richness, followed by the catfish family Siluridae. The fish species recorded during the present study were compared with the study conducted by CIFRI during 2013 and the IUCN category status and the NBFGR category status of fish species are also listed. Among the exotic fish species, *Hypophthalmichthys* *molitrix*, was recorded during the present study. As per the NBFGR (2013) status categorisation, *Tor tor, Ompok pabda, Systomus sarana* and *Rhinomugil corsula* were listed in threatened categories (table 9). The IUCN status listed catfishes like *Wallago attu, O. pabda* and *O. bimaculatus* in the Near threatened (NT) category. The comparison with previous study conducted by CIFRI during 2013 showed absence of certain species especially the exotic fishes like *Cyprinus carpio* and also added some more species into the checklist.

The temporal and spatial variation in the catch composition was estimated during the study period. A higher catch was observed at the Sector C compared to other sectors, as the fishing effort was also higher in that sector. *T. tor* formed a comparatively good share of the catch in sector B and C during the monsoon season and was found almost absent during post-monsoon. The major carps like *L. rohita, L. catla* and *C. mrigala* contribute relatively more to the catch at all the sectors throughout the study period, except in sector B during post-monsoon season. In sector B, during the post-monsoon season the catch was mainly composed of small catfishes. The catfish species that mainly contributed to the catches are *O. pabda* and *Sperata seenghala*. The total catch in both seasons shows that the carps formed 75-85% of the catch, followed by catfishes. The giant freshwater prawn, *M. rossenbergii* was recorded in a very less quantity at sector C only during the post-monsoon season and was found totally absent in the catch during the other parts of the study period. The catches of feather backs (*Notopterus notopterus*) and spiny eels (*Mastacembelus armatus* and *Macrognathus pancalus*), which are a major inland fish resource were very less throughout the study period. The catch of large sized catfishes like *Wallago attu* were totally absent in the reservoir.

Fig. 225b. Consultation meeting with fisheries stakeholder at Gadher village beside Sardar Sarovar Reservoir on 30 May 2018

Project Tiltle	**:**	**Assessment and Impact study on biodiversity, eco-hydrology, fish population dynamics and livelihood of fishers in Narmada River with special focus on downstream of Sardar Sarovar Dam and Bhadbhut Reservoir**
Project Personnel	**:**	B. K. Das, S. Samanta, A. Pandit, G. Chandra, A. K. Sahoo, R. K. Raman, D. Bhakta, S. P. Kamble, Lohit Kumar, S. Som
Associates	**:**	S. K. Majumdar, D. Saha, A Roychowdhury, S. Saha, R. K. Tah and J. K. Solanki

The study was carried out with the objective to assess the present status of ecology and fisheries in the downstream of Sardar Sarova Dam (SSD). During post-monsoon season 34 species belonging to 20 families were reported from the downstream part of Sardar Sarovar dam and the relative abundance of the fish species above and below the proposed barrage was calculated. The fish species recorded from 5 stations *viz.,* Kevadiya, Garudeshwar, Sisodra, Jhanor and Bhadbhut station of downstream stretch composed of the freshwater fishes and also the migrant marine/estuarine fishes.

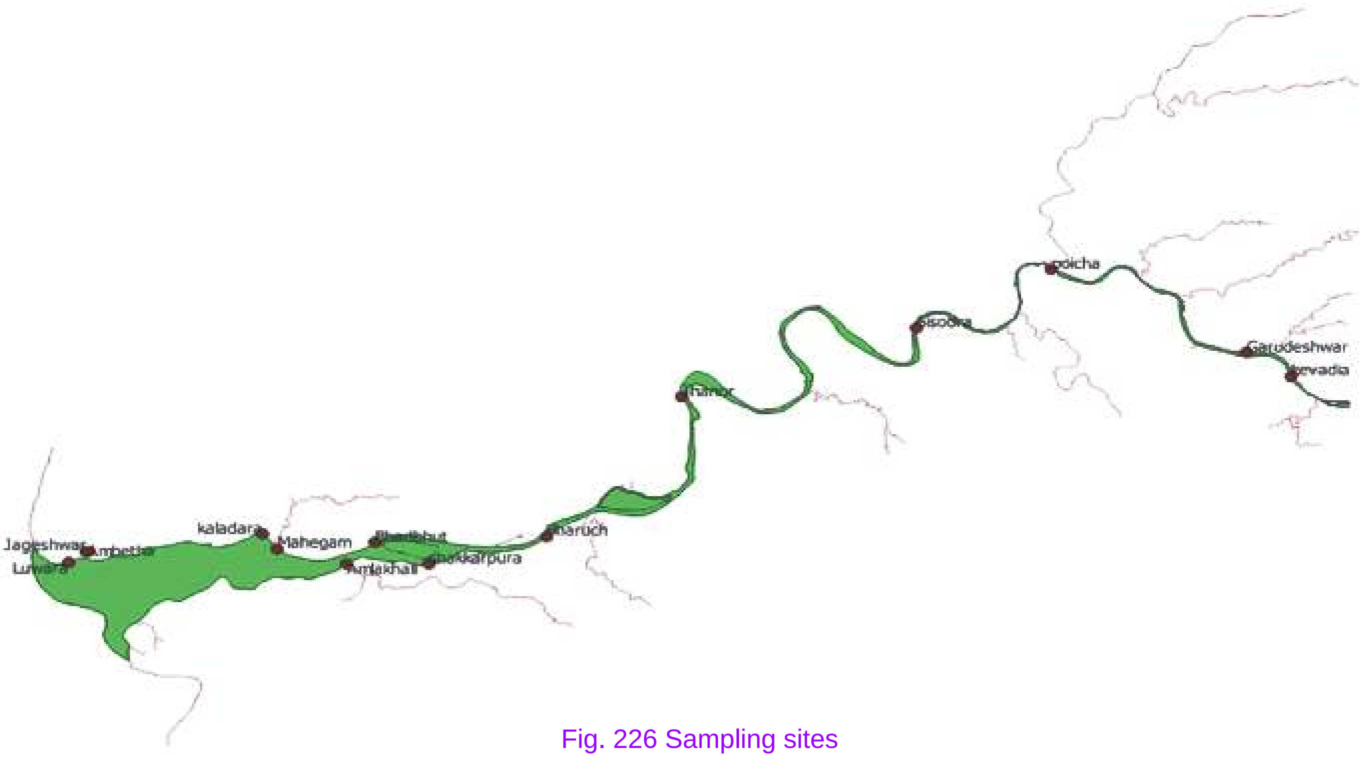


Fig. 226 Sampling sites

A total of 47 fish and shellfish species under 27 families and 11 orders were recorded during the lean period, comprising of 40 fin fishes, 3 crabs and 4 prawn species. During this sampling period out of 14 sampling stations, active fishing was observed only from 6 stations *viz.,* namely Sisodra, Jhanor, Bharuch, Bhadbhut, Mahegam and Jageshwar.

It has been observed that winter season had more fish species diversity with 59%. During post monsoon season about 21% of the species were recorded belonging to family Cyprinidae, followed by family Bagridae and during lean period, maximum number of species belonged to Gobidae family by 10% followed by Mugilidae and Cyprinidae.

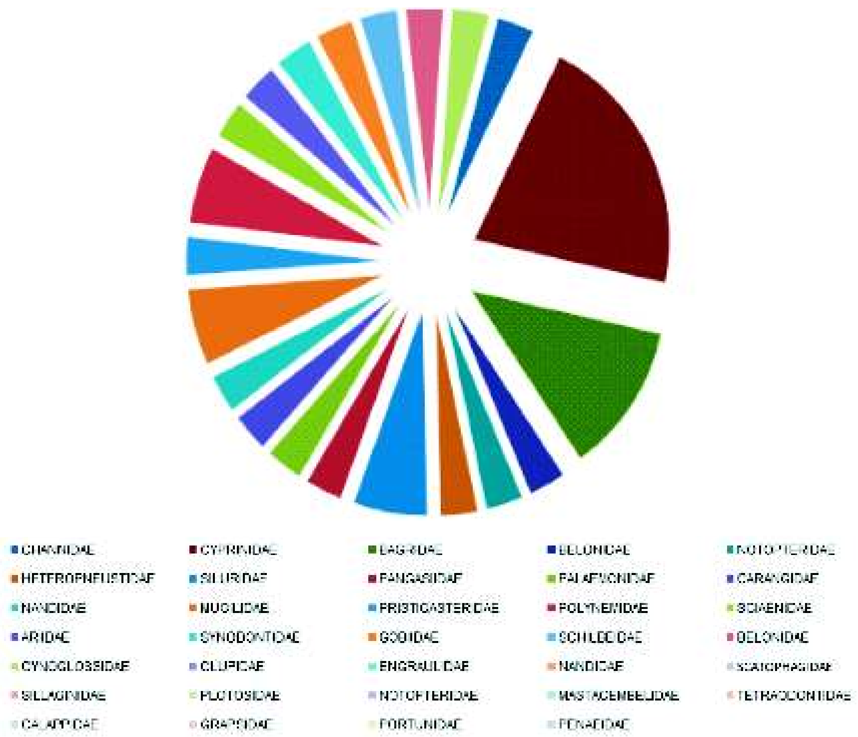


Fig. 227 Fish species abundance during post-monsoon season

Project Title : Status of fish diversity, abundance and population dynamics of tilapia in Halali reservoir, Madhya Pradesh for sustainable fisheries management

Project Personnel : B. K. Das, U. K. Sarkar, A. K. Das, S. Koushlesh and J. Canciyal

Quarterly samplings were carried out to assess the ecological parameters, fish diversity, catch pattern and the population dynamics of tilapia (*Oreochromis niloticus*) from different stations of Halali reservoir. The overall fish diversity of Halali reservoir consists of 15 fish species under 12 genera. Catch composition at Halali reservoir was dominated by Tilapia (*O. niloticus*) which contributed to more than 90% of the daily catch with major carps merely contributing 5-10%. Results of this study delineated

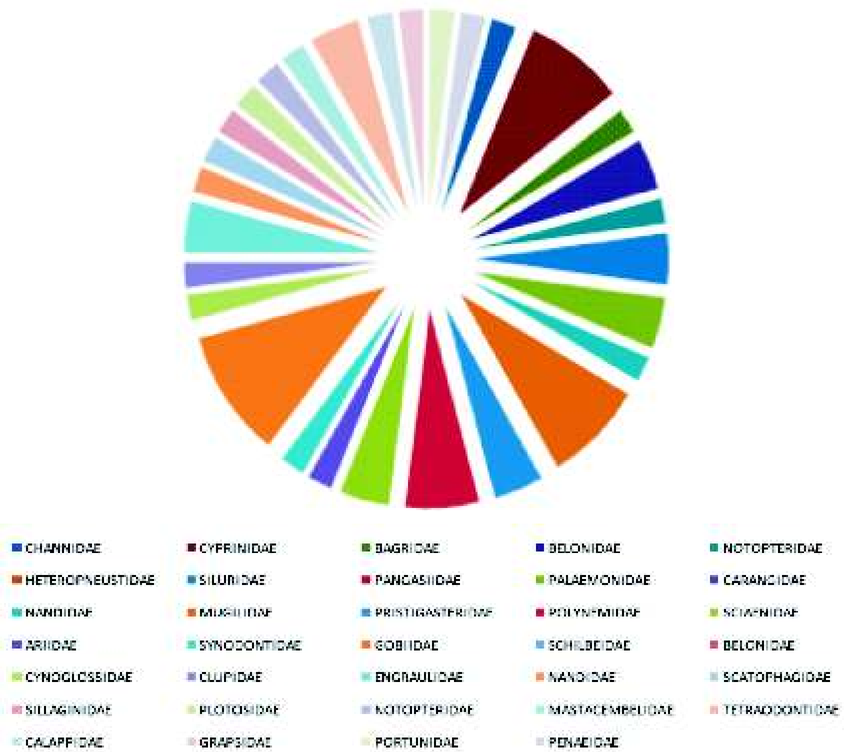


Fig. 228 Fish species abundance during lean season

Fig. 229 *Oreochromis niloticus* as a major finfish catch from Halali reservoir

increased abundance of tilapia species in the fishery and have now established feral population in the reservoir. The size of the tilapia fish ranged from 12 cm - 37.4 cm in length and 41 to 1048 g in weight. The length frequency distribution of landings reveals the higher relative abundance of larger size groups (25 cm TL and above) in the catches of Patra Nalah as compared to Halali dam site, indicating greater abundance of mature individuals. This can be attributed to higher level of detritus of allochthonous origin carried into the reservoir from Bhopal city and nearby areas. The introduction of tilapia in the reservoir had steadily enhanced the total landings conversely, a significant reduction in the catch per unit effort (CPUE) of other commercially important species was observed after the introduction of tilapia in the reservoir.

Project Title : Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar reservoir

Project Personnel : B. K. Das, U. K. Sarkar, A. K. Das, S. Koushlesh and J. Canciyal

Periodical samplings were conducted in Ahilya Ghat at Maheswar, Rajghat, Koteshwar and Narmada-Hathni river confluence at Kakrana region of Sardar Sarovar part of Madhya Pradesh to assess the present status of the ecology of fish habitat characteristics and fisheries status for the development of fisheries management strategies of Madhya Pradesh part of Sardar Sarovar Dam (SSD). A total of 37 fish species belonging to 28 genera, 14 families and seven orders have been recorded during the sampling period from the MP part of Sardar Sarovar reservoir. Commercially important large sized catfishes such as, *Sperata seenghala*, *S. aor, Rita rita* and the carp *Labeo calbasu* were observed to be dominating the fish catch in

Sardar Sarovar reservoir, contributing more than 80 % of the market landings along the selected stations except Kakrana. The catch composition at Narmada – Hathini confluence at Kakrana is dominated by SIFs (Small indigenous freshwater fish species) mainly *Salmostomata bacaila* which forms the major fishery at this station.

Fig. 230 Tribal fishers of Koteshwar Sardar Sarovar reservoir in M.P.

Project Title : **Assessment of impact of fly ash leakage on abiotic and biotic components of river Ganges due to force majeure of loaded barges**

Project Personnel : B. K. Das, S. Samanta, S. K. Das and S. K. Koushlesh

Associates : S. Chakraborty and K. Mondal

This short term project was undertaken with the following objectives :

- To assess the impact of incidental entry of fly ash from the associated barges on the water and sediment quality of the river Hooghly
- To assess the impact of such incidents on the biotic community including microorganism, plankton, benthic community and higher animals like fishes.

Fig. 231 Barge carrying fly ash through Indo-Bangladesh protocol route

Fig. 232 Experiment with 100% fly ash in *Labeo rohita* fingerlings

- To assess the advantages of water transportation of fly ashes through barges versus the associated risk of pollution in incidents due to force majeure

Field studies were conducted along the Indo-Bangladesh Protocol Route through the inland waterways at Budge Budge, Godakhali, Geokhali, Haldia and Hemnagar. The fly ash generated at the thermal power plants of Budge Budge, Haldia and Kolaghat are filled in the barges having capacity of 14000 tons at Budge Budge and Haldia and are transported to Bangladesh through the water ways protocol route. During the movement, the barges face different challenges and even meet with accident at unfavourable weather conditions and mismanagement. In some occasions, the ill-fated barges sink in the waterway which may even lead to leakage of the fly ash in water. To understand the impact of such accidental leakage in the aquatic system the study was conducted in the areas such as Godakhali and Hemnagar where such accident has taken place. It was observed that, since the study route is highly tide influenced and has vast expanse, the impact, if any of such one or two accidents and leakage of fly ash has little or no impact on the aquatic communities. Aquarium experiments with *Labeo rohita* fingerlings has shown that fly ash is creating minor impact on the fingerlings at even 100% replacement of sediment with fly ash. The study of heavy metal contents in fly ash exhibited presence of the metals like chromium, copper and nickel at the pollution level but since under accidental cases the amount of fly ash leakage may not be significant due to tidal and dilution effects, the overall impact of fly ash contamination is estimated to be low. However, some adverse effect (e.g., on plankton community) in the aquatic system is anticipated, which is obvious due to barge movement as has been recorded in the previous studies with the Inland Waterways Authority of India.

Project Title : Reservoir fish production enhancement and establishment of a GIS and Spatial Planning Cell in Odisha

Project Personnel : B. K. Das, B. P. Mohanty, A. K. Das, M. A. Hassan, B. K. Behera, S. K. Sahu, A. Roy, P. K. Parida, H. S. Swain

A collaborative project has been initiated by ICAR-CIFRI with Worldfish – Odisha for stocking and co-management of five selected reservoirs in Odisha based on primary productivity assessment. Further, capacity will be built for DoF and project staff on reservoir fisheries co-management, captive nursery fingerling production techniques, pen culture and cage culture and CIFRI Mobile App for reservoir data collection. In addition to that, establishment and operationalization of GIS and Spatial Planning cell in the Directorate of Fisheries, Cuttack. ICAR-CIFRI has conducted capacity building training programme on different aspects of cage culture and pen culture for the cooperative society members of PFCSs. Production enhancement strategies from reservoir were explained by the team of Scientists of ICAR-CIFRI to the officials of PFCS. A training programme on “GIS and Spatial Planning” was conducted during 18-20 February, 2019 at ICAR-CIFRI, Barrackpore. This three days training programme was attended by a total of nine officials including four women participants of Odisha Fisheries Department. This training programme has provided hands on experience of handling GPS, Google earth and QGIS. Also emphasis has been given on the process of creating point, line, polygon and thematic maps in QGIS. The process of integrating the information to the different types maps were also covered under the training. The process of exporting the required design of map was also covered in the training process.

Fig. 232a. Training on GIS & Spatial Planning for the Fisheries Official of Govt. of Odisha

Director, ICAR-CIFRI felicitating Hon'ble Minister of Fisheries, Tripura, Shri N. C. Debbarma

Interactive Workshop on Management of Openwater Fisheries at Agartala

Interactive workshop on 'Management of openwater fisheries' was organized in collaboration with Directorate of Fisheries, Department of Fisheries, Govt. of Tripura at Agartala, during 4-5 January, 2019. The objective of the workshop was to share vast work experiences and technologies of ICAR-CIFRI in managing and enhancing fisheries in larger waterbodies especially in reservoirs and wetlands of the country and the same being planned and implemented in the state. The major focus was on simple and low-cost technologies (such as pen and cage aquaculture) and guidelines (fish stock enhancement) that are to be popularized in Dumbur reservoir, large lakes, barrages, swampy areas and rivers for improving fish production. The workshop was graced by Shri Narendra Chandra Debbarma, Hon'ble Minister of Fisheries, Govt. of Tripura, Dr. B.K. Das, Director, ICAR-CIFRI, Barrackpore, Shri G.R. Das, TCS, Director of Fisheries, There were 40 participants including

Department Fisheries Officials, Professors of College of Fisheries, Lembucherra and Scientists from ICAR RC for NEH Region, Tripura Centre. Shri Rameshwar Das, IFS, Secretary (Fisheries), Govt. of Tripura urged the scientists and departmental officials for making cage aquaculture practice in Tripura a success. Many suggestions were made by the participants, to which ICAR-CIFRI, Barrackpore team assured all technical guidance to the DoF-GoT for development of aquaculture and fisheries through scientific stock enhancement and enclosure culture technologies in openwater resources of Tripura.

Interactive Workshop on Openwater Fisheries Management in NE Region at Guwahati

An interactive workshop on 'Openwater fisheries management in NE region was conducted during 12-13 February, 2019 at its Regional Centre, Guwahati. A total of 60 officials representing Directorate of Fisheries, Govt. of Assam, Meghalaya and Arunachal Pradesh; Assam Fisheries Development Corporation Ltd., Guwahati; FISHFED, Govt. of Assam; NFDB Northeast Regional Centre, Guwahati; NABARD Assam Regional Office, Guwahati and Scientists/Researchers of ICAR-CIFRI participated in the programme.

The workshop was graced by Dr. S. C. Pathak, Former Chief General Manager (CGM), NABARD Regional Office, Pune; Dr.UshaMoza, Former PS of Fisheries Division, ICAR, New Delhi; Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore, Mr. P. K. Hazarika (Project Director, AFDC Ltd., Guwahati), Mr. J. K. Samal (DGM, NABARD Regional Office, Guwahati) and Ms. Dipmala Roy (Officer In-charge, NFDB Regional Centre, Guwahati). Dr. B. K. Das explained the

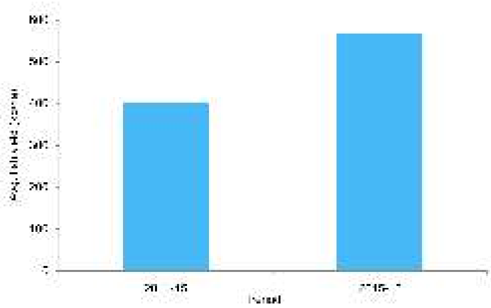
Dignitaries and participants of the Workshop held at Guwahati background and purpose of the workshop and stressed on the development of openwater fisheries in the region for increasing fish production on a sustainable manner. Dr. S. C. Pathak urged all the state fisheries departments of the region to work unitedly with the common goal of achieving self-sufficiency in fish production through concerted efforts of all R&D agencies. Dr.UshaMoza emphasized on the need for making the NE region self-sufficient in fish production by utilizing all available fisheries resources. In the technical session, Dr. B. K. Das discussed on the theme topic 'Role of ICAR-CIFRI in development of openwater fisheries resources of India'. Dr. B. K. Bhattacharjya, Mr. J. K. Samal of NABARD, Dr. B. Lahon of NFDB, Dr. S. Yengkokpam, Dr.Pronob Das and Mr. S. Borah of ICAR-CIFRI delivered lectures on different areas including Strategies for Scientific fishery management of openwater fisheries resources, Institutional finance, NFDB schemes, pen culture, cage culture and stock enhancement for openwaters, respectively.

Interactive Workshop on Openwater Fisheries Management of Manipur

An Interactive Workshop in collaboration with Directorate of Fisheries, Manipur on 'Openwater Fisheries Management of Manipur' was held at Imphal on 18 February, 2019. The major theme of the workshop was dissemination of the knowledge generated by ICAR-CIFRI for development of inland fisheries in the State of Manipur without compromising ecosystem and environmental sustainability. Fifty participants from the Department of Fisheries, Govt. of Manipur attended the programme. Dr. B. K. Das, Director, ICAR-CIFRI and Convenor of the workshop emphasised that the Department of Fisheries, Govt. of Manipur should look towards the diversification of fish species having local preferences. Shri

Dignitaries and participants of the Workshop held at Imphal

Khamsing Ahum, Additional Director of Fisheries, Govt. of Manipur urged his Departmental officials to take full advantage of the knowledge generated by ICAR-CIFRI on management of inland openwaters. The technical session consists of management of openwaters of India by ICAR-CIFRI, pen and cage aquaculture in NE and status of openwater fisheries resources of Manipur. In the valedictory session, Mrs. Bidyarani Ayekpam, Director of Fisheries, Govt. of Manipur thanked Dr. B.K. Das, Director, ICAR-CIFRI and all the scientists of the ICAR-CIFRI for organizing the workshop at Imphal and sought active collaboration and support in future endeavours of the Directorate of Fisheries, Govt. of Manipur.

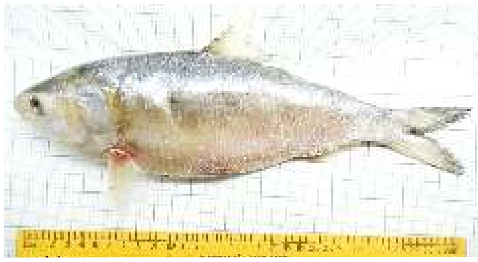


Average fish yield of Sorbhog beel before and after CIFRI intervention

Fish stock enhancement of Sorbhogbeel, Assam

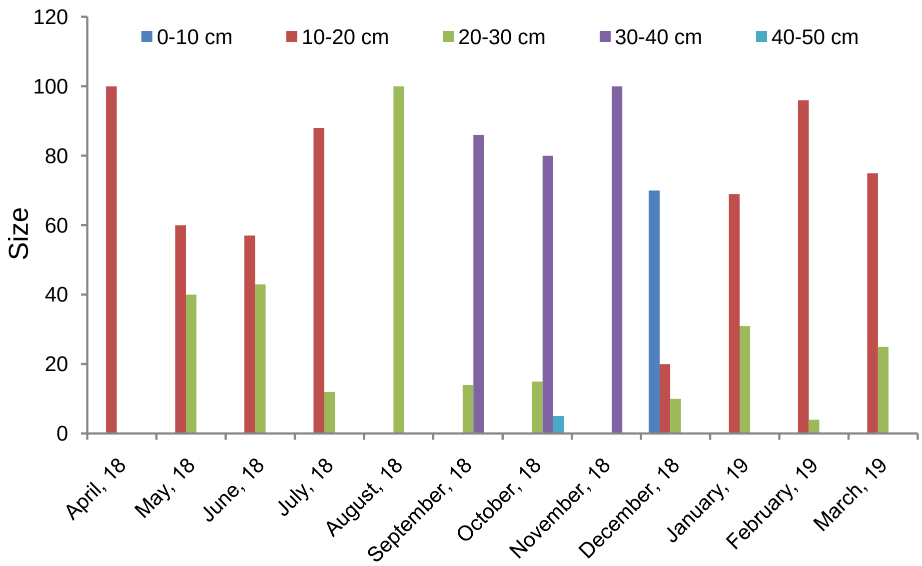
Fish stock enhancement programme was initiated by the Institute in Sorbhogbeel, Barpeta district of Assam in collaboration with Assam Fisheries Development Corporation Ltd., Guwahati under its NEH Component. With the intervention of ICAR-CIFRI, the fish production has increased by 41%, i.e. from 401 kg/ha in 2011-15 to 566 kg/ha in 2015-18 with supplementary stocking of 3,000 nos./ha.

Catch structure of *Tenualosa ilisha* at Dhubri landing centre of Brahmaputra River, Assam



Measuring length-weight of hilsa

ICAR-CIFRI analysed the catch structure of *Tenualosa ilisha* from Dhubri landing centre of River Brahmaputra in Assam during 2018-19. Analysis of 1293 specimens showed that the hilsafishery is constituted by specimens in the size range of 10-40 cm. Individuals in the size range of 10-20 cm dominated the catch during January to July, contributing 57-100% of the total samples of Hilsa examined at Dhubri landing centre, while during August, individuals in the size range of 20-30 cm dominated the total catch. During September to November, the catch was dominated by bigger sized individuals in the size range of 30-40, contributing 80-100% of the total samples examined during the period, which coincide with breeding season of the species in River Brahmaputra. In December, individuals of the size upto10 cm dominated the landings, contributing 60% of the samples examined.



Catch structure of *T. ilisha* at Dhubri landing centre of Brahmaputra River, Assam during 2018-19

Tribal Sub Plan

Scientist-fishers interaction

HDPE pen installed in Kalo reservoir of Odisha for *insitu* rearing of fish seed

ICAR-CIFRI is actively involved in tribal developments through fish production enhancement applying technologies. The Institute through its Headquarters and the regional centers are working in different states for uplift of tribal fishers. ICAR-CIFRI has taken up TSP activities in West Bengal (4 districts, 6 locations), Odisha (2 district, 3 locations), Kerala (1 location), Madhya Pradesh (one location) and Assam (one location), Meghalaya (one location), Arunachal Pradesh (one location), Karnataka (two location), Gujarat (one district 2 locations). A total of 3365 no of tribal fishers were benefitted through the initiatives. A total of 7 field demonstrations of pen culture and 12 demonstrations of production enhancement in different water

The details of the number of programmes and inputs provided are mentioned below.

Description	Quantity
Awareness programme on enhanced fisheries production	16 Nos.
Fishers-Scientist interaction	11 Nos.
Installation of Pen	7 Nos.
Distribution of fishing nets	270 Nos.
Capacity building trainings	7 Nos.
Distribution of feed	35 Tonnes
Distribution of lime	200 Kg
Distribution of fish seed	1,00,000 Nos.

Distribution of fishing nets to the triabl fishers of sagar by the Hon'ble MLA, Shri Bankim Chandra Hazra

Stocking of fish seed in the Pen of Gradanmari wetland

bodies (Wetland, check dam, canal, derelict water bodies and reservoirs) were carried out. A new initiative on Happa based culture of small indigenous fishes was started in this year to ensure the house hold nutritional security to the tribal families. For the 1st time, women centric development under TSP through promotion of fish farming in unutilized canals in Sundarban was given. ICAR-CIFRI has conducted mass awreness programmes in the unreachable area of Gosaba block of Sunderban, West Bengal and more than 600 Women were sensitized on ornamental fish farming. Scientists of ICAR-CIFRI also participated in a workshop on “Aquaculture as a Livelihoods option for Tribal development” at ICAR-CIFA, Bhubaneswar to demonstrate the livelihoods improvement activities carried out by ICAR-CIFRI for the tribal fishers.

Scheduled Caste Sub Plan

Scientist-fishers meet at Chamrdaha beel

Scheduled Caste Sub Plan (SCSP) programme has been started in the year 2018-19 in ICAR. Under this programme two flood plain wetlands (Beledanga and Chamardaha) have been identified in West Bengal for demonstration of fish production enhancement protocol. Two mass awareness programmes have been conducted to sensitize the SC fishers about the SCSP programme and integrated wetland management in these beels. Baseline information of these beels has been collected. Fishing implements, fish feed etc have been distributed among the members of the Primary Fishermen Co-operative Society in Chamardaha. In Amtoli (Gosaba), Sundarban, 75 nos. of FRP tanks have been distributed for ornamental fisheries development.

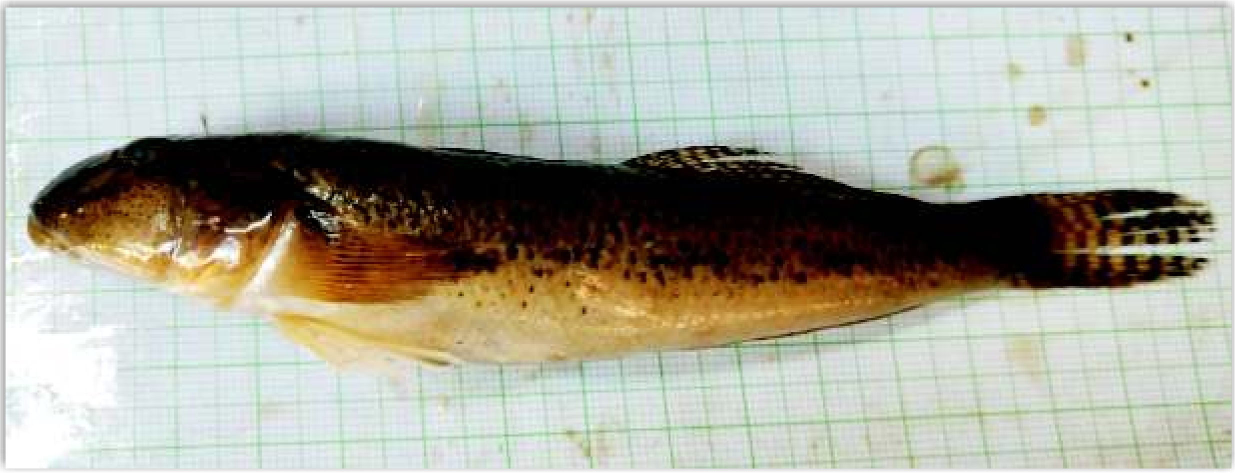
Mass awarness generation with the fishers of Chamardaha beel on integrated wetland managment

Awareness generation among the fishers of Beledanga wetland on Beel managment

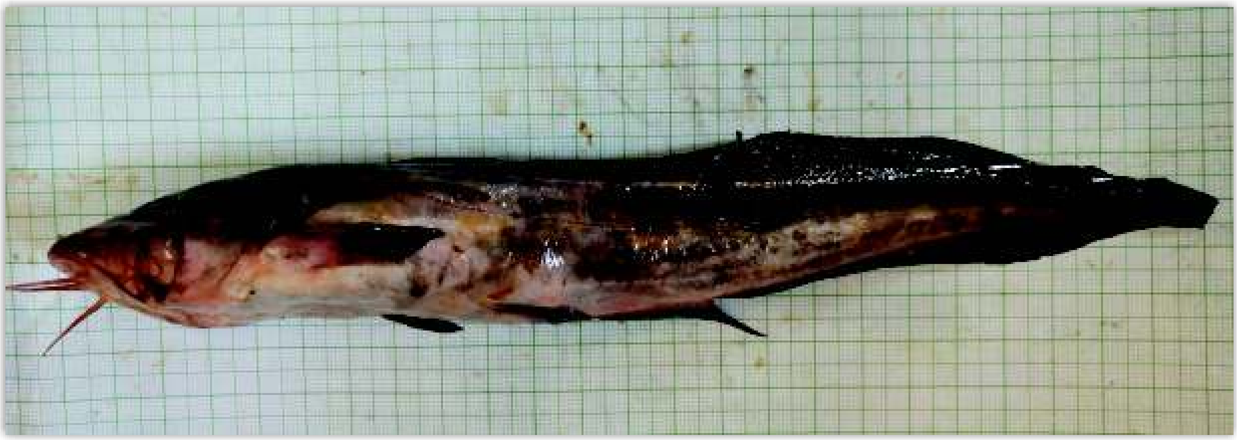
New Records of Fish Species from the Narmada River System

River Narmada, the fifth largest river in the country, is the largest (1312 km) west flowing river of India and harbors one of the richest aquatic biodiversity in Central India. During the winter sampling surveys conducted by ICAR – Central Inland Fisheries Research Institute (2018-19) on the impact of hydro-ecological changes on fisheries downstream of Sardar Sarovar Dam as per the SSNNL (Sardar Sarovar Narmada Nigam Limited) Consultancy Project, 48 fish species were recorded from the river stretch downstream of Sardar Sarovar Dam. Among the recorded fish diversity, ten species were reported for the first time from the Narmada river system which includes *Awaous grammepomus* (Bleeker 1849), *Parambassis lala* (Hamilton 1822), *Plotosus canius* (Hamilton 1822), *Takifugu oblongus* (Bloch 1786), *Thryssa stenosoma* (Wongratana 1983), *Caranx ignobilis* (Forsskal 1775), *Atule mate* (Cuvier 1833), *Antennarius indicus* (Schultz 1964), *Filimanus heptadactyla* (Cuvier 1829) and *Lethrinus nebulosus* (Forsskal 1775).

The scribbled goby (*A. grammepomus*) and the eel catfish (*P. canius*) were collected from the gill net catches at Sisodra (21^{o} 54' 44" N; 73^{o} 20' 47.2" E) and Jhanor (21^{o} 50' 19.82" N; 73^{o} 07' 48.16" E) respectively. The other eight species, viz., the slender thryssa (*Thryssa stenosoma*), highfin glassy perchlet (*Parambassis lala*), yellowtail scad (*Atule mate*), Indian frogfish (*Antennarius indicus*), seven finger threadfin (*Filimanus heptadactyla*), spangled emperor (*Lethrinus nebulosus*), giant trevally (*Caranx ignobilis*) and lattice blassop (*Takifugu oblongus*) were recorded from the catches of bag nets (locally known as 'golava' fishery) operated along the estuarine stretch of Narmada at Bhadbhut (21^{o} 23' 52.10" N; 72^{o} 50' 42.6" E).



Awaous grammepomus (Scribbled goby)



Plotosus canius (Eel catfish)

Thryssa stenosoma (Slender thryssa)

Antennarius indicus (Indian frogfish)

Takifugu oblongus (Lattice blassop)

Atule mate (Yellowtail scad)

Parambassis lala (Highfin glassy perchlet)

Lethrinus nebulosus (Spangled emperor)

Filimanus heptadactyla (Seven finger threadfin)

Caranx ignobilis (Giant trevally)

Marsupenaeus japonicus (Bate, 1888), has been reappeared in the estuarine catch of the Hooghly river.

First record of the pouched octopus, *Cistopus platinoidus* Sreeja, Norman and Biju Kumar 2015 from Narmada estuary

Octopuses, popularly known as 'devil fishes', are exclusively marine and benthic organisms with the normal inhabitance ranges from shallow intertidal zones up to abyssal depths of more than 5000 meters. About 10 specimens of *C. platinoidus* were collected from the estuarine zone of the Narmada at Bhadbhut in December 2018 from the catches of bag nets operated along the region (locally known as 'golava' fishing). The collected specimens had a mean total length of 236.8 mm with a range of 199.0 - 326.0 mm. This was the first record of an octopus specimen in an estuary or any inland waterbodies.

Cistopus platinoidus

Hilsa Ranching

Hilsa fish ranching was held as a part of the NMCG-Hilsa Phase II project for hilsa fisheries improvement in river Ganga to increase the natural stock of hilsa in the upstream of Farakka barrage with wild collected hilsa juveniles. A first ever hilsa ranching station has been also established by ICAR-CIFRI at the upstream of Farakka barrage on 24 January 2019. 151 Hilsa fishes with an average length of 468mm and with an average weight of 259 gm were ranched during the period December 2018 to March 2019.

Establishment of Aquatic Quarantine Facility in Eastern Zone of India

Lots of ornamental and other fishes are being exported abroad from Kolkata. For international compliance, the exported fishes have to be quarantine tested for OIE listed pathogens. ICAR-CIFRI has been already involved in quarantine testing of OIE listed pathogens for ornamental fishes. Realizing the importance, ICAR-CIFRI has initiated to establish a quarantine facility at the Headquarters in Barrackpore with the financial support from NFDB, Hyderabad.

Initiation of Farmer Participatory Programmes for Fish Production Enhancement of Wetlands in Bihar

Management of wetland fisheries and strengthening of the fisheries cooperatives/SHGs has been initiated by ICAR-CIFRI through establishment of Participatory/co-management regime with financial and knowledge empowerment of communities and stakeholders by creating sustainability fund and their capacity building for enhanced livelihood generation. ICAR-CIFRI technologies are applied for in-situ fish seed rearing and fisheries enhancement techniques for stock enhancement and enclosure cultures for the purpose of tapping the fish production potential of the wetlands in Bihar.

Breeding of Native Ornamental Fishes

Macrognathus pancalus and *Macrognathus aral* from West Bengal, *Channa stewarti* from Assam, and *Pethia manipurensis* from Manipur were bred for the first time under the Institute Networking project Breeding of Indigenous fish species of ornamental value from West Bengal and Assam (ICAR). Detailed studies of the breeding behaviour and other biological characteristics of the fishes were also conducted.

Fish Pass Establishment

ICAR-CIFRI has initiated a scientific investigation on the assessment and impact study on biodiversity, eco-hydrology, fish population dynamics and livelihood of fishers in river Narmada. Special emphasis has been provided on the downstream of Sardar Sarovar Dam and Bhadbhud reservoir. The main objective of the project is to assess the present status of ecology and fisheries in the downstream of Sardar Sarovar Dam, review the existing environmental flows from Sardar Sarovar Dam and to develop suitable methods for estimating environmental flow for sustainable fisheries, and to study the requirements of various clearances and its relevance to fisheries. In this regards, the Government of Gujarat in association with the scientific team members of CIFRI selected 15 sites for the study purpose representing the freshwater, estuarine water and marine environment.

AMR Study in ONE Platform

Antimicrobial resistance (AMR) has been identified as a global health issue with serious health and economical implications. Under the ONE health approach programme, India has a global commitment to combat AMR. Realizing the importance, ICAR in collaboration with FAO, New Delhi initiated the AMR activities in Fisheries and Aquaculture for the first time with the collaboration of ICAR - CIFRI.

Study of Fish Breeding Biology in High Altitude Fishes (under the auspices of Satluj Jal Vidyut Nigam Ltd.)

ICAR-CIFRI has initiated research nvertigation on the reproductive biology of rain-bow trout (*Oncorhynchus mykiss*) and snow trout (*Schizothorax sp.*) to understand the period of upstream breeding migration at the high altitude level of 1,600 m MSL. The importance of undertaking the study signifies the pattern of migration and the migratory path in river Ton, a tributary of river Yamuna for a sustainable fish population of the identified species in the light of upcoming hydro-power projects at high altitudes.

Feasibility Study of *Labeo bata* in Rain-fed Wetlands of Assam

Since *Labeo bata* is one of the commercially important minor carps having good consumer preference especially in Eastern part of India, a standard package-of-practice has been developed for culturing *Labeo bata* in cages in rain-fed wetlands of Assam as a new initiative. With a high price fish and a good market value of *L. bata*, the practice of cage aquaculture is still in its infancy in Northeast India. Two experiments were conducted to optimize stocking density of *L. bata* fingerlings in CIFRI-GI cages in Samaguribeel, a seasonally open floodplain wetland of Nagaon district, Assam, India to produce stocking material and marketable fish. The B-C ration obtained was 1.44.

Study of *Amblypharyngodon mola* as a candidate species for climate resilient pen culture along with IMC

An initiation for pen culture in hapas with *Amblypharyngodon mola* as a candidate species along with Indian Major Carps has been taken under the umbrella of an externally funded project of WorldFish at Beledanga wetland in North 24 Parganas district in West Bengal. This would serve as an excellent climate resilient small indigenous fish species for culture-based fisheries in inland fisheries.

Diversification of cage culture using pabda, *Barbonymus gonionotus*, *Puntius sarana* and *Etroplus suratensis*

A study was conducted to evaluate the feasibility of grow out farming of rohu for cage culture in different tropical reservoirs of India at three different agro-climatic condition; Salia reservoir, Odisha, Palair reservoir, Telengana and Kamath reservoir, Maharashtra, India. It was the first attempt to study the grow-out farming of rohu in inland open water cage culture and the result showed possibility of incorporation of rohu in inland cage culture along with species like pangasius and tilapia.

Clam culture in Lake Vembanad for Increasing Livelihood Option and Productivity

Successful demonstration of climate resilient pen structure for clam culture in Lake Vembanad in Kerala was carried out. The culture earned revenue of Rs. 26,300 from sales of clam meat and clam shell. In a very short payback period of one year, a benefit-cost ratio of 1.26 was obtained.

Scoping Study on Dry Fish Matters

A new programme on mapping the social economy of inland dried fish for enhanced well being and nutrition has been initiated by ICAR-CIFRI in collaboration with University of Manitoba, Canada.

Reservoir Fisheries Database

Designing the Reservoir Fisheries Database was the brainchild of the Dr. B. K. Das, Director of ICAR, CIFRI. We are all aware of the fact that Reservoirs are known as Sleeping Giants bears unexplored scope for manifold increase in Inland Fisheries Production. Keeping this in mind, ICAR-CIFRI has set up a Reservoir Fisheries Database on its website which contains the details of 108 reservoirs of different States of India. The information will assist to identify the potential reservoir resources and their holistic characteristics eventually aiding in framing the effective management plan, Budgetary requirements, fisheries enhancement and devise wise policies for water allocation to fisheries sector.

Fish Disease Mobile App

The Fish Disease App is an educative app designed by the ARIS Cell of ICAR-CIFRI. This mobile app can be downloaded in any android mobile from Google Playstore. The striking feature of this App is that it contains abundant information on diseases of freshwater fishes. The diseases have been etiologically categorized along with detailed medications to remove the diseases and methods for further prevention. This app will be immensely helpful for fish farmers to identify the disease and timely recovery.

Library Mini-Conference Room

An area of approximately 271sq. ft in the first floor of the Central Library of ICAR-CIFRI, Barrackpore has been modified as a Mini-Conference Room to facilitate intimate discussion on various research areas, new initiatives, brainstorming sessions etc. for CIFRI library users and other stakeholders. It is for the first time such an initiative has been undertaken for modernization of the Central Library with user-friendly scholastic features.

Extension Initiatives

The highest number of fishers and fish farmer (937 nos.) were trained this year for skill development programmes (20 nos. of training programmes) with the support of National Fisheries Development Board. This year has also witnessed a new initiative in the in-house training programmes within the purview of capacity enhancement of Skilled Support Staff of ICAR-CIFRI for their orientation training programmes to other ICAR institutes in West Bengal.

ICAR-CIFRI Pension Database and CIFRI Pension App

ICAR-CIFRI launched the ICAR-CIFRI Pension Database and CIFRI Pension App on 20th February, 2019. To bring about hassle free access to pension data at home itself, ICAR-CIFRI has devised an online platform for the same. The Pension Database was visualized and conceptualized by Dr. B. K. Das (Director, ICAR-CIFRI) and Shri NVRN Murty, Senior Finance and Accounts Officer. The database has been designed by Mr. Pratik Pathak, (Young Professional-II). All it requires the pensioner to know is his PPO

Complaint Management System

The Complaint Management System is an online portal developed by the ARIS Cell in ICAR-CIFRI. This portal acts as a complaint box for all IT related problems. CIFRI users can log into the portal for reporting any constraints faced by them in handling hardware and software. All complaints are checked regularly and immediate actions are taken to address the same.

Smart Door System at Office

ICAR-CIFRI has introduced the Smart Door System at its Headquarters at Barrackpore to prevent unauthorised entry of people into the CIFRI main building. Biometric authentication is being used as a form of identification and access control. Finger scanning which is the digital version of the ink and paper fingerprinting process is being utilised in patterns of raised areas and branches in a human finger image. Only after recognising the authorising person's finger impression the smart door will open. This is a milestone towards the Digitalisation and enhanced security in the Institute.

Sensor-based Light for Energy Saving

In order to curb the huge electricity consumption in the Institute, ICAR-CIFRI has introduced sensor based lights. This is a stepping stone to reduce the power consumption. The lighting control sensors control the automatic lighting mainly using two mechanisms- Presence Detection and Absence Detection. These lights remain active after detection of movements and also ensures the appropriate level of light is provided at the right time giving satisfactory user experience. This initiative has greatly reduced the expenditure on electricity consumption and is an eco-friendly mechanism.

Systematic Inventorization of Institute File Movements

The random assigning of file numbers had long been a source of confusion in the file movements in the Institute. In fact the ISO auditor had also suggested for a complete change over in the system. Hence after much deliberation, under the able guidance of the Competent Authority, a completely new file numbering system has been developed. This new file numbering system indicates brief subject, unique number, year, concerned Section/Cell/Division/Centre etc. Implementation of this innovative idea of using Section/Cell/Division specific colour code for file numbering has resulted in smoother file transmission with almost zero scope of misplacing them.

State	Resource	Activities
Assam	**River**	? Investigation on habitat characterization, fisheries, estimation of environmental flow and socioeconomics of River Siang ? Exploratory surveys were conducted in floodplain wetlands of Assam for ecological assessment in relation to climate change. ? Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in 47-Morakolong beel in Assam ? Forecasting of Hilsa catch in River Brahmaputra
	Wetland	? Rearing of *Labeo bata* in CIFRI-GI Cages as a winter crop in Samaguri beel, Assam ? Arsenic contamination at Morigaon ? Risk assessment of Tilapia ? Initiation of breeding of indigenous fish species of ornamental value ? Pen culture under TSP Scheme at Goalpara District ? Road map for fisheries development in Assam ? Fish disease Surveillance has been conducted in four districts ? Ornamental fish exploratory survey in Dhemaji District ? AMR exploratory survey
Arunachal Pradesh	**River**	? Investigation on habitat characterization, fisheries, environmental flow and socioeconomics of River Siang ? Capacity building of the officials of the Dept. of Fisheries, Govt. of Arunachal Pradesh
	Wetland	? Selected wetland in Namsai district for pen culture ? Road map for fisheries development in Arunachal Pradesh in collaboration with NABARD ? NMHS project on Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers
Andaman & Nicobar Islands	**Mud volcano** **Inland Aquatic Resources**	? Identification of bacterial diversity ? Providing guidelines for the productivity enhancement of inland open water fisheries
Meghalaya	**Wetland**	? Ecological profiling of Boro, Katuli and Kumligaon wetlands ? Pen culture demonstration under TSP in Tura district ? Road map for fisheries development in Meghalaya ? Capacity building and brain storming session of the officials of the Dept. of Fisheries, Govt. of Meghalaya ? NMHS project on Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers

State	Resource	Activities
Tripura	**Reservoir**	? Fisheries survey in Dumbur reservoir ? Capacity Building Workshop on inland fisheries development organized ? Development of guidelines for enclosure culture in the state and productivity enhancement in the state ? Road map for fisheries development in Tripura
Sikkim	**Wetland**	? Road map for fisheries development in Sikkim ? Held Capacity Building Workshop
Manipur	**Wetland**	? Evaluation of pen culture technology in Loktak Lake and Takmupat Lake developed by ICAR-CIFRI ? Ecological profiling of Takmu Pat ? Provided guidelines for the productivity enhancement of inland open water fisheries of Loktak Lake ? Farmer awareness programme organized ? Development of guidelines for renovation and reinstallation of existing pen structure in Loktak Lake ? Road map for fisheries development in Manipur ? NMHS project on Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India
West Bengal	**River**	? Investigation on emerging contaminants in river Torsa and associated wetlands and their effect on selected biota ? Nutrigenomic studies on hilsa from the rivers Hooghly and Padma ? Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan ? Breeding of wild fish germ plasm and ranching in depleted stretches of river Ganga ? Assessment of efficacy of fish passes provided across Teesta Low Dam Stage III and IV power stations
	Canal	? Exploratory survey and study of Bishalakhi canal in Sagar Island and Bhetkimari canal in Madangunj in Sundarbans studied for fisheries development with local stake holders participation.
	Wetland	? Study of the emerging contaminants in East Kolkata Wetlands and their effect on selected biota ? Exploratory surveys in four floodplain wetlands for ecological assessment in relation to climate change. ? Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising are being conducted in Mathura and Bhomra beels ? Arsenic contamination in Khalsi and Chandania ? Disease investigations in Khalsi, East Kolkata and Moyna wetlands ? AMR exploratory survey ? Ornamental fish exploratory survey ? Road map for fisheries development in West Bengal
	Estuary	? Spatial characterization of commercial landings of Hilsa in Hooghly-Matlah estuary
	Pond	? Arsenic contamination in three ponds of Nadia district

State	Resource	Activities
Jharkhand	**Reservoir**	? Demonstration of Electronic Data Acquisition System (e-DAS) for fish catch data collection from reservoirs (at Patratu Dam site) ? Evaluation of cage culture technology developed by ICAR-CIFRI ? Efficacy of floating feed CIFRI-CAGEGROW was tested in a farmer's cage installed in Chandil reservoir. ? Fish disease investigations in Patratu, Tenughat, Chandil and Getulsud reservoirs ? Road map for fisheries development in Jharkhand
Bihar	**River**	? Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan
	Wetland	? Fisheries development in Kararia, Majharia, Rulhi, Sirsa and Kothia wetlands of Motihari region through empowerment of communities and stake holders participation for improved livelihood opportunity and capacity building ? Study of Arsenic contamination at Hajipur and Patna ? Road map for fisheries development in Bihar
	Reservoir	? Assessment of ecological and fisheries status of Jargo reservoir
Odisha	**River**	? Assessment of pollution, water and sediment qualities and fisheries status in river Kathajodi ? Estimation of environmental flows in river Kathajodi
	Reservoir	? Assessment of ecological and fisheries status and the trophic state index (TSI), fish production potential, and impact of fish seed stocking on yield were also assessed of Derjang, Salia, Kalo reservoirs ? Evaluation of cage culture technology developed by ICAR-CIFRI ? Technical guidance on cage culture in Salia dam ? Tribal Sub Plan activities with distribution of inputs. Training to the fishers in Kalo reservoir ? Circular cage installation in Hirakud reservoir ? Road map for fisheries development in Odisha
	Wetland	? Pen installation
Madhya Pradesh	**River**	? Investigation on habitat characterization, fisheries and socioeconomics of River Tapti
	Wetland	? Resource assessment and pen culture in Loni wetland situated in Rewa district
	Reservoir	? Status of fish diversity, abundance and population dynamics of tilapia in Halali reservoir, Madhya Pradesh for sustainable fisheries management ? Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of Sardar Sarovar reservoir
Chhattisgarh	**Reservoir**	? Evaluation of cage culture technology developed by ICAR-CIFRI
Himachal Pradesh	**Reservoir**	? Demonstration of cage culture technologies in Pong and Govindsagar reservoirs
Punjab	**Canal**	? Exploratory survey of one canal in Sirhind in Punjab for fisheries development for last one year

State	Resource	Activities
Gujarat	River	? Investigation on habitat characterization, fisheries and socio-economics of River Tapti ? Investigation on habitat characterization, fisheries and socio-economics of River Narmada
	Reservoir	? Cage culture activity in different reservoirs ? Pen culture under TSP ? Impact assessment of hydro ecological changes on fisheries and socio economy of fisheries downstream of Sardar Sarovar Dam in Narmada Basin
	Reservoir	? Evaluation of cage culture technology developed by ICAR-CIFRI in Pench and Bor reservoirs ? Disease investigations in Pench and Bor reservoirs
Telangana	Reservoir	? Collaborative cage culture programmes with DoF ? Fish Disease investigations in Sriramasagar reservoir ? Implementation of E-matsya for fish catch data collection ? Total waterbody productivity enhancement ? Road map for fisheries development in Telangana
Tamil Nadu	River	? Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	? Assessment of ecological and fisheries status in Mettur reservoir, Krishnagiri. ? Implementation of Electronic Data Acquisition System (e-DAS) for fish catch data acquisition
Karnataka	River	? Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	? Habitat characteristics and fish assemblage of Harangi reservoir ? Study on Potential Fishery Zones in medium and large reservoirs using hydroacoustics in Krishnarajasagar (KRS) reservoir
	Wetland	? Exploratory surveys in wetlands of Karnataka for ecological assessment in relation to climate change
Kerala	River	? Investigation on habitat characterization, fisheries and socioeconomics of River Cauvery
	Reservoir	? Assessment of ecological and fisheries status of Mangalam reservoir
	Wetland	? Study on impact of climate change in inland fisheries and development of adaptation strategies in Vemanand lake ? Pen culture activities initiated with the installation of three pens in Thycauttuserry and Muhamma in the Alleppy District ? Exploratory surveys conducted in coastal backwaters for ecological assessment in relation to climate change ? Demonstration of Climate Resilient Pen Systems (CRPS) for fish raising in Vembanad lake

ICAR-CIFRI in Disaster Assessment

Assessment of Flood Impact on Mainstream Ecology and Fisheries of Rivers Periyar and Pampa, Kerala

Continuous occurrence of high intensity rainfall in the state of Kerala beginning on 15 August 2018 through 26 August 2018 resulted in the condition of extreme floods in the state. In this connection, ICAR – CIFRI had conducted a rapid assessment study about the flood impact on mainstream ecology and fisheries of rivers Periyar and Pampa in Kerala.

Major impacts in around river Periyar

- Periyar river was tremendously affected due to the flood. The habitat of the river underwent drastic changes on a large scale, especially in the upper stretches, where the channel got widened at few stretches. Bank erosion, damage to riparian vegetation, sediment dispersal and accumulation of debris at scales beyond possible immediate management interventions. The incessant rains, massive flood and landslides caused 10 to 95 % change/ damage to shoreline habitats in the stations studied along the Periyar river.

- The analysis of physico-chemical parameters indicated variations from pre flood status as reported by former workers. Conductivity and TDS were the major water quality parameters that were altered by floods. Pre-flood scenario indicated that the lower and middle stretch exhibited conductivity of 29.4 µS/cm to 31.6 µS and 33.6 µS/cm to 45.8 µS/cm. After the flood, conductivity increased two folds.

- BOD increased three-folds post flood, which pointed out accumulation of biodegradable organic matter in the river water and classified as moderately polluted.

- Comparative analysis of plankton diversity recorded in present study with the earlier reports indicated severe loss in diversity of phytoplankton.

- Opening of dams caused escapement of stocked fish species in reservoirs, viz., Indian Major Carps (*Labeo catla*, *L. rohita* and *Cirrhinus mrigala*) into the rivers. Several fishermen reported increased catches of the Indian major carps immediately after floods. These species are not original germplasm of the river.

- Flooding of fish culture farms, ponds and aquarium establishments resulted in dispersal of cultured and non-native species like *Pangasianodon hypophthalmus* (Striped catfish), *Piaractus brachypomus* (red belly; pacu), *Clarias gariepinus* (African catfish), *Oreochromis mossambicus*, *O. niloticus*, which were recorded in the present study. Species like the *Ctenopharyngodon idella* (Grass carp), *Arapaima gigas* (arapaima), *Atractosteus spatula* (alligator gar), arowana, giant gourami, *Helostoma temminckii* (kissing gourami), koi carp, *Carassius auratus* (gold fish) and sucker catfish *Pterygoplichthys* spp. also escaped in to the river. If established in the natural ecosystem, these exotic fishes may compete with the indigenous fish species for space, food and other resources. Carnivorous species like the alligator gar and African catfish would predate on the native fish species.

- Post flood, fishermen reported a sharp decline in the several commonly available native fishes in their catches.

- Loss incurred by fishers owing to loss of fishing gear ranged from Rs. 15000 to 25000/fisher along the river with maximum loss along the upper stretches of the river. Livelihood loss ranged from Rs. 7000 to 15000/fisher along the river. Similarly fishers suffered loss due to damage to infrastructure ranged from Rs. 20000 to 50000/ fisher.

Major Impacts in and around river Pampa

- The incessant rains, massive flood and landslides caused 10 to 90 % change/ damage to shoreline habitats in the stations studied along the Pampa river.

- Post flood the water quality parameters of river Pampa showed transitory effects, which were more pronounced along the lower stretches.

- The pre-flood neutral to acidic property of water shifted towards alkaline conditions throughout the river stretch post flood.

- Alkalinity and salinity were almost twice higher than the pre flood scenario, though the values were within the ranges required for fish survival and growth.

- Decreased conductivity and increased dissolved oxygen are also the major changes observed post flood.

- Sand deposits recorded along the upper stretches of the river, while clay deposits at heights up to 2 m on the river banks were recorded along the middle and lower stretches, apparently washed down from the upper stretch.

- The river course shifted post flood at Aranmula from 9° 19' 58?N, 76° 41' 50?E to 9° 19' 59? N, 76° 41' 50? E, i.e, around 30 m towards right bank.

- An increase in occurrence of exotic fish species in the river system was recorded (3.3 % pre flood to 15.6 % post flood) raising a threat to the endemic fish fauna and biodiversity of the river.

- Exotic fish species previously recorded were *Cyprinus carpio* and *Clarias gariepinus*; the flood brought in *Piaractus brachypomus, Pangasianodon hypophthalmus, C gariepinus, Oreochromis niloticus* and *O. mossambicus* also in to the river, apparently from holdings along the catchments.

- The common indigenous fishes like *Heteropneustes fossilis, Horabagrus brachysoma, Labeo dussumieri* and *Wallago attu*, which were abundant before flood, became rare in catches post floods while large quantities of *Oreochromis niloticus, P. hypophthalmus* and *P. brachypomus* started appearing in catches. More than 500 kg each of *P. brachypomus* and *P. hypophthalmus* were landed immediate post flood.

- The loss and damage to fishing implements caused financial loss of Rs. 10000-50000/fisher along the river.

- Fishers income decreased from pre to post flood period. The average income was around Rs. 1000/day which has declined to less than Rs. 250/day.

Demonstration & Transfer of Technology

Climate resilient Pen for clam culture in Vembanad Lake, Kerala

The clam culture was done at Thycattussery area and Clams collected from the wild (Paathiramannal) were segregated and stocked at the rate of 5000 nos/ sq.m. It yielded a production of 2000 kg from the pen, earing revenue of Rs. 26,300 from sale of clam meat and clam shells. Thus, in a very short payback period of one year, benefit cost ratio of 1.26 was obtained.

Pen culture as climate resilient technology for beel fishers of Assam

A demonstration of pen culture as a climate resilient technology for wetland (beel) fishers in 47-Morakolong beel, Morigaon district, Assam has been undertaken. Five pens of 100 m^2 area each (10 m x

10 m) were constructed and stocked with seeds of Indian major carps *Labeo catla, Labeo rohita* and *Cirrhinus mrigala* along with small indigenous fish species (SIFs) such as *Amblypharyngodon mola, Gudusia chapra* and *Puntius sophore*. Harvesting programme was conducted in October, 2018 with active involvement of about 50 members of fishers co-operative society. An interactive meeting was also organized on 'Pen culture as a climate resilient technology for beel' in which Dr. Bhattacharjya, Acting Head, Guwahati Centre, explained the purpose and the preliminary results of pen culture demonstration. Dr. U. K. Sarkar emphasized that pen culture could potentially be a suitable climate-resilient technology for generating additional income and livelihood for beel fishers, especially during closed fishing season. The technology would help the fishers for augmenting production in natural water bodies and their livelihood.

Demonstration of pen culture at Harangi reservoir, Karnataka (under Tribal Sub Plan)

Demonstration and mass awareness programme on pen culture for fingerling raising at Harangi reservoir, Karnataka were organized for tribal fishermen under the Tribal Sub Plan (TSP) on 24 January 2019. The species stocked were *Labeo catla* and *Labeo rohita* in the reservoir. The pen structure (0.1 ha) installed in Harangi reservoir, the first of its kind in Karnataka will mainly be used for raising fry to fingerlings. The fingerlings, after attaining the size of about 100 mm will be used for stocking in the reservoir. About 80 fishermen of the Cauvery Fishermen Cooperative Society attended the demonstration programme, besides officials from Department of Fisheries, Govt. of Karnataka.

Cage and Pen culture Demonstration (under TSP)

Vadodara Regional research centre of ICAR-CIFRI successfully organised demonstration programme of cage and pen culture for fingerlings raising for tribal fishermen of Movi and Boridra village of Narmada district at Karjan Reservoir on 06 January, 2019 under Tribal Sub plan (TSP). During demonstration, advance fry of IMC were stocked in 0.2 ha CIFRI HDPE Pen, and in four number of cages. The Pen structure installed in Karjan reservoir is the first of its kind in Gujarat. The species stocked were *Labeo catla, Labeo rohita* and *Cirrhinus mrigala*. The Fishermen were demonstrated stocking management in cage and pen culture.,From transportation of fish seeds to acclimatization of fish seeds till their release. They were also provided awareness on feeding, water quality and health management in cage and pen culture for fingerling raising. Fifty tribal fishermen of the cooperative society attended the demonstration programme.

Awards and Recognitions

- The Institute Hindi magazine 'Nilanjali' was awarded the first prize of the "Ganesh Shankar Vidyarthi Hindi Griha Patrika" Puraskar for the year 2016-17 by the Indian Council of Agricultural Research, New Delhi on 16 July 2018.
- Dr. B. K. Das, Director was awarded Fellow of The National academy of Agricultural Sciences (NAAS) in the year 2019.
- Dr. B. P. Mohanty was recognized as a Jury Member in the 4th India International Science Festival at Lucknow during 3 - 6 October 2018.
- Dr. B. K. Bhattacharjya, Principal Scientist was recognized as Member, Technical Expert Committee of Assam Fisheries Development Corporation Ltd., Guwahati to render technical advice to the Corporation.
- Dr. Arun Pandit received the best oral presentation award for the paper 'Factors affecting economic vulnerability of the fishers' households of floodplain wetlands' in the national seminar on "Integrated farming system for enhancing farmers' income and nutritional security" organized by the Indian Society of Extension Education, New Delhi and West Bengal University of Animal and Fishery Sciences, Kolkata on 05-07 December, 2018.

- Dr. Arun Pandit and his team was assigned the task of presenting the Achievements of the Institute for the period 1958 to 1967. The team performed the task on 25.01.2019 and got the first prize among 7 groups.
- Shri N.V.R.N. Murty, SFAO received awards under the ICAR Cash Award Scheme 2017 for administrative category for his efficient management of finance and audit in the institute.
- Dr. R. K. Raman received Young Scientist Award in the International Conference on “Rural Livelihood Improvement by Enhancing Farmers Income through Sustainable Innovative Agriculture and Allied Enterprises".
- Dr. R. K. Raman received the Best Oral Presentation Award at BIT, Patna for the paper “Investigation on fisheries of flood plain wetlands for livelihood support and sustainable ecology case study Ansupa lake, Odisha, India.”
- Dr. R. K. Raman received the Best Paper Award from the *Indian Society of Agricultural Statistics, New Delhi, Pusa for the paper 'A comparative study of various classification techniques in multivariate skew normal data'.*
- Ms. Chayna Jana received third prize in Hindi poster presentation *Ã&fQ'k ¼Ã&eNyh½ cktkj & ekfRL;dh dh u;h fn'kk* in Hindi Workshop on 16 March 2019.

- Ms. Supriti Bayen received 3rd best poster presentation award in the one-day workshop on Þtìfodkikt u e vrLFkyh; ekfRL;dh dh Hkfedkß on 16 March 2019 at ICAR-CIFRI, Barrackpore.
- Dr. R. K. Manna and team got 2nd prize in the decadal presentation of ICAR-CIFRI, Barrackpore, on the occasion of 'History of Central Inland Fisheries Research Institute' on 25 January 2019.
- Dr. V. R. Suresh acted as a Member, RAC meeting of ICAR-CIARI, Port Blair during 6-7 July 2018.
- Dr. V. R. Suresh acted as a Member, Institute Management Committee meeting of ICAR-CIBA on 3 September 2018.
- Dr. V. R. Suresh acted as a Member, Advisory Committee of NASF Project at Viswabharati University on 18-19 February 2019.
- Dr. R. K. Manna represented ICAR-CIFRI in the Meeting of the 'Parliamentary Standing Committee on Water Resources' for evaluation of 'Namami Gange' program at Hotel Taj Bengal.
- Dr. A. K. Sahoo, as a Representative of ICAR - CIFRI, acted as a member of EAC, River valley projects, MoEFC, New Delhi.
- Dr. A. K. Sahoo, as a Representative of ICAR - CIFRI, acted as a member in the Guideline development for longitudinal connectivity, CWC, MoWRRD & GR.
- Mr. Raju Baitha was awarded the Ph.D. degree by ICAR-Central Institute of Fisheries Education, Deemed University, Mumbai on 4 December 2018.
- Mr. K. Lohith Kumar has been designated as “National Facilitator” by CCS-National Institute of Agricultural Marketing, Jaipur.
- Dr. U. K. Sarkar was nominated by the DG, ICAR as a member of the Institute Management Committee of ICAR-NBFGR, Lucknow.
- Dr. U. K. Sarkar was nominated as advisory committee member of UGC - SAP programme of the Department of Zoology, Guru Nanak Dev University, Amritsar.
- Dr. U. K. Sarkar was nominated by the Vice Chancellor, BCKV as external expert and reviewed DSIR funded research project at BCKVV, Kalyani.
- Dr. U. K. Sarkar was nominated as selection committee member of the DPC, ICAR-CRIJAF.
- Dr. U. K. Sarkar was nominated to attend the brainstorming meeting on Fisheries Informatics on NFDB and BOBP project proposals held at NFDB, Hyderabad.
- Dr. U. K. Sarkar delivered invited talk on climate change on inland fisheries in a workshop held at University of Kalyani, West Bengal.
- Dr. U. K. Sarkar delivered invited talk in Fisheries Conclave organized by CII at Kolkata.
- Dr. A. K. Das was nominated by Vice Chancellors of PAU, WBUAFS, VidyaSagar University and ICAR-CIFE as external examiner.
- Dr. A. K. Das acted as DDG's nominee in Scientists Assessment Committee meeting (CAS) of ICAR-CIFE, Mumbai.
- Dr. M. A. Hassan was nominated for meeting with Dept. of Fisheries, Andaman Nicobar Islands for Fisheries development, A&N islands.
- Dr. M. A. Hassan, Dr. A. K. Das and Mr. H. S. Swain were nominated for attending meeting with WorldFish at Odisha.

- Dr. A. Sinha was nominated as member of selection committee, RAU, Samatispur, Bihar, ICAR-CIFE, Mumbai and CAU, Lembucherra.
- Ms. Suman Kumari, Scientist was awarded PhD degree in Fisheries Resource Management from ICAR - CIFE, Mumbai.
- Dr. Suman Kumari received certificate of appreciation from IUCN as speaker during “Sustainable Agriscape for Future: State Level Experience Sharing and Consultation workshop” on 29 March 2019 at Patna, Bihar.
- Dr. A. K. Das and Dr. P. K. Parida visited WorldFish, Dhaka, Bangladesh during 22 - 28 October 2018 for exposure on small scale fisheries achievements by WorldFish, Bangaldesh.
- Dr. Soma Das Sarkar delivered lecture as a key note speaker on River Health Monitoring in International Conference on River Health Assessment to Restoration at IIT – BHU, Varanasi, Uttar Pradesh on 16.02.2019.
- Dr. Soma Das Sarkar, Scientist got first prize for her paper presentation in one day workshop onþthfodkikt u e vrLFkyh; ekfRL;dh dh Hkfedkß on 16 March 2019 at ICAR-CIFRI, Barrackpore.
- Dr. Sona Yengkokpam got second prize for her poster presentation in one day workshop onþthfodkikt u e vrLFkyh; ekfRL;dh dh Hkfedkß on 16 March 2019 at ICAR-CIFRI, Barrackpore.
- Dr. Aparna Roy was conferred Young Scientist Award 2018 by Indian Society of Extension Education at ISEE National Seminar-2018 at WBUA & FS, Kolkata.
- Scientist of the year award was given to Dr. (Mrs.) Kalpna Shrivastava of Allahabad Centre of ICAR – CIFRI, by Kalas Research and Welfare society, Prayagraj (U.P).
- Dr. Ajoy Saha won the best oral presentation award (Third Prize) in one day workshop on þthfodkikt u e vrLFkyh; ekfRL;dh dh Hkfedkß on 16 March 2019 at ICAR-CIFRI, Barrackpore.
- Dr. R. Palaniswamy received best poster award for NICRA workshop held at ICAR-CIFRI, Barrackpore on 'Climate Change Impact on Inland Open Water Fisheries: Status and Way Forward' on 15 March 2019.
- Ms. Thankam Theresa Paul, Scientist of Kochi Centre was conferred Ph.D. degree in Fishery Resource Management on 27 November 2018 by ICAR-CIFE, Mumbai.
- Ms. Piyashi DebRoy has been selected as a National Facilitator of CCS National Institute of Agricultural Marketing (A Government of India autonomous organization under the Ministry of Agriculture and Farmers Welfare) from 5 December 2018.
- Ms. Piyashi DebRoy has been awarded with Ph.D. Degree on 21 January 2019 at ICAR – Central Institute of Fisheries Education, Mumbai.
- Dr. Sona Yengkokpam got the best oral presentation award for her paper on “Standardization of stocking density of *Labeo bata* in cage aquaculture in Samaguri beel, Assam, India” at 31 All India Congress of Zoology at CAU, Imphal organized by the Zoological Society of India, Bodh Gaya.
- Dr. Thankam Theresa Paul received the best poster presentation award in ICAR-CIFRI NICRA workshop on “Climate Change Impact on Inland Open Water Fisheries: Status and Way Forward” organized by ICAR-CIFRI, Barrackpore and Inland Fisheries Society of India. Dr. S. Yengkokpam, Sr. Scientist and her team (D. Debnath, B. K. Bhattacharjya, U. K. Sarkar and B. K. Das) also awarded the 3rd prize for the poster on 'Pen aquaculture as a climate-resilient technology for beel fishers of Assam' in the said workshop.

- Dr. Dipesh Debnath was recognized as the External Member in the Board of Undergraduate Studies in Life Science of Assam University, Silchar to render technical advice on fisheries and aquaculture in Northeast.
- Mr. Simanku Borah was recognized as the Expert member of Department of Fisheries, Govt. of Assam for providing technical guidance on establishment of a fisheries laboratory at Directorate of Fisheries, Assam.
- Ms. Nabanita Chakraborty obtained 3rd position in a national science writing competition : 'Augmenting Writing Skills for Articulating Research' organized by Vigyan Prasar, Dept. of Science & Technology, Govt. of India.

The following awards were declared in the Institute Foundation Day on 17 March 2019.

Award		Awardee
• Division/Section/Unit/Centre of the year	:	FREM Division, ICAR-CIFRI
• Scientist of the Year	:	Dr. B. K. Behera, Pr. Scientist
• Technical Staff of the Year	:	Dr. Sanjay Bhowmick, CTO
• Administrative Staff of the Year	:	Shri N. V. R. N. Murthy,SF & AO
• Supporting Staff of the Year	:	Shri Amar Nath Prasad, SSS
• Scholar(s) of the Year	:	Shri Abhishek Das & Shri Ajay Kumar Raut

Training & Capacity Building

Farmers' Training at the Institute (Sponsored by DoF, Bihar)

Sl. No.	Training Title	Venue	Participants	Duration
1	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	27 (26+1) nos. farmers from Sheikhpura, Bihar (DoF)	11-17/05/18
2	Hands on training programme "Cage culture techniques in reservoirs"	CIFRI, H.Q. Barrackpore	40 fishers/ fish farmers	16-17/05/18
3	Training on fisheries management in wetlands	CIFRI, H.Q. Barrackpore	35 nos. farmers of Bihar	18-22/06/18
4	fcgkj d vkæ{k=k ¼>hy] pkj ,o eu½ e ekfRL;dh çcèku	East Champaran, Bihar	78 fishers/ fish farmers	18-22/06/18
5	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	25 (24+1) nos. farmers from Nawada, Bihar (DoF)	06-12/09/18
6	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	31 (30+1) nos. farmers from Rohtas, Bihar (DoF)	13-19/09/18
7	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	30 (29+1) nos. farmers from Sitamarhi, Bihar (DoF)	22-28/09/18
8	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	31 (30+1) nos. farmers from Bhagalpur, Bihar (DoF)	25-31/10/18
9	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	25 (24+1) nos. farmers from Jamui, Bihar (DoF)	28/11/18 - 04/12/18
10	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	30 (29+1) nos. farmers from Khagaria, Bihar (DoF)	07/12/18 - 13/12/18
11	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	31 (30+1) nos. farmers from Seikhpura, Bihar (DoF)	05-11/01/19

Farmers Training (Sponsored by ATMA)

Sl. No.	Title of the training	Venue	Participants	Duration
1	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	(20+1) 21 nos. farmers from ATMA, Kumargram Block, Alipurduar	31/03/18 to 04/04/18
2	Inland open water fisheries management & development	CIFRI, H.Q. Barrackpore	(22+1) 23 nos. farmers from ATMA, Raghunathgunj	25-27/09/18
3	Inland open water fisheries management & development	Bangalore Centre, ICAR-CIFRI	35 nos. farmers along with officials from Agricultural Technology Management Agency (ATMA), Vanaparthy, Telangana state	27/03/19

Skill Development of Farmers (NFDB Sponsored)

Sl. No.	Title of the training	Participants	Venue	Duration
1.	Culture Based Fisheries for Improving Livelihood of Inland Fishers	50 farmers	CIFRI, H.Q. Barrackpore	09-11/07/18
2.	Conservation and Culture of Small Indigenous Fishes for Livelihood and Nutritional Security	50 farmers	CIFRI, H.Q. Barrackpore	02-04/08/18
3.	Canal Fisheries Development for Income Generation of Fishers	52 farmers	CIFRI, H.Q. Barrackpore & Namkhana, Sundarbans, West Bengal	17-19/08/18
4.	Enclosure Culture for Doubling Fishers' Income	50 farmers	A.P.M.C. Hall, Vadodara	21-23/08/18
5.	Reservoir Fisheries Management for employment generation	50 farmers	ICAR-CIFRI, Bangalore	10-12/10/18
6.	Inland fisheries management for livelihood improvement	50 farmers	Allahabad	22-24/10/18
7.	Inland fisheries management for livelihood improvement"	38 fishers	ATIC Hall, CMFRI campus, Kochi	14-16/11/18
8.	Small Indigenous fish culture and conservation for livelihood and nutritional security".	50 farmers from Sunderban, Hingalgunj	CIFRI, H.Q. Barrackpore	18-20/11/18
9.	'Beel fisheries management for livelihood improvement'	50 fishers	ICAR-CIFRI Regional Centre, HOUSEFED Complex, Dispur, Guwahati	13-15/12/18
10.	Inland ornamental fisheries management for income generation'	50 fishers	ICAR-CIFRI Regional Centre, HOUSEFED Complex, Dispur, Guwahati	10-12/12/18
11.	Inland Fisheries Management for Livelihood Improvement	42 farmers from Kochukhali, Sunderban.	CIFRI, H.Q. Barrackpore	21-23/01/19
12.	Reservoir Fisheries Management for Employment Generation	50 farmers	Krishnagiri, Tamil Nadu during.	05-07/02/19
13.	'Fisheries management in Maun for doubling fisher's income' inaugurated	50 farmers	Kothia maun, East Champaran, Bihar.	13-15/02/19
14.	Upcoming fishers for developing their skills in augmenting fish production and to enhance their livelihood income	50 farmers	CIFRI Kochi Centre	20-22/02/19
15.	Enclosure Culture for Doubling Fishers' Income	50 farmers	ICAR-CIFRI, Vadodara	28/02/2019 - 02/03/2019
16.	Inland Fisheries Management for Employment Generation	50 farmers	ICAR-CIFRI, Allahabad, U.P.	28/02/2019 - 02/03/2019
17.	Canal Fisheries Development for Income Generation of Fishers	50 farmers	CIFRI, H.Q. Barrackpore	06-08/03/19
18.	Conservation and Culture of Small Indigenous Fishes for Livelihood and Nutritional Security	50 farmers	Namkhana, Sundarban	12-14/3/19
19.	Inland ornamental fisheries management for income generation'	50 farmers	CIFRI, H.Q. Barrackpore	15-17/3/19
20.	Inland Fisheries Management for Employment Generation	50 farmers	Sargachi, Murshidabad	27-30/3/19

Technology Transfer and Training

Title	Venue	Duration	No. of participants
Training of Trainers programme on "Reservoir Fisheries Management for Employment Generation"	ICAR-CIFRI, Bangalore	25/02/18-01/03/18	16
Training of Trainers programme on "Reservoir Fisheries Management for Employment Generation"	ICAR-CIFRI, Bangalore	27-31/08/18	20
Skill Development Programme on "Reservoir Fisheries Management for Employment Generation"	Averahalli, Bangalore, Karnataka	10-12/10/18	50
Reservoir Fisheries Management through Culture based Fisheries, Pen culture and Cage culture	CIFRI, H.Q. Barrackpore (in collaboration with Odisha-World Fish and Odisha State Fisheries Department)	13-18/12/18	92
Skill Development Programme on "Reservoir Fisheries Management for Employment Generation"	Krishnagiri, Tamilnadu	05-07/02/19	50
Demonstration of CIFRI HDPE PEN under TSP	Loni Wetland	14/02/19	40
Enclosure culture in wetland under TSP	Loni Wetland	21-23/02/19	40

Students Training

Sl. No.	Title of the training	Venue	Participants	Date
1	Fish Disease & Ornamental Fish Breeding	CIFRI, H.Q. Barrackpore	25 nos. B. Sc. (Industrial Fish & Fisheries) Student from S. K. Mahila College, Begusarai, Bihar.	03-06/04/18
2	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	24 nos. of M.Sc. Students from Vinoba Bhabe University, Hazaribag.	01-10/05/18
3	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	34 nos. of M.Sc. Students from P. K. Roy Memorial College, Dhanbad, Jharkhand.	19-26/05/18
4	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	24 nos. of B.Sc. (Ag.) Students from BHU, Varanasi.	08-15/06/18
5	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	8 nos. of M.Sc. Students from CIFE.	28/08/18-11/09/18
6	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	35 nos. of B.Sc. (IFF) Students from A.P.C. College, New Barrackpore.	29/10/18-04/11/18
7	Inland Fisheries Management	Bangalore centre, ICAR - CIFRI	10 Post Graduate students of Shivaji University, Kohlapur	04/02/19
8	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	44 nos. B. Sc. (FFM) Students from Ramnagar College, Purba Medinipur.	12-18/02/19

Training of Officials

Sl. No.	Title of the training	Venue	Participants	Date
1	Inland Fisheries Management	CIFRI, H.Q. Barrackpore	26 nos. of Officials from DoF, Chhattisgarh	09-13/04/18

NFDB Sponsored Training for Officials

Sl. No.	Title of the training	Venue	Participants	Date
1	Beel Fisheries Management for Livelihood Improvement	ICAR-CIFRI Regional Centre, Guwahati, Assam	26 Officers from various states	06-10/08/2018
2	Field Level Diagnosis of Inland Fish Diseases for Doubling Farmers' Income	CIFRI, H.Q. Barrackpore	25 Officers from various states	20-24/08/2018
3	Enclosure Culture (Cage and Pen) for Inland Fisheries Management (Training of Trainers)	CIFRI, H.Q. Barrackpore	23 Officers from various states	27-31/08/2018
4	Reservoir Fisheries Management for Employment Generation	ICAR-NBAIR Auditorium, Hebbal, Bangalore	20 Officers from various states	27-31/08/2018
5	Culture-based fisheries for improving livelihood of inland fishers (Training of Trainers)	CIFRI, H.Q. Barrackpore	20 Officers from various states	08-12/10/2018
6	Inland ornamental fisheries management for income generation'	ICAR-CIFRI, Guwahati	25 Officers from various states	17-21/12/2018
7	Reservoir Fisheries Management for Employment Generation	ICAR-NBAIR Auditorium, Hebbal, Bangalore	16 Officers from various states	25/02/19-01/03/19

Exposure visits to CIFRI

Sl. No.	Particulars of visitors	Date of visit	Purpose
1	9 nos. of M.Sc. Students & 1 Teacher from Sidhu Kanhu Birsha University, Purulia.	11/05/18	Educational visit
2	29 nos. of fish farmers from Manipur, Sponsored by NFDB, Hyderabad.	02/06/18	Exposure visit
3	25 nos. of trainees from Inland Fisheries Management Centre (I.F.T.C.), Manipur.	11/07/18	Exposure visit
4	22 nos. of Msc. Zoology Students & 1 Teacher from Andhra Fisheries College. .	16/07/18	Educational visit
5	31 nos. of Msc. Zoology Students & 1 Teacher from Vidyasagar University, Medinipur.	18/08/18	Educational visit
6	18 nos. of farmers from Karbi Anglong, Assam.	13-15/09/18	Exposure visit
7	22 nos. of students & 1 Teacher from Panthnanagr University.	11-14/10/18	Educational visit
8	33 nos. of students from CoF Mangalore.	13/11/18	Educational visit
9	48 nos. of trainees from freshwater fisheries & research centre (FFRTC), Kulia, Kalyani, Nadia.	27/11/18	Exposure visit
10	28 nos. of B.F.Sc. students & 3 nos. of Teachers from CoF, Ratnagiri.	04/12/18	Educational visit
11	47 nos. trainees (fishers) from Kamarhati.	06/12/18	Exposure visit
12	20 nos. of B.F.Sc final year students from CoF, Panagaad, Kerala.	18/12/18	Educational visit
13	50 nos. students & 14 nos. teachers from Kidzee, Barrackpore.	21/12/18	Educational visit
14	15 nos. of B.F.Sc. Students from CoF GADVASU, Ludhiana.	07/01/19	Educational visit
15	27 nos.of B.F.Sc. Students from CoF, Lembucherra, Tripura.	08/01/19	Educational visit
16	25 nos. of trainees from Directorate of Horticulture, Govt. of Odisha.	09/01/19	Exposure visit
17	40 nos. of H.S. students (Geography) from Sodepur Sushil Krishna Sikshayatan for Girls, Sodepur.	14/01/19	Educational visit
18	27 nos. students from College of Basic Science and Humanities, OUAT, BBSR.	15-17/01/19	Educational visit
19	13 nos. of B.Sc. (Zoology) students & 2 Teachers from Jawaharlal Neheru College, Boko, Assam.	16/01/19	Educational visit
20	12 nos. of B.Sc. (Ag.) students & 2 nos. of staff (Associate Professor) from CoF Kyrdemkulai, Meghalaya.	17/01/18	Educational visit
21	28 nos. students from West Bengal University of Animal & Fishery Science.	28-31/01/18	Educational visit
22	108 nos. (Class VII) students from St. Stephen's School from Habra.	11/02/19	Educational visit
23	74 nos. progressive farmers from Odisha, Dhenkanal.	15/02/19	Exposure visit
24	108 nos. students from Barrackpore Girls' High School.	16/02/19	Educational visit
25	17 nos. students from Sovarani Memorial College, Jagatballavpur, Howrah.	01/03/19	Educational visit
26	25 nos. DoF Officials trainees from TFTI, Udaipur, Tripura.	04/03/19	Exposure visit
27	45 nos. ASCI trainees "Aquaclinics & Aqua Entrepreneurship Development' sponsored by NFDB of ICAR CIFE, Saltlakt City, Kolkata.	07/03/19	Exposure visit
28	27 nos. students from Anundrom Borooah Academy Degree College, Barpeta, Assam.	11/03/19	Educational visit

Workshops/Seminars conducted by the Institute

Sl. No.	Seminar/Symposium/Workshop/Training	Date	Venue
1	1st National Training on "Advanced Analytical Tools - Gas Chromatography Mass Spectrometry".	28/05/18 - 01/06/18	ICAR-CIFRI, Barrackpore.
2	A Proteomics Workshop (named Barrackpore Proteomics Workshop, BPW)	27/06/18 - 02/07/18	ICAR-CIFRI, Barrackpore.
3	Work Shop on "Catch Per Unit Effort (CPUE) and Data Collection	30/07/2018	ICAR-CIFRI, Barrackpore.
4	A one day workshop on "Application of Biosensor Technology in Inland Fisheries".	01/08/18	ICAR-CIFRI, Barrackpore.
5	Interactive Seminar on "User Awareness Programme Oxford Journals and how to Publish with Oxford University Press" under CeRa consortium.	10/09/18	ICAR-CIFRI, Barrackpore.
6	Workshop on "Metagenomics in Fisheries Research.	01-02/12/18	ICAR-CIFRI, Barrackpore.
7	Interactive Workshop on 'Openwater Fisheries Management of Manipur' in collaboration with Directorate of Fisheries, Department of Fisheries, Govt. of Manipur at Imphal, Manipur	18/02/19	Imphal, Manipur
8	Interactive workshop on 'Open water fisheries management in NE region'.	12-13/02/19	Regional Centre, Guwahati
9	Workshop on Climate Change Impact on Inland Open Water Fisheries: Status and Way Forward.	15/03/19	ICAR-CIFRI, Barrackpore.

Training received by the staff members of the Institute as part of the human resources development initiative

Sl. No.	Events/Training	Venue	Period	Participant(s)
1	1st Barrackpore Proteomics Workshop	ICAR-CIFRI, Barrackpore	27/06/18-02/07/18	Prajna R. Behera
2	Advanced statistical methods and computational software for fisheries research and management	ICAR-CIFT, Kochi	17-26/07/18	Deepa Sudheesan
3	Application of Biosensor Technology in Inland Fisheries	ICAR-CIFRI, Barrackpore	01/08/18	Prajna R. Behera
4	Concept building and basic statistics in Inland fisheries management	ICAR-CIFRI, Barrackpore	03-10/08/18	Sibina Mol S, Piyashi DebRoy, R.K.Manna, Satish Kumar Koushlesh, P. Gogoi, Suman Kumari, Dibakar Bhakta
5	Competence Enhancement programme on soft skills personality development	ICAR- NAARM, Hyderabad	18-27/09/18	Mr. Vijaykumar, M.E.
6	Modeling of Aquatic Ecosystem using ECOPATH with ECOSIM	ICAR-CIFRI, Barrackpore	24-29/09/18	Soma Das Sarkar, K Lohith Kumar, Satish Kumar, Suman Kumari Koushlesh, T.N. Chanu, P. Gogoi, Lianthuamluaia, Dibakar Bhakta
7	Inland fish taxonomy and biodiversity	ICAR-CIFRI, Barrackpore	09-12/10/18	Sibina Mol S, K Lohith Kumar, Suman Kumari
8	CAFT Training on Recent Advance in Agriculture Bioinformatics: Big Data Analytics Perspectives	ICAR-IASRI, New Delhi	14/11/18-04/12/18	V. L. Ramya
9	FAO-ATLASS training on Antimicrobial resistance tools	ICAR-CIFT, Kochi	21-25/01/19	A. K. Sahoo

Training Programmes conducted by ICAR – CIFRI for HRD

Sl. No.	Tentative Areas of Training	Participants	Tentative Period	Venue	Co-ordinator(s)
1.	1st National Training on Advanced Analytical Tools-GC-MS	4	28/05/18 – 01/06/18	ICAR-CIFRI, Barrackpore	Dr. B. P. Mohanty
2.	1st Barrackpore Protemics Workshop	3	27/06/18 – 02/07/18	ICAR-CIFRI, Barrackpore	Dr. B. P. Mohanty
3.	Concept Building and Basic Statistical Analysis for Inland Fisheries Management	7	03-10/08/18	ICAR-CIFRI, Barrackpore	Dr. M. Naskar & Dr. R. K. Raman
4.	Advanced training on sediment and water quality assessment for managing sustainable fisheries in inland open waters	12	27/08/18 – 01/09/18	ICAR-CIFRI, Barrackpore	Dr. S. K. Nag
5.	Application of ECOPATH with ECOSIM for Assessing Inland Fisheries	7	24-29/09/18	ICAR-CIFRI, Barrackpore	Dr. Firoz Khan/ Dr. PreethaPanikkar
6.	Inland Fish Taxonomy and Biodiversity	6	09-12/10/18	ICAR-CIFRI, Barrackpore	Mr. Roshith C. M. Mr. S. Koushlesh
7.	GIS for Inland Fisheries Sector	6	26-30/11/18	ICAR-CIFRI, Barrackpore	Mr. S. K. Sahu
8.	"Orientation Programme for newly recruited technical assistants (T3)"	3	22/11/18 – 16/01/19	ICAR-CIFRI, Barrackpore	Mr. Roshith C. M.
9.	Capacity Building in MS Excel and PowerPoint Presentation for Skill Development'	20	15-16/01/19	ICAR-CIFRI, Barrackpore	Dr. R. K. Raman

Sl. No.	Date	Particulars	Place
1	13-19/04/18	Krishi Unnati Mela- 2018	Motihari, Bihar.
2	16-18/05/18	International Symposium on Aquaculture and Fisheries Education (ISAFE3).	ICAR-CIFE
3	03-07/06/18	9th Krishi Fair, 2018, Organised by Shree Shrikshetra Soochana.	Puri
4	29-30/06/18	Agri Vikas - 2018	Bhubaneswar
5	13/07/18	Rotary Club of Bhubaneswar Royal (One day Exhibition cum Rural Fair on different facets of Agriculture & allied aspects for improving rural economy at Hirapur Village).	Bhubaneswar
6	26-29/07/18	6th Indian National Exhibition cum Fair 2018.	Patuli, Kolkata.
7	03-06/08/18	22nd National Agriculture Exhibition, Organised by Central Calcutta Science & Culture Organisation for Youth.	Nimta, Kolkata.
8	06/08/18	22nd National Agriculture Exhibition	New Barrackpore
9	25/10/18	World Food Day & 60th Foundation Day of OKS organised by Orissa Krusshak Samaj.	Bhubaneswar.
10	22/11/18	Livestock cum Agricultural Mela organised By ICAR-NDRI.	Ayodhya, Purulia.
11	20-29/12/18	23rd Sunderban Kristi Mela O Likosanskriti Utsav-2018 organised by Kultali Millon Tirtha Society.	Kultali, 24 Pgs (S)
12	22-31/12/18	Sunderban Yuba Mela organised by Taldi Bahurpee Sangha.	Taldi, 24 Pgs (S)
13	24-31/12/18	'Naihati Utsav' organised by Naihati Utsav Welfare Samity.	Naihati Railway Maidan.
14	28-29/12/18	7th Annual General Body Meeting of Odisha Fisheries Service Association (OFSA).	Bhubaneswar.
15	28-31/12/18	Krishi Samridhi Mela Cum National Workshop on IFS.	RKMA, Sargachi.
16	05-07/01/19	Mathsya Mela-2019 organized by Department of Fisheries, Government of Karnataka	Sindhanur, Raichur District, Karnataka
17	7-13/01/19	Gramin Krishi Mela organised by Madhakhali Ektarpur Self Helf Farmers Society.	Purba Medinipur.
18	15-16/01/19	Zoological Congress organised by ZSI, Bodhgaya & CoF, Lembuchera.	Lembuchera, Tripura.
19	15-18/01/19	Bajarpur Gramin Prodarshani O Mela organised by Alukaranbarh Seva Sangha.	Purba Medinipur.
20	18-22/01/19	Vibrant Gujarat Global Trade Show	Mahatma Mandir, Gandhinagar, Gujarat
21	23-25/01/19	World Brackishwater Aquaculture Conference Organised by SCAF & CIBA.	Chennai.
22	09-11/02/19	'Agri Summit-2019'	Motihari, Bihar.
23	14-16/02/19	Technology week & District Krishi Mela organized by Sashyashyamala Krishi Vigyan Kendra, Sonarpur under RKMVERI, Belur.	Sonarpur 24 Pgs (S)
24	20-23/02/19	XIV Science Congress Innovations for Agricultural Transformation organized by NAAS & ICAR-IARI.	New Delhi, NASC Complex.
25	26-28/02/19	Eastern Zone Regional Agricultural Fair (RAF)	OUAT, Bhubaneswar.
26	02-04/03/19	Costal Agri Expo-2019 organized by ICAR-CCARI. Participated by ICAR-CIFRI Centre, Bengaluru, facilitated by E&T Cell, Barrackpore	Old Goa.
27	17/03/19	NMCG pavilion during Krishi Samriddhi Mela and 73rd CIFRI Foundation Day	ICAR-CIFRI, Barrackpore

Ongoing Projects

Institute Projects

Sr. No.	Project code	Project title
1	REF/17-20/07	Habitat characterization, fisheries and socio -economics of rivers Cauvery, Tapti, Siang and Chaliyar
2	REF/17-20/08	Exploration of canal resources of Punjab and Sundarbans (WB) for fisheries development
3	REF/17-20/09	Investigation on environmental flows in rivers Kathajodi, Siang and Tamas tributary of Ganga
4	REF/17-20/10	Impact of major tributaries and wetlands on biodiversity and ecological function of river Ganga
5	RWF/17-20/05	Resource assessment and refinement of fisheries management plans through co-management in selected floodplain wetlands of different eco-regions
6	RWF/17-20/06	Fisheries resource assessment and refinement of enhancement protocol through participatory mode in selected reservoirs of India
7	RWF/17-20/07	Assessment and validation of potential fishing zones in medium and large reservoirs using hydro-acoustics
8	RWF/17-20/08	Studies on exploitation of insects as feed and food
9	RWF/17-20/09	Diversification of fish species for enclosure culture in reservoir and wetlands
10	FREM/17-20/11	Pollution benchmarking and monitoring of rivers Kathajori and Godavari
11	FREM/17-20/12	Emerging contaminants in rivers (Teesta, Torsa) and East Kolkata Wetland and their effect on selected biota
12	FREM/17-20/13	EIA and mitigation of Arsenicosis as a serious environmental challenge with special reference to fish and fishery resources
13	FREM/17-20/14	Fish health management and antimicrobial resistance in inland open waters
14	FREM/17-20/15	Application of statistical tools for assessing inland fishery resources
15	FSE/17-20/03	Impact assessment of CIFRI technologies (cage and pen culture) and training
16	OR/ER/18-19/02	Outreach project : Fish genetic stocks
17	nil	Network project on Antimicrobial Resistance (AMR) in fisheries and aquaculture
18	nil	Breeding of indigenous fish species of ornamental value from West Bengal and Assam (ICAR)

Externally Funded Projects

Sl. No	Project title	Funding agency
1.	Impact of climate change in inland fisheries and development of adaptation strategies (NICRA)	DARE, Ministry of Agriculture
2.	National surveillance programme for aquatic animal diseases	NFDB-NSPAAD
3.	All India Network Project on Fish Health	ICAR- CIBA
4.	Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan	Namami Gange programme
5.	Development of standard protocols and molecular tools for fish food authentication for food safety and quality assurance	FSSAI
6.	Fisheries development in Majhariamaun of Bihar through refinement of site specific fisheries enhancement technology – an innovative project	DAHD&F
7.	Fisheries development in Sirsa wetland of Bihar through in-situ fish feed rearing and fisheries enhancement techniques for tapping fish production potential – an innovative project	DAHD&F
8.	Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholder participation for capacity building and improved livelihood – an innovative project	DAHD&F
9.	Fisheries development in Rulhi wetland of Bihar through Stakeholders' participatory fisheries management model (Co-management) in a sustainable manner – an innovative project	DAHD&F
10	Fisheries development in Kothia maun of Bihar - A pilot project	NFDB DAHD&F
11	Metagenomic Applications and transcriptome profiling for inland aquatic environmental health surveillance	CABiN, ICAR-IASRI
12	Exploratory survey of Hilsa (*Tenualosa ilisha*) catch and life stages availability along up/down stream of Farakka barrage	National Mission for Clean Ganga
13	Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India	National Mission on Himalayan Studies
14	Cage Culture in Reservoirs as collaborative programme between Department of Fisheries, Telangana state and ICAR -CIFRI during 2018 – 2020	Deparment of Fisheries, Telangana
15	Nutrient profiling of fishes of Loktak Lake in Manipur, a high altitude Lake with organic fauna and potential scope for GI tagging	DBT, New Delhi
16	National Agricultural Innovation fund (NAIF) component-1 ITMU	NAIF-ITMU
17	Collaborative research Project with WorldFish Centre under Window-3 Program	ICAR-WorldFish

Consultancy Projects

Sl. No.	Project title	Funded by
1	Assessment and Impact study on bio-diversity, eco-hydrology, fish population dynamics and livelihood of fishers in Narmada river with special focus on downstream of SardarSarovar Dam and Bhadbhut Reservoir.	Narmada, Water Resources, Water Supply & Kalpasar Department, Govt of Gujarat
2	Determination of e-flow for non-lean and non-monsoon months in respect of Teesta Stage-IV HE Project, Sikkim	NHPC Ltd.
3	Impact assessment of hydro-ecological changes of fisheries and socio-eonomy of fishers downstream of SardarSarovar Dam in Narmada Basin	SSNL
4	Investigation on ecological status, conservation and enhancement of fisheries in Gujarat part of SardarSarovar Reservoir	SSNL
5	Investigation on ecological status, conservation and enhancement of fisheries in Madhya Pradesh part of SardarSarovar Reservoir	MP Fisheries Federation
6	Status of fish diversity, abundance and population dynamics of Tilapia in Halali reservoir, Madhya Pradesh for sustainable fisheries management	MP Fisheries Federation
7	Rapid risk assessment of the potential invasiveness of Genetically Improved Farmed Tilapia (GIFT)	World Bank financed APART
8	Study on assessment of efficacy of fish pass/fish ladders in Teesta low Dam III and Teesta low Dam IV power stations, West Bengal	NHPC Ltd.
9	Assessment of impact of fly ash leakage on abiotic and biotic components of river Ganges due to force majeure of loaded barges	Coal Ash Institute of India, Kolkata
10	Reservoir Fish Production Enhancement and Establishment of a GIS and Spatial Planning Cell in Odisha	World Fish
11	Study on vailable and feasible alternative on the blocked migratory movement of fish species due to construction of Natiwar Mori HE project	SJVNL

Meetings, Workshops and Seminars

1st Barrackpore Proteomics Workshop

The 1st Barrackpore Proteomics Workshop was organized by the Institute at Barrackpore during 27 June - 02 July, 2018. Dr. B. P. Mohanty, HOD-FREM was the Course Director. The participants of the workshop included faculties from Stewart Science College, Cuttack, Sri Venkateswara Veterinary University, Nellore; Scientists from ICAR-CIFRI and Research Scholars from College of Veterinary Sciences, OUAT, Bhubaneswar, and Kalyani University. The six-days workshop included lectures by eminent researchers in this field. Hands-on training including analytical techniques like SDS-PAGE, 2D gel electrophoresis, Western Blot, 1D and 2D Gel Image analysis and transcript analysis by RT-PCR was imparted to the participants.

Workshop on "Application of Biosensor Technology in Inland Fisheries"

A one day workshop on "Application of Biosensor Technology in Inland Fisheries" was held on 01 August, 2018 at ICAR-CIFRI, Barrackpore. The workshop was aimed to sensitize the professionals working on Inland Fisheries Management and the potentials of bio-sensing technology in aquatic health monitoring. In view of the wide application of this technology in other sectors like food safety and medical diagnostics, the workshop also focused on application of this technique to detect pollutants like heavy metals, pesticides, PAHs, PCBs etc. in the inland aquatic environment. Not only small molecules, detection of various pathogenic microbes is also possible through this technique along with advantages of low cost, fast detection, high specificity, low limit of detection, etc. Eminent personalities like Prof. Vipul Bansal, RMIT University, Melbourne, Australia; Dr. Nabarun Bhattacharyya, Director, C-DAC, Kolkata; Dr. D. Pradhan, Professor, IIT-Kharagpur; Prof. Priyabrat Sarkar, Calcutta Institute of Technology; Prof. Rajib Bandopadhay, Jadavpur University, Kolkata; Dr. P. Swain, Principal Scientist, ICAR-CIFA; Dr. K. Krishnani, Principal Scientist, ICAR- CIFE; Prof. A. K. Dasgupta, Calcutta University; Dr. Anindya Sen, Heritage Institute of Technology, Kolkata actively participated and delivered lectures in the workshop. The workshop was jointly organized by ICAR-CIFRI and Inland Fisheries Society of India (IFSI). Dr. B. K. Das, Director, ICAR-CIFRI was the convener and Dr. B. K. Behera was the Organizing Secretary of the workshop. More than120 participants including scientists, research scholars and students attended the workshop.

Inception Workshop on "Pen Aquaculture for Upliftment of Floodplain Wetland Fishers of North Eastern Region"

The Regional Centre of ICAR-CIFRI, Guwahati organized an inception workshop on 'Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India' on 24 August, 2018 at the College of Veterinary Science, AAU, Khanapara. The project was sponsored by the National Mission on Himalayan Studies, Ministry of Environment and Forest, Govt. of India. The aim of the project was refinement of pen aquaculture technology for socio-economic upliftment of wetland fishers of North-east India, which would be implemented by ICAR-CIFRI in collaboration with Directorates of Fisheries, Govt. of Manipur, Meghalaya and Arunachal Pradesh. Dr. B.K. Bhattacharjya, Head (Acting), ICAR-CIFRI Regional Centre, Guwahati was the Convener of the programme., Dr. J. K. Jena, DDG (Fisheries and Animal Sciences), ICAR, New Delhi in his inaugural address stated that by adopting scientific methods of fishery enhancement including pen aquaculture in large and productive floodplain wetlands, the North-eastern region would be able to supply local fish to its large fish eating population. He further stated that fish farming is highly profitable and entails the advantages of on-demand harvest & sale. Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore stated that there is immense scope for large-scale adoption of the technologies developed and commercialized by the Institute in open waters (wetlands and reservoirs) of Assam, Manipur, Meghalaya, Arunachal Pradesh. Prof. Dr. R. N. Goswami, Dean, CVSc (AAU), Khanapara mentioned that fisheries and animal husbandry are the two sunrise sectors in agriculture that are expanding rapidly in the North Eastern Region. Shri H. Biramani Singh, Director of Fisheries, Manipur expressed the willingness of Department of Fisheries, Manipur to extend full cooperation in implementing the collaborative pen aquaculture project in the pats/ lakes of Manipur under NMHS project.

The workshop was graced by a galaxy of eminent fisheries scientists and officers including; Dr. S. Rajkhowa, Director, National Research Centre on Pig, Guwahati; Shri H. Biramani Singh, Director of Fisheries, Govt. of Manipur; Shri J. K. Samal, Deputy General Manager, NABARD, Guwahati; Scientists of ICAR-CIFRI Regional Centre, Guwahati; Dr. Rajdeep Dutta, Assistant Professor, College of Fisheries, AAU, Raha Nagaon. Fisheries Officers and 12 fishers from Manipur, Meghalaya and Arunachal Pradesh also participated in the workshop. In the technical session, Dr. B. K. Bhattacharjya explained the salient aspects of pen aquaculture technology developed by ICAR-CIFRI, Regional Centre, Guwahati in the North East region. Dr. Dipesh Debnath, Scientist, ICAR-CIFRI Regional Centre, Guwahati explained the salient objectives and activities of NMHS.

Institute Management Committee Meeting

The 47th Institute Management Committee meeting was held at the Institute Headquarters on 07 September, 2018. Dr. B. K. Das, Director of the Institute and Chairman, IMC welcomed the members and apprised them of the activities that had been carried out by the Institute since last meeting. The Members lauded the progress of research work in the Institute and congratulated the Director and scientists for such accomplishments. Shri Rajeev Lal, Chief Administrative Officer and Member Secretary, IMC presented the agenda items for discussion, which included progress in ongoing construction/works, purchase of equipments, constitution of Grievance Committee etc. Dr. S. K. Nag, Principal Scientist delivered a presentation on “Contaminants in the inland open waters”.

Workshop on Pension and Retirement Benefits

A two days workshop was organized at ICAR-CIFRI, Barrackpore during 03-04 September 2018. Officials from Audit & Accounts of the Institute, Officials from other ICAR Institutes attended the workshop. Dr. K. K. Panth, retired Professor, ISTM delivered special lectures on the occassion.

Meeting with Pensioners

A meeting was organized at the institute Headqarters for addressing the pending issues and other grivences of the pensioners. Around 20 retired ICAR Employees attended the meeting, Their grievences and other pending issues were discussed in the presence of Director, Chief AO, SFAO, AFAO and Bank Officials. The pensioners felt satisfaction over the discussion and desired to have this kind of meeting frequently.

Oxford University Press - User Awareness Programme

Oxford University Press organised a programme on “Flavours of Oxford University Press - User Awareness Programme on Oxford Journals and How to Publish with Oxford University Press” at CIFRI, Barrackpore on 10 September 2018. Mrs. Sumita Sen, Asst. Manager, Training, South Asia & South East Asia, Oxford University Press, gave a detailed presentation on various aspects of journals and books published by Oxford University Press. She highlighted the facilities available for Oxford journals through Consortium of e-Resources in Agriculture (CeRA) and also enlightened about the download facilities for books. She also discussed about the modalities of incorporation of new Oxford journals into CeRA, against any specific need of scientists of CIFRI.

Mid Term IRC Meeting

The mid-term Institute Research Committee meeting for the year 2018-19 was held at the Institute Headquarters, Barrackpore on 25-26 September 2018. The objective of the meeting was to assess the achievements made so far and mid-course correction, if any. Dr. B. K. Das, Director, ICAR-CIFRI chaired the meeting. Scientists from the CIFRI Headquarters, Kolkata Research Station and Project Principal Investigators from Regional Centers/Stations attended the meeting. The Chairman stressed on on-time completion of the objectives of the projects and on time submission of RPP III of the completed projects. He stressed upon proper and systematic sampling plans to collect the seasonal data for good research outputs and international publications. He urged scientists to quickly publish the output in the form of research paper, policy paper, advisories, database development etc.

Interactive Meeting on Pen Culture as Climate Resilient Technology for Beel

An interactive meeting on 'Pen culture as a climate resilient technology for beel' was organized at 47-Morakolong beel, Morigaon district, Assam on 25 October 2018. Dr. U. K Sarkar, Head, Reservoir and Wetland Fisheries

Division, ICAR-CIFRI and PI of NICRA project, Incharge of Regional Centre, Guwahati; Faculty from College of Fisheries, AAU, Raha; Sr. Executive, NFDB, Regional Centre, Guwahati; Dr. S. Purakayastha, Adviser to World bank funded APART project, Guwahati; field staff of Assam Fisheries Development Corporation Ltd., Guwahati; Scientists of ICAR-CIFRI RC, Guwahati and more than 25 active members of 47-Morakolong Meen Samabay Samiti (Coop. Society), Morakolong were present in the meeting. It was informed in the meeting that both IMC and small indigenous fishes can be stocked together in the pen culture in beels. It was also informed in the meeting that the pen culture could be a potential climate-resilient technology for generating additional income and livelihood for beel fishers especially during closed fishing season.

Workshop on 'Metagenomics in Fisheries Research'

A workshop on "Metagenomics in Fisheries Research" was held at ICAR-CIFRI, Headquarters on 01 - 02 December 2018. This two-day workshop was jointly organized by Inland Fisheries Society of India, Barrackpore, ICAR-CIFRI, Barrackpore and ICAR-Indian Agricultural Statistical Research Institute, New Delhi. This workshop aimed at covering the use of publicly available resources to manage, share, analyze and interpret NGS data in the various fields of microbial community study *viz*. water, sediment and soil, gut and skin and antibiotic resistance microbiome. Dr. George John, Former VC, Birsa Munda Agriculture University graced the Inaugural Session of the workshop as Chief Guest. Dr. P. K Agarwal, ADG, NASF, ICAR and Dr. Anil Rai, Head, CABin, IASRI were the 'Guests of Honour'. More than 70 researchers/scientists from various institutions like IGIB, New Delhi; Assam Agriculture University; OUAT, National institute of Bio-Medical; IICB, Kolkata; Institute of Cholera and Enteric Disease, Kolkata; ICAR-CIFA, Bhubaneswar; ICAR-CIBA, Chennai participated in this workshop. During the workshop some potential uses of metagenomics in the study of microbial diversity, microbial roles in microcosms, antibiotic resistance genes, novel and potential pathogens, microbial communities forming bioflocs, probiotics and other applications were addressed.

Visit of IPS Probationers to ICAR-CIFRI, Barrackpore

A One-day interactive session was arranged for Indian Police Service (IPS) probationers during their one month academic training. Eleven IPS probationers from Swami Vivekananda State Police Academy, Barrackpore Cantonment, Kolkata, West Bengal visited ICAR-CIFRI on 01 December 2018. Dr. B. K. Das, Director, ICAR-CIFRI interacted with the officers and explained the role of Inland Fisheries Sector and CIFRI in augmenting the fish production of the country leading to doubling of Farmer's income by 2022. The officers were enlightened on the vision, mission and mandates of the ICAR-CIFRI. They visited the Aquarium, Ornamental Fish Hatchery Unit, Re-circulatory Aquaculture Systems and the different laboratories of the Institute to get a glimpse of the ongoing researches carried out by ICAR-CIFRI.

Quinquennial Review Team Meeting for the period April 2013 – March 2018

The Director General of the Indian Council of Agricultural Research constituted the Quinquennial Review Team to examine the performance and progress of research and other activities of ICAR-CIFRI for the period April 2013 to March 2018 and make recommendations for improvements in its research performance. The QRT is comprised of Dr. C. Vasudevappa (Chairman), Dr. S. C. Pathak (Member), Dr. V. R. Chitranshi (Member), Dr. A. K. Sahu (Member) and Dr. (Mrs.) Usha Moza (Member). The first QRT meeting was held on 14 December 2018 in ICAR-CIFRI Headquarters, Barrackpore, Kolkata. Further, the Quinquennial Review Team Visited ICAR-CIFRI Research Centre, Bangalore during 28 - 29 December 2018 and conducted the review of research activities of the Center. The QRT meeting of ICAR-CIFRI Regional Centre, Guwahati and ICAR-CIFRI Center at Allahabad was held on 11 February 2019 and 29 March 2019 respectively. During the QRT Meeting, thorough discussions were made on strategies to strengthen the ongoing research projects of ICAR-CIFRI. Further the Review Team also stressed on extending the benefits of the outputs of the research to fish farmers and fishers engaged in the inland fisheries sector.

Visit of DDG to ICAR-CIFRI, Regional Centre, Vadodara

On 28 December, 2018, Dr. J. K. Jena, Deputy Director General (Fisheries & Animal Sciences) visited the Vadodara Regional Research Centre of ICAR-CIFRI. The In-charge of ICAR-CIFRI, Vadodara, Dr. Suhas P. Kamble and other scientists of the centre viz., Dr. D. Bhakta, Mr. W. A. Meetei and Mr. Vaisakh G., were also present on the day of visit. The DDG had individual discussions with the scientists and other staffs regarding the ongoing research activities and the major constraints confronted by the centre. The publications and other scientific outputs from the centre in the last five years were also evaluated by DDG and he envisaged the major milestones to be formulated in the way forward for the betterment of the Centre. He urged the scientists and other staffs of the centre to uphold the fame of ICAR-CIFRI in the state by undertaking novel researches in the fisheries sector and developing proper network with the stakeholders in the sector and State departments. Dr. Jena also reviewed the training and other extension activities carried out in the Centre. He appreciated the efforts to conduct such activities and encouraged the staffs for doing more innovative researches.

Workshop for Improving Fish Production From Large Water Bodies of Tripura

ICAR-CIFRI, Barrackpore, organized an interactive workshop on 'Management of open water fisheries' in collaboration with the Directorate of Fisheries, Department of Fisheries, Government of Tripura at Agartala, Tripura during 04 - 05 January 2019. The objective of the workshop was to share the contributions of ICAR-CIFRI in managing and enhancing fisheries in large water bodies especially, in reservoirs and wetlands of the country and further planning and implementation of similar activities in the state of Tripura. Dr. B.K. Das, Director, ICAR-CIFRI, Barrackpore and the Convener of the workshop, welcomed the dignitaries and delegates. Some of the eminent participants included Deputy Directors of Fisheries, Superintendents of Fisheries, Fishery Officers of Department of Fisheries, Govt. of Tripura; Professors of College of Fisheries, Lembucherra and Scientists from ICAR Regional Centre for NEH Region, Tripura Centre). Shri G. R. Das, TCS, Director of Fisheries, Government of Tripura was the joint Convenor of the workshop. In the Inaugural session, Chief Guest Shri Narendra Chandra Debbarma, Hon'ble Minister of Fisheries, Govt. of Tripura sought CIFRI's intervention in improving fish production from natural water bodies so that the common people at large get the benefits. Two Technical Sessions were held. Shri Bappi Basfore, Fishery Officer,

Directorate of Fisheries, Government of Tripura elaborated on the different centrally sponsored schemes that were adopted for development of open water fisheries in Tripura. Dr. Sona Yengkokpam, Scientist, ICAR-CIFRI, Regional Centre, Guwahati discussed about the pen aquaculture demonstrations and experiments undertaken in the North Eastern states which had proved to be successful in terms of economic viability. In the Interactive-cum-Plenary Session, Shri Rameshwar Das, IFS, Secretary (Fisheries), Government of Tripura urged the scientists and departmental officials to implement innovative ideas for popularizing cage aquaculture practice in Tripura.

CABin Project Progress Review Meeting

The CABin Project Progress Review Meeting was held during 10 – 11 January, 2019 at ICAR-CIFRI, Barrackpore. Dr. J. K. Jena, D.D.G. (Fisheries & Animal Sciences), chaired the Progress Review Meeting of Fisheries and Animal Science Section of CABin Project. He reviewed the progress made by the different Institutes in the Project. Eight ICAR Research Institutes, four from Animal Science (ICAR-IVRI, ICAR-CIRG, ICAR-CIRB and ICAR-NBAGR) and four from Fisheries Science (ICAR-CIFA, ICAR-CIBA, ICAR-NBFGR and ICAR-CIFRI) participated and presented their progress made in the Project for the Year 2018-19. Dr. L. M. Bhar, Director, ICAR-IASRI, Dr. Anil Rai, HoD and Coordinator, CABin, ICAR-IASRI and Dr. B. K. Das, Director, ICAR-CIFRI were present in the Review Meeting and provided their valuable inputs for improvement of the on-going Projects under the CABin scheme.

Stakeholders' Meeting with Clam Fishers

A stakeholders meeting with clam fishers was held on 17 January 2019 at Thycattussery, Alappuzha, Kerala under NICRA project. Around 50 fishers attended the programme. Dr. U. K Sarkar, PI of NICRA project, Dr. T.T. Paul and other staff of Kochi Research Station of the Institute were present on the occasion.

Women Cell Meeting at ICAR-CIFRI

A meeting of all the women members of ICAR-CIFRI was held on 21 January 2019 at the Institute Headquarters. The meeting was jointly organized by the Women Cell and Women Complaint Cell of CIFRI and it was presided over by Dr. B.K Das, Director, ICAR-CIFRI. The Institute has a strength of 57 women employees which is 24% of the total strength employees in position of CIFRI. Forty four women employees including SRFs and contractual staffs were present in the meeting. Dr. (Mrs.) Aparna Roy, Chairman, Women Complaint Cell, CIFRI addressed the newly joined women employees about the role and responsibilities of the Women Cell and Women Complaint cell. The Director, CIFRI mentioned in his address that these two cells were aimed to maintain a harmonious atmosphere at the Institute and enable women to pursue their work with dignity and reassurance. All women employees expressed their satisfaction about the working environment in CIFRI.

Research Advisory Committee Meeting

The Research Advisory Committee (RAC) meeting of the Institute was held on 04 - 05 February 2019. The Chairman of RAC, Prof. Dr. B. Madhusoodana Kurup, other RAC members like Dr. H.C. Joshi, Dr. G. N. Chattopadhyay, Dr. Shivaprakasha. S. M., Assistant Director General (Marine and Inland Fisheries) Dr. P. Pravin, Assistant Director General, CIFT participated in the meeting. On first day the committee reviewed various achievements of the Institute projects and other activities at their respective Divisions, units, Headquarters and Regional Centres of ICAR-CIFRI. On the second day, different ICAR network and outreach projects were presented by the respective Principal Investigators. Prof. Kurup, Chairman, and other members expressed satisfaction in the overall progress and also appreciated various initiatives taken by the institute.

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Interactive Workshop on "Openwater Fisheries Management in North Eastern Region"

ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore organized an Interactive workshop on 'Open water fisheries management in North East region' during 12 – 13 February 2019 at its Regional Centre, Guwahati under NEH component of the Institute. A total of 60 officials representing Directorate of Fisheries, Govt. of Assam, Meghalaya and Arunachal Pradesh; Assam Fisheries Development Corporation Ltd., Guwahati; FISHFED, Govt. of Assam; NFDB Northeast Regional Centre, Guwahati; NABARD Assam Regional Office, Guwahati and Scientists/ Researchers of ICAR-CIFRI participated in the programme. The workshop was presided by Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore. Dr. S. C. Pathak, Former Chief General Manager (CGM), NABARD Regional Office, Pune graced the function as Chief Guest. Dr. Usha Moza, Former Principal Scientist of Fisheries Division, ICAR, New Delhi and Dr. A. K. Tripathi, Director, ATARI, Zone-VI, Guwahati was the Guest of Honour. Mr. P. K. Hazarika (Project Director, AFDC Ltd., Guwahati), Mr. J. K. Samal (DGM, NABARD Regional Office, Guwahati) and Ms. Dipmala Roy (Officer In-charge, NFDB Regional Centre, Guwahati) were also present. The Technical Session of the workshop was chaired by Dr. S. C. Pathak Former CGM, NABARD Regional Office, Pune. Dr. B. K. Das delivered a lecture on "Role of ICAR- CIFRI in development of open water fisheries resources of India". Mr. J. K. Samal of NABARD, Dr. B. Lahon of NFDB, Dr. S. Yengkokpam, Dr. Pronob Das and Dr. S. Borah of ICAR-CIFRI talked on various topics like Institutional finance, NFDB schemes, pen culture, cage culture and stock enhancement for open waters, respectively. Dr. B. Lahon, Senior Consultant, NFDB Regional Centre, Guwahati assured to extend financial support for developing open water fisheries in the region. Dr. P. Das, Organizing Secretary and Scientist of the Centre presented a brief report of two days' workshop.

Institute Joint Staff Council (IJSC) meeting

The 68th meeting of the IJSC was held on 14 February, 2019 at the Institute headquarters, Barrackpore under the Chairmanship of the Director. Official side was represented by Shri Rajeev Lal, CAO; Shri NVRN Murty, SFAO; Ms. Piyashi Debroy, Scientist; Dr. R. K. Raman, Scientist and AAO (Adm. III), while staff side was represented by Shri Rabiul Sk and others. As special invitees Dr. P. C. Das, Dr. B. N. Paul, ICAR-CIFA and Dr. N. K. Chadha, ICAR-CIFE were also present. Various agenda items like cashless medical treatment facility, holding regular IJSC meetings, etc. were discussed in the meeting.

Workshop on Open water Fisheries Management of Manipur

ICAR-CIFRI, Barrackpore, organized an Interactive Workshop on 'Open water Fisheries Management of Manipur' in collaboration with the Directorate of Fisheries, Department of Fisheries, Government of Manipur at Imphal, Manipur on 18 February, 2019. The major focus was on simple and low-cost technologies (such as pen and cage aquaculture) and guidelines (fish stock enhancement) that are to be popularized in reservoirs, large lakes, swampy areas and rivers of Manipur for improving fish production. There were about 50 participants from the Department of Fisheries, Government of Manipur. Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore and Convener of the workshop encouraged the Department of Fisheries, Government of Manipur to look into diversification of fish species with local preferences. Shri Khamsing Ahum, Additional Director of Fisheries, Government of Manipur urged his Departmental officials to take full advantage of the knowledge generated by ICAR-CIFRI on management of Inland open waters presented the status of open water fisheries resources of Manipur. In the Technical session of the workshop, Dr. B.K. Das discussed about the management of open waters of India developed by ICAR-CIFRI. Mrs. Bidyarani Ayekpam, Director of Fisheries, Govt. of Manipur also graced the workshop.

Hindi Parliamentary Committee Meeting

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Fourth Stakeholder Consultation on Bay of Bengal Large Marine Ecosystem Project

ICAR-CIFRI hosted the fourth Stakeholder Consultation on BOBLME SAP Project Document Preparation for the States of Odisha and West Bengal on 04 March, 2019. The Consultation was co-organized by the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) and the Food & Agriculture Organization of the United Nations (FAO). The broad objectives of the Consultation were to identify and garner local priorities within the Strategic Action Plan (SAP) and Project

Framework Document (PFD) of the Bay of Bengal Large Marine Ecosystem Programme Phase -2 (BOBLME-2) and to explore the scope of collaboration & coordination for implementation of SAP. Inaugurating the Consultation, Dr B K Das, Director, ICAR-CIFRI remarked that this Stakeholder Consultation was being organized at a critical juncture when both fisheries and environment were confronted with challenges. Dr Yugraj Singh Yadava, Director, BOBP-IGO lauded CIFRI's efforts in the first phase of the BOBLME and expressed his eagerness to see the Institute playing a bigger role in the second phase, especially in areas of management of iconic species such as hilsa, maintenance of health of estuaries, livelihoods, climate change adoption, etc. Mr. C.M Muralidharan, Consultant FAO, explained the activities carried out during the first phase of the BOBLME Project, with special reference to India. Dr E. Vivekanandan, Fisheries Consultant, BOBP-IGO elucidated the activities proposed under the SAP phase of the BOBLME Programme. Discussions were held under two heads-Fisheries and Environment about the existing policies, measures for improving implementation of existing policies and policy gaps and scope of collaboration with BOBLME programme in the States of Odisha and West Bengal. Forty-five participants representing Governmental agencies, academia, other ICAR Institutes like ICAR- CIFRI, ICAR-CIFT, ICAR-CMFRI; NGOs and CBOs and fishermen from Sundarbans took part in the Consultation.

Workshop on "Climate Change Impact on Inland Fisheries"

ICAR-CIFRI organized a one-day workshop on 15 March, 2019 on "Climate Change Impact on Inland Fisheries". The workshop addressed four major thematic areas *viz*., inland open water fisheries management, impact of climate change on inland open fisheries, vulnerability assessment of wetland fisheries w.r.t. climate change and climate resilient adaptation strategies for inland fisheries. Ten eminent speakers were invited to share their opinions in the workshop. The Inaugural Session of the workshop was graced by Dr. A. G. Ponniah, Former Director, ICAR-CIBA, Chennai, who was the Chief Guest as well. Dr. M. Prabhakar, PI, NICRA, ICAR-CRIDA, Hyderabad; Dr.

(Prof.) B. B. Jana, Retd. Professor in Zoology and Vice Chairman, ICES, University of Kalyani, Dr. M. K. Das, Former Head, Fishery Resources and Environment Management Division, ICAR-CIFRI; Dr. Sanjib Bandyopadhyay, IMD, Alipore, Kolkata; Dr. Abhijit Mitra, Former Head, Dept. of Marine Science, University of Calcutta, Dr. S. Adhikari, ICAR-CIFA, Kolkata, Dr. (Prof.) S. K. Das, Dept. of Aquaculture, WBUAFS; Prof. Lalu Das, B.C.K.V.; Dr. U. K. Mandal, ICAR-CSSRI, Regional Centre, Canning, along with all the Divisional Heads of ICAR-CIFRI actively participated in the workshop. Dr. B. K. Das, Director, ICAR-CIFRI and Convener of the Workshop highlighted briefly CIFRI's work and achievement in the area of fisheries and aquaculture. Dr. U. K. Sarkar urged the participants to actively engage in deliberations during the workshop. Dr. A. G. Ponniah and Dr. M. Prabhakar appreciated CIFRI's work for climate change and acclaimed that it is one of the best among all the partner Institutes. There were two technical sessions and a session for poster presentation. The workshop was coordinated by Dr. U. K. Sarkar, Principal Investigator, NICRA and Dr. S. K. Nag, Principal Scientist, ICAR-CIFRI.

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Institute Research Committee Meeting

The Institute Research Committee Meeting 2018-19 was held at the Institute headquarters during 18-20 March, 2019. Dr. B. K Das, Director chaired the meeting in which all the Scientists of the Institute participated. Dr. Arun Pandit, Member Secretary, extended hearty welcome to the newly joined scientists and congratulated all those scientists who had been promoted and successfully acquired PhD. degree. The Director presented an overview of the recent developments in the research projects and urged all the Scientists to get approval of the Animal Ethical Committee of the Institute for further experiments. He emphasized on timely publication of research papers and creating field notebooks with better precision and insight. Moreover, he also encouraged about quick analysis of samples after their collection. Director also introduced the on-line Complaint Management System for proper redressal of complains. Dr. B. K. Behera, In-charge PME Cell, briefed about PME work and Dr. S. K. Nag, Member Secretary RAC, gave an overview of the RAC recommendations. On the next two days, the Scientist presented their individual research achievements.

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24th ICAR Regional Committee Meeting

The ICAR Regional Committees provide a forum for the stakeholders to examine in depth the major gaps in current research and training efforts, to identify priorities and to decide agenda of research and extension in agriculture, animal husbandry and fisheries for a region for the coming year. The 24th meeting of the Regional Committee II comprising members from the states of West Bengal, Odisha, Andhra Pradesh, Telangana and UT of Andaman and Nicobar Islands, held at Institute on Management of Agricultural Extension (IMAGE), Bhubaneswar on 22- 23 June 2018. Dr T. Mohapatra, Secretary, DARE and Director General, ICAR, New Delhi, presided over the inaugural session and chaired the two-day long technical sessions. In his address he remarked that the region offers tremendous scope and opportunities for

multifaceted growth of agriculture sector, including animal husbandry, fisheries, horticulture, sericulture and others. He called for concerted efforts of ICAR, SAUs and state governments to ensure that doubling of farmers' income becomes a reality by 2022. Dr J. K. Jena, DDG (Fisheries Science & Animal Science) and Nodal Officer of this region performed a lead role in successfully organizing this meeting.

Senior officers from ICAR hqrs. New Delhi including Shri Chhabilendra Roul, Special Secretary (DARE) & Secretary (ICAR), Shri Bimbardhar Pradhan, Additional Secretary & Financial Advisor (DARE/ICAR); Directors of ICAR research institutes, Vice Chancellors of the State Agricultural Universities, Senior Officials of the State Departments of Agriculture, Animal Husbandry, Dairy and Fisheries participated in the meeting. A total of 39 fresh action points with time frame were formulated.

Honourable Union Minister of Agriculture and Farmers Welfare Inaugurated Four Wetland Development Projects at Motihari, Bihar

Honourable Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh inaugurated four wetland fisheries development projects on 13 April 2018 on the sidelines of Regional Agriculture fair at Motihari, Bihar. The projects aim at enhancing nutritional security and livelihood of the dependent fishers. These projects are being executed by ICAR-CIFRI in four wetlands namely, Kararia, Sirsa, Majharia and Rulhi in East Champaran district of Bihar through stakeholders' participatory fisheries management model (co-management) in a sustainable manner. Shri Sachindra Prasad Singh, Honourable MLA, Shri Bablu Gupta, Honourable MLC; Dr. J. K. Jena, DDG (Fishery Science); Dr. A. K. Singh, DDG (Agril. Extension); Dr. A. K. Singh, DDG (Horticulture), Dr. Gopal Krishna, Director, ICAR-CIFE, Mumbai; Dr. S. Raizada, ADG (Inland Fisheries); Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore, Dr. B. P. Bhatt, Director, ICAR-RCER, Patna, were present on this occasion.

Rabindra Jayanti

The institute celebrated the birth anniversary of Rabindranath Tagore on 05 May 2018 with fervour, zeal and enthusiasm. The staff had put up a cultural programme based on Tagore's composition. Many staff recited poems and showed deep respect to the Bard by their exclusive performances. The celebration commenced with garlanding Gurudev by the Director. A mesmerizing performance by Ms. Keya Saha and other enthralled the audience. The Director discussed "Tagore's Love for Nature", his profound interest in conservation of nature. Wonderful messages by the Heads of the

Divisions made the audience spellbound. They remarked that Tagore and his compositions should be imbibed in every soul and every heart. We need to inculcate the values of life through his compositions.

World Biodiversity Day

The institute celebrated World Biodiversity Day on 23 May, 2018 fervently at the Head Quarters, Barrackpore with an aim to create awareness among the institute staff, research scholars, young professionals, students on importance of conservation of biodiversity especially aquatic ones. Dr. Jose T Mathew, IFS, Principal Chief Conservator of Forests, Govt. of West Bengal; Dr. Arun Padiyar P, Project Coordinator, Odisha World Fish Project and Dr. B. K. Das, Director were the dignitaries present on the occasion. The Chief Guest elaborated the basic principles of biodiversity conservation in the present perspective. Thirty four M.Sc., Zoology students of P.K.R. Memorial College (PG), Dhanbad; Shri K. L. Manjhi, Chief General Manager and Shri R. K. Chowdhury, Regional Manager, MP Fisheries Federation were also present.

World Environment Day

The Institute celebrated World environment day on 05 June 2018 at the HQs and different centres. The day was marked by planting saplings of Mangrove Sundari trees (*Heritiera fomes*) on the bank of river Ganga involving native populace and sensitizing them about river bank erosion and role of plantation in it's mitigation. Local school children have also been encouraged in planting the mangrove saplings. Tulsi and Neem (medicinal plants) saplings were also planted in the Institute campus.

4th International Day of Yoga

The Institute celebrated 4th International Day of Yoga on 21 June, 2018. The Yoga Session was conducted under the guidance of eminent Yoga expert, Mr. Sujit Ghorei and his group of Yoga Kendra, Barrackpore based on the Common Yoga Protocol provided by Ministry of AYUSH, Government of India. Around 150 staff members and their family attended the program

in the morning of 21 June, 2018 in the Lobby of ICAR-CIFRI. Earlier, on 20 June, 2018 a lecture on, "Health benefits of Yoga" was also organized for the physical and mental health benefits of members of ICAR-CIFRI family. Few members clarified their doubts by asking questions on the specific yoga for specific health related benefits. ICAR-CIFRI regional centres Guwahati, Bangalore and Vadodora also celebrated yoga day on this occasion.

National Fish Farmers' Day

ICAR-C1FRI, Barrackpore celebrated the National Fish Farmers' Day on 10 July, 2018. The day is commemorated in the memory of the path-breaking Induced Breeding Technology developed by Dr. Hira Lal Chopudhury and Dr. Alikhuni, former scientists of the Institute in the year 1957. Dr. B. K. Das, Director, ICAR-CIFRI mentioned that this technology developed by the CIFRI Scientists, was instrumental in bringing about the Blue Revolution in the country. Dr. A. N. Roy, Director, NIRJAFT who was present in the celebration stressed on the role of fisheries sector in livelihood security in West Bengal. Prof. B. C. Mall, Vice Chancellor of JIS Group University, Kalyani and the Guest of Honour

shared his experience in aquaculture engineering sector. Shri Swami Atmapriyanand Ji, Vice Chancellor of Ram Krishna Vivekanand University and Research Institute, Belur Math was the Chief Guest of the function. Around 150 fish farmers from various states like West Bengal, Bihar, Odisha, Jharkhand, Uttar Pradesh and Chhattisgarh actively participated in the event. Eleven fish farmers from West Bengal, Odisha, Telangana, Jharkhand, Bihar, Uttar Pradesh were awarded the "Best Fish Farmer Award" in the function for their contribution to fisheries and aquaculture sector of India. Two training programmes were also organized under Skill Development Programme and Tribal Sub Plan for the wetland fish fanners of West Bengal and tribal fish farmers of Sundarbans respectively which aimed at providing solutions to fishing related problems.

Independence Day

The institute celebrated 72nd Independence Day on 15 August, 2018 with great enthusiasm. Dr. B. K. Das, Director unfurled the tricolor and paid rich tribute to the nation. He remarked that in the last 72 years the institute has grown tremendously with the growth of the country. He congratulated all the staff for the great achievements. However, he cautioned that there is no room for complacency. Some of the security staff were decorated for their outstanding services. A cultural programme was also organized on the occassion.

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Tribute to Bharat Ratna, Late Atal Bihari Vajpayee

On 16 September, 2018 ICAR-CIFRI organized a programme of recitation of poems composed by Bharat Ratna late Shri Atal Bihari Vajpayee, Former Prime Minister of India under the guidance of the Director, Dr. B. K. Das. The programme was conducted as per instructions received from ICAR. In the programme, all Staff members of the Institute including Scientists, Administrative, Technical & Supporting, along with Research Scholars and other invited guests, poets and literary figures were present. The programme started with offering floral tributes to the late Shri Atal Bihari Vajpayee Ji. There was a brief commentary on the life journey and achievements of Shri Atal ji. There were around thirty recitations of poems composed by him like: vkvk fQj l fn;k tyk;] dne feydj pyuk gkxk] nèk e njkj i< xÃ] eukyh er tb;k] jkg dku lh tkÅ e\] ;{k ç'u] vej g x.krU=] tx u gku nx] xhr ugÈ xkrk g] ekr l Fku xÃ] >d ugÈ ldr etc. Smt. Renu Khanna, a poetess and editor of Hindi magazine "Sankalp", Jharkhand, graced the occasion, recited poem and shared some live events of late Vajpayee Ji. Shri Rajeev Lal, CAO, ICAR-CIFRI highlighted Atal ji's exceptional personal traits and his literary accomplishments. Shri S. K. Sahu, Scientist and Dr. B. K. Behera, Principal Scientist recited some poems composed by the late leader and elaborated on his Jan-Nayak image.

Ranching of Native Bred Major Carps in River Ganga on Birth Anniversary of Gandhi ji

To pay tribute to the Father of the Nation, on the 150th Birth anniversary of Mahatma Gandhi, and as a part of Namami Gange Programme, fish ranching programme was organized by ICAR-CIFRI on 2 October, 2018 at three consecutive Ganga ghats (Seoraphuli, Mangal Pandey and Gandhi ghat) at Barrackpore, Kolkata, West Bengal. Prized fishes of River Ganga like Rohu, Catla and Mrigal, also known as the Indian Major Carp (IMC) have declined over the years due to anthropogenic stresses. Thus, it is need of the hour to re-establish these highly demanded fishes of Ganga through ranching in indentified stretches of the river. On the occasion, Shri Nabin Naik, Director, Nehru Yuva Kendra Sangathan graced the event. He talked about the ongoing degrading situation of the holy river and encouraged the local people to do their bit to make River Ganga clean. Dr. B. K. Das, Director, ICAR-CIFRI and Principal Investigator, CIFRI- MCG project highlighted the project activities and emphasized on the need of ranching in the River Ganga through distribution of trilingual leaflets and pamphlets. As a part of the event, total 2.8 lakh native bred fingerlings of Rohu, Catla, Mrigal were released in the River Ganga at different ghats.

Celebration of 'Mahila Kisan Divas'

ICAR has mandated celebration the Mahila Kisan Divas on 15 October across all ICAR Institutes. Keeping in tune with that and to recognize the socio-economic role fisher

women and unleash their unbound potential for future development of the fisheries sector ICARCIFRI celebrated the Mahila Kisan Divas on 15 October, 2018 at its Headquarters in Barrackpore. The programme was convened by Dr. B. K. Das, Director, ICAR-CIFRI, Barrackpore who gave immense inspiration to make the programme memorable. Swami Vishwamayanandaji, Secretary, Ramakrishna Mission, Sargachhi, Murshidabad was the Chief Guest. Apart from him, Brahrnacharini Ashima Ji, Secretary, Berigopalpur Ramakrishna Mission Ashram, North 24 Paraganas, Brahrnakumaris Ritika Ji, In-charge, Brahrnakumaris, Shyarnnagar Unit, North 24 Paraganas, Brahrnacharini Gyananandamoyee ji, Pranab Kanya Sangha, Bharat Sebasram Sangha, and Dr. Madhumita Nandi Ghosh, Assistant Director of Agriculture, North 24 Paraganas were also present. Around 100 progressive women farmers from various agriculture and allied sectors were invited to the programme and they shared their experiences. A Scientist-women farmer interactive session was conducted where they discussed about fishing as livelihood, security of farm families, fisheries component in Integrated Framing Systems etc. The day was celebrated by ICAR-CIFRI with the hope to empower the women farmers in fisheries sector which could be instrumental to bring about the Second Blue Revolution in our country.

Vigilance Awareness Week

The Vigilance Awareness Week 2018 was observed at ICAR-CIFRI Barrackpore during October 29 November, 2018 with the theme 'Eradicate Corruption -Build a New India'. On the first day the Integrity pledge was administered by Dr. B. K. Das, Director of the Institute to all staff members of the Institute. A human chain was made by the staff and research scholars at the Krishna garden lawn of the Institute to demonstrate solidarity and unity in fighting the corruption in the society. Different slogans and posters depicting the evil effects of corruption on the society were also displayed on that day at the institute premise. An extempore competition was organised among the students of APC College, New Barrackpore. An essay writing and extempore competition was also organized among the Institute staff and research scholars. Next day CIFRI reached out to the students of different local schools and conducted many co-curricular activities on the theme. As a part of outreach activity addressing the rural population, an awareness Gram Sabha was organised at a Village near Dhankal More, Mathura beel, Kanchrapara-Jagulia Road, North 24 Parganas district in West Bengal wherein many farmers and villagers took active part in discussions on vigilance and corruption. Shri Dipankar Bhattacharyya, IPS, DIG, Training-cum- Principal of Swami Vivekananda State Police Academy West Bengal was the Chief Guest and he deliberated on the current corrupt scenario in our society and our approach to eradicate it.

World Fisheries Day

The Food and Agriculture Organization (FAO) has declared 21st November as the World Fisheries Day. To commemorate the same, ICAR-CIFRI arranged two special events on 20 November, 2018 "Ranching Programme at Ganga River and Conservation of Fish Biodiversity" and" Nutrition and Livelihood Security of Fishermen by Small Indigenous Fish (SIF) culture and conservation". Shri Pradecp Bagela, Vice Chairman, Shri Navin Nayek, Director and Ms. Madhabi Agarwal, Governing Body Member, Nehru Yuva Kendra were present as special guests. The day started with the ranching programme under the "Namarni Gange" project of Government of India in which the Director of the Institute, Dr. B. K. Das released 1.5 lakhs fish seeds of Indian Major Carp in the Ganga river. An Interaction Session was arranged in which the Director of the Institute and the guests of the event conversed with the fishermen about fish conservation and nutritional value of SIFs. Shri Pradip Bagela

ardently encouraged the present fishermen and rural youth to take up farming as an entrepreneurial activity. Hapas were distributed among the fisherwomen of Sundarbans to promote SIF culture and conservation for nutritional security. The Institute also conducted a discussion session on the occasion of "Cooperative Week" which started from 14th November. In this event the fishermen from the "Akaipur Darbasini Fishermen' s Society" and "Hingalgunj Agricultural society" were present and opined on the necessity of Cooperatives in fisheries. The day witnessed the presence of around 130 fishermen from Sundarban, North 24 Paraganas, Howrah and Mayurbhanj district of Odisha. The celebration of such events by Institute propagated the Government of India's initiative of "Doubling Farmers' Income".

World Antibiotic Awareness Week

The World Antibiotic Awareness Week (AWWA) was observed at ICAR-CIFRI, Barrackpore as a part of "Antimicrobial Resistance in Fisheries and Aquaculture" Project during 12 to 18 November, 2018. The programme was inaugurated by Dr. B. K. Das, Director, ICAR-CIFRI, in presence of Shri Navin Nayak, Director, Nehru Yuva Kendra, research staffs of ICARCIFRI and the youths and Fish farmers of West Bengal. During the period, a series of awareness lectures by Dr. B. K. Das, Director. Dr. A. K. Sahoo, PI and Dr. A. K. Bera on antibiotics used in aquaculture and fisheries, important pathogens in fish culture, pattern of antibiotic resistance development and use and misuse of antibiotics in fisheries was deliberated. 35 students from the College of Fisheries. Mangalore and 100 youths and fish farmers from West Bengal took active part. Banners and posters displaying messages on Antimicrobial Resistance (AMR) were placed in different locations for spreading the awareness among the local people and visitors.

Communal Harmony Campaign Week and Flag Day

To foster and reinforce the spirit of communal harmony and national integration, ICAR-CIFRI observed the Communal Harmony Campaign Week & Flag Day during 19-25 November, 2018. The week long programmes commenced on 19 November with the pledge taking of national integration by all the staff members of Institute. A sensitization programme was organized among the fraternity on the said theme on 20 November in which Director Dr. B. K. Das appealed to all the staff for promotion of the noble cause. 22 November was celebrated as the Flag Day and a voluntary fund raising campaign was conducted in which the Institute staff contributed with zeal and enthusiasm. A concluding ceremony was held on 24 November in which an Interactive Discussion Session on 'Communal Harmony and National Integration' was organized in which the opinions of the staff echoed the values of secularism, non-communalism and non-violence.

World Fishery Day and Cooperative Week

The Institute celebrated the World Fisheries Day on 20 November 2018. To make this day a memorable one the Institute arranged ranching programme at Ganga River and a workshop on "Nutrition and livelihood security of fishermen through Small Indigenous Fish (SIF) culture and conservation". Officials from Nehru Yuva Kendra including Shri Navin Nayek, Director were present as special guests. In the interactive session the dignitaries interacted with the fishermen on fish conservation and nutritional value of SIFs. Hapas were distributed among the fisherwomen of Sundarbans to promote SIF culture and conservation for nutritional security. The institute also arranged a special session on the occasion of "Cooperative Week" which started on 14 November. On this event the fishermen from the "Akaipur Darbasini Fishermen's Society" and "Hingalgunj Agricultural Society" were present and shared their experiences. The day witnessed the presence of around 130 fishermen from Sundarbans, North 24 Paraganas; Howrah (W.B.) and Mayurbhanj district (Odisha).

Agricultural Education Day

ICAR-CIFRI, Barrackpore celebrated the "Agricultural Education Day" on 3 December 2018 in a grand way to highlight the role of agricultural education in nation building. Dr. George John, Former Vice Chancellor, Birsa Agricultural University and an eminent fish geneticist and biotechnologist chaired the programme as Chief Guest. Dr. Sanjib Bandyopadhyay, Deputy Director General, Indian Meteorological Department and also an eminent educationist graced the occasion as the Guest of Honour. About sixty-five students of B.Sc. in Industrial Fish and Fisheries, APC

College. New Barrackpore, M.Sc. Zoology students with specialization in fisheries from P. K. Roy Memorial College, Dhanbad. and Vinoba Bhave University, Hazaribagh participated in the programme. Lectures, laboratory, field visits and demonstrations were organized for them. Dr. B. K. Das. Director, CIFRI in his inaugural address emphasized on the prospects of agricultural education in the present scenario of India. Dr. Bandyopadhyay also gave a presentation on the importance of weather forecasting in agriculture and fisheries sector.

Women in Agriculture Day

To recognize and acknowledge the role and importance of women in Indian agriculture, 4 December is celebrated as the "Women in Agriculture Day" across all ICAR institutes. ICARCIFRI observed the day at its Headquarters at Barrackpore by a Brain Storming Session. Five eminent women scientists and educationists - Dr. K. C. Dora, Former Dean of WBUA& FS, Prof. Branjul Bhattacharyya. Head of the Statistic Department, BCKV, Prof. Kalyani Ray, Head of Gynecology and Obstetrics Department, WBUA&FS and Dr. Lopamudra Haldar, Associate Professor, WBUA & FS graced the event with their informative presentations on women in agriculture and allied sector. More than forty farm women from various Self Help Groups participated. Dr. Archana Sinha, Principal Scientist. ICAR-CIFRI spoke on the status of women in fisheries. Dr. Dr. B. K. Das, Director of the Institute categorically highlighted the role played by women in agriculture and allied sector of the country. A lecture compendium on "Women in Agriculture and Allied Sectors" was released on this occasion. The day

concluded with an interactive session between the experts and the farm women present in the programme.

World Soil Day

ICAR-CIFRI, Barrackpore celebrated the "World Soil Day"' on 5 December 2018 in a grand way to highlight the importance of soil health in sustaining agricultural production and environmental health. Dr. Subrata Mondal, CGM, NABARD chaired the programme as Chief Guest and Dr. Sushanta Kumar Pal. Prof. Agricultural Chemistry & Soil Science, BCKV Nadia, an eminent soil scientist, was the Guest of Honour. About 100 farmers from North & South 24 Parganas, Nadia and Hooghly participated in the programme. Under Mera Gaon Mera Gaurav (MGMG) - a Flagship program of the Hon'ble Prime Minister Shri Narendra Modi, soil samples were collected from 10 clusters of 50 villages across four districts of West Bengal. On this day, 155 Soil Health Cards were distributed among the farmers. Dr. B. K Das. Director, CIFRI in his inaugural address encouraged the farmers to relook into the soil health of their respective fields which are under degradation and take prompt initiatives. He also remarked on the need of Pond Health Card in the line of Soil Health Card which would enhance fish production system in rural India acting as a bigger step towards the Second Blue Revolution for Doubling Farmers' Income by 2022. Many farmers presented their views on importance of soil health, committed themselves to sustain soil health with aids from ICAR-CIFRI. A brief presentation on the importance of soil in Agriculture on World Soil Day-2018 was made by Dr. Srikanta Samanta, Principal Scientist of CTFRT in a modest way.

New Year Celebration

Director and all the staff celebrated the new year on 01 January, 2019 at the institute lawn with great fanfare and enthusiasm. The Director addressed the staff and wished them a happy new year.

Republic Day

The Institute celebrated the Republic Day with great enthusiasm on 26 January, 2019. Dr. B. K. Das, Director hoisted the tri-colour and paid rich tribute to the nation. He elaborated that India gained freedom after lot of struggle by the freedom fighters. Hence, preserving the unity of our nation is our sacred duty. In his speech, he also recounted the achievements of CIFRI during the last one year. He remarked that a good working atmosphere and team spirit are the key to success. Winners of 'CIFRI history' presentations were felicitated by him. All the CIFRI staff and their family members were present on the occasion.

Field Day in Samaguri Beel of Assam

Guwahati Regional Centre has been undertaking demonstration of cage aquaculture for rearing *Labeo bata* fingerlings in Samaguribeel, Nagaon district, Assam. A series of ICAR-CIFRI GI-cages (individual cage dimension of 5 x 5 x 2m^3) were installed in the beel and successfully reared *L. bata* seeds. Larger fish were harvested and smaller fish (>50g) were released in the beel for stock enhancement. On the occasion of fish harvesting, a field day was conducted on 28 February 2019 which was attended by Shri P. K. Hazarika, Project Director and field staff of Assam Fisheries Development Corporation (AFDC) Limited; Dr. Pabitra Saharia, Asst. Professor, College of Fisheries, Raha; Shri Bhagirath Das, Manager, Samaguri beel; staff of ICAR-CIFRI Guwahati Regional Centre and more than 40 fishers.

Remembering Pulwama Martyrs

Terrorist's attack in Pulwama, Jammu and Kashmir, is one of the deadliest terror attacks in the country in which 40 Central Reserve Police Force (CRPF) personnel were martyred. The attack happened on February 14, 2019 when a notorious terrorist rammed a vehicle laden with explosives into CRPF convey. The country mourned the heinous attack and stood united against any such terrorist attack in the country. ICAR-CIFRI also stood against the attack and did candle march on 16 Feb, 2019 to pay tribute to the slain Jawans. CIFRIans hold candlelight march to express solidarity with families of the CRPF Jawans killed in the Pulwama terror attack.

International Women's Day

ICAR-CIFRI celebrated the International Women's Day on 8 March, 2019. The day started with Hon'ble Prime Minister, Shri Narendra Modi's live speech being telecasted in the national television. All the staff members of the Institute gathered in the Auditorium to listen to the Speech with rapt attention. Dr. B. K. Das, Director of the institute addressed the audience and highlighted on the irreplaceable role of women in strengthening science and education system of the country He also felicitated all the lady staff members of the Institute with flowers and congratulated each of them for their individual roles in management of the Institute. A brief Brain Storming Session was arranged to celebrate the occasion. Dr. Suhrita Chakroborty, Professor, B.C.K.V graced the occasion as Chief Guest. She gave an eloquent speech on women empowerment and gender concepts. This was followed by a cultural programme in which women members of the Institute took participated with sheer vigour.

Matsya Samriddhi Mela and 73rd Foundation Day of ICAR-CIFRI

ICAR-CIFRI, Barrackpore celebrated its 73rd Foundation Day by organizing the Matsya Samriddhi Mela on 17 March, 2019. The grand ceremony was inaugurated with ranching of

30,000 advanced fingerlings of Indian Major Carp seeds in River Ganga by the Hon'ble guests at Barrackpore ghat. In his welcome address, Dr. B. K. Das, Director CIFRI, Barrackpore congratulated all the CIFRIans, progressive fish farmers, fisheries industries, etc. who were part of the glorious 72 year journey of ICAR-CIFRI. The Director, ICAR-CIFRI congratulated everyone on their various achievements and encouraged everyone to remain committed to this hard work which would be the mini steps towards the Second Blue Revolution. Dr. Vijay Laxmi Saxena, General President (Elect) of Indian Science Congress and Chief Guest of the function congratulated the Director and all the staff members of ICAR- CIFRI. She stressed on how ranching efforts can pave the way for improved fish diversity in River Ganga. Several dignitaries like Dr. N. Saha, Vice Chancellor, Burdwan University, Dr. Ashok Kumar Saxena, Former General President of Indian Science Congress, Dr. Subrata Mandal, Chief General Manager, NABARD, Kolkata, Shri Navin ayak, Director, Nehru Yuva Kendra, West Bengal and A & N Islands graced the occasion and lauded CIFRI and its scientists for its persistent contributions in research world. Shri Bablu Majumdar, Awardee Fish Farmers expressed his gratitude to CIFRI for playing a major role in his accomplishments. A number of exhibition stall had been installed encompassing live fish, Hilsa life story, ornamental fish unit, feed companies, fish health units etc. As a part of the Mela, Farmers-scientists Interactive Session, Industry Interface Meet, Fisherwomens' Session were organized. Around 2000 farmers including 100 progressive fish farmers, 300 students of different Universities, 200 youths, entrepreneurs, fish traders, fish processors, SHGs, ornamental fish growers and hatchery owners also participated in the event and added to celebration of the Institute's Foundation Day. A cultural programme was also organized wherein all Staff Members of the Institute enthusiastically performed.

Mera Gaon Mera Gourav

ICAR-CIFRI conducted Mera Gaon Mera Gourav (MGMG) programme with the objective to disseminate scientific knowledge from 'Lab to Land'. The summary of the annual progress under MGMG programme in West Bengal is given below:

Total No of Groups/team formed	No. of Scientists Involved	No. of villages covered	No. of field activities conducted	No. of messages/ advisory sent	Farmers benefited (No.)
10	55	51	25	155	600

Under MGMG programme, ICAR-CIFRI conducted field days and provided literature on various aspects like Small indigenous fish for livelihood and nutritional security; Hilsa fishery conservation; Pen culture technology; Fish as health food; Biodiversity conservation; Climate-change and adaptation techniques etc. The farmers were sensitized on fish disease control, soil fertility, hilsa conservation, Climate-change and adaptation techniques etc.

Case study of successful demonstration in MGMG village

Gardanmari, a small village, in Bhatar Block of Bardhaman district, West Bengal and dominated by tribal population, is resource

poor with almost all its population residing below poverty line and possessing minimal socio-economic and physical assets. Around 98 per cent of the villagers are either agricultural labourers in adjacent villages or work in various factories in nearby towns and cities as seasonal labourers. Most of these people are landless or possess negligible amount of agricultural land on their own and have poor educational status leaving them with very few employment and livelihood options. Finding ways for alternative income generating options for villagers is a challenge in this village. The village has a 10 ha rainfed wetland (Dighi) which, if utilised efficiently for fisheries development, could generate revenues for the villagers. In the year 2018 the Gardanmari Village was taken up under MGMG programme.

For establishing rapport with the villagers, the MGMG team established linkage with Gardanmari Adibasi Dighi Unnayan Samiti which was formed in the year 2014 with an existing strength of 337 members. The team conducted benchmark survey of the village and also on the physical and chemical properties and productivity of the water body. Fish feed, fish stock, fishing gear and one coracle have been provided by the institute to the fishermen community of the village under Tribal Sub Plan. One pen and 50 *hapa* have also been installed in the wetland so that higher productivity could

be achieved with more efficient management of multiple fish species within the enclosure structures. These structures are properly maintained by the villagers. Small indigenous fishes like *Mola* and *Punti* are being cultured in the *hapa* for nutritional security while the Indian major carps like Rohu, Catla, Mrigel are being cultivated in the pen for raising quality fingerlings for stocking the seed in the wetland. Training programme and awareness camps were arranged in the MGMG village. The pen was stocked on 5 October 2018, and were released in the wetland on 6 Febuary 2019. It took three and a half months to grow the fish from fry to advanced fingerling stage for release, and mortality of the released fingerlings was very low. Shri. Ratan Homram, President of the Society and the members are hopeful that pen culture technology will help in enhancing the production from wetland by many folds.

Imbibing the Concept of Swachha Bharat

Under the 'Swachha Bharat Pakhwada,' ICAR-CIFRI organized an awareness programme in Mera Gaon Mera Gaurav (MGMG) adopted Kathuria and Rudrapur villages in Barasat Block, North 24-Parganas on 24th May, 2018 to imbibe the concept of Swachh Bharat Mission in the villages. A sensitization programme was organized in Mochpul Primary School, Barasat Block. More than 50 villagers including women from these two villages participated in the sensitization

programme. After initial briefing, a cleanliness drive was taken by the ICAR-CIFRI family members along with the villagers to clean the periphery of the Primary Health Centre of Kathuria village. Bleaching Powder was distributed among the villagers. A team of CIFRI staffs have actively participated in sensitizing and disseminating the *swachhta message* of the Govt. of India among villagers.

A team of staff members from CIFRI proceeded to MGMG village Saibana and Fatepur during September, 2018. ICAR-CIFRI scientists shared their thoughts and experiences about Swachh Bharat mission and sensitized village women about the importance of cleanliness in their daily life and also importance of garbage pit which can be utilised in agricultural field. In continuation, all members including villagers cleaned a pilgrimage place, Nandadulal temple, which is a 400 years old temple located in the village. As a symbolic activity, ICAR-CIFRI also donated a dust bin to be placed in the temple premises for collecting biodegradable waste materials. At the end, sanitizing agents like bleaching power and soap were distributed among villagers and school students.

Swachh Bharat Abhiyan

As a part of Swachh Bharat Abhiyan, various kinds of activities pertaining to cleanliness, awareness and maintenance of basic hygiene, were taken up at ICAR-CIFRI Headquarters and its Regional Centres. Swachchta Pakhwada was celebrated at regular intervals and all staff members actively participated in it. Oath taking, cleaning of campus and beautification of surrounding areas, sensitizing MGMG

adopted villages, distribution of hygiene products were regularly performed. The day to day activities done during the Swachhta Pakhwada Campaign were uploaded on CIFRI website on a regular basis. A tour was performed for seasonal sampling in the Katiganga and Bishnupur wetland, Berhampur, Murshidabad, West Bengal during 25-28 July, 2018 wherein Swachhta Activities were undertaken. ICAR-CIFRI, Barrackpore had organized a “Health Camp” under Swachh Bharat Programme on 25 August 2018 where Staff Members and their family members received free health check up. On 2 October 2018, Swachch Bharat Diwas was celebrated by organizing Clean Ganga Campaign and ranching of major carp seeds in River Ganga at Barrackpore.

Installation of Vermi Compost Pit at ICAR-CIFRI, Headquarters was one of the revolutionary initiatives resulting in cleaner campus and higher revenue in the form of sale of vermi compost manure. Vermi Compost is a


SWACHHTA PAKHWADA-2018

nutrient rich (C:N:11:1) organic manure which was produced from CIFRI vermin compost unit. This was essentially a part of the Swachhta Pakhwada Programme. Garden waste, chopped banana leaves and weed mass were used as compost material. The residents of CIFRI Campus enthusiastically collected organic wastes from their kitchens, gardens, open areas and disposed it in the Vermi Compost Pit. The initiative to dispose organic wastes had virtually assumed the form of a movement. A total of 250 kg (approx.) vermi compost manure was harvested last year. It is mention-worthy here that it has generated Rs. 3750 in the form of revenue contributing in Institute Fund.

Moreover, 56 office records were digitized during the Swachhta Pakhwada Campaign. The mass awareness programmes at various locations like local schools, on-boat training for local residents and tribal fishermen- all have brought about a massive change in the mindset of people for the better.

संस्थान में राजभाषा हिंदी से जुड़े कार्य

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bl volj ij fun'kd] Mk- fc- d- nkl u vkef=r e[; vfrfFk] Mk- fot;y{eh lDluk vkj Mk- v'kd dekj lDluk dk gkfnd Lokxr fd;kA fun'kd egkn; u lLFkku d leLr oKkfudk] vfèkdkfj;k] 'kkèk Nk=&Nk=kvk ,o x.kekU; vfrfFk;k d Lokxr lEcèku e lLFkku dh 'kkèk miyfCèk;k ,o —"kdk d fgr e tkjh fØ;kdykik dh tkudkjh nh rFkk jktHkk"kk çgnh e lLFkku }kjk fd; tk jg ç;klk d ckj e crk;kA mUgku leLr depkfj;k dk Lokxr djr g, dgk fd oKkfud dk;k e Hkh fgUnh dk c<kok nuk pkfg, rFkk oKkfud rduhdk dk vfèkd l vfèkd eNvkjk rd igpk;k tkuk pkfg, rkfd mudh vk; dk nkxuk fd;k tk ldA mUgku eNyh ikyu d {k= e vku oky pukfr;k vkj bu pukfr;k l fuiVu d rjhdk dk [kktu ij cy fn;k rkfd xjhc eNvkjk] tk eRL; ikyu d {k= l tM g] bldk lEi.k ykHk mBk ldA bl volj ij dkQh l[;k e 'kkèk vkj ykØfç; y[k çkIr g,A bu y[kk dk ldfyr dj nk iLrd r;kj dh xb &

1- thfodkiktu e vrLFkyh; ekfRL;dh dh Hkfedk ¼ ekfRL;dh oèku e tyh; ikfjLFkfrdh dk ;kxnku

2- thfodkiktu e vrLFkyh; ekfRL;dh dh Hkfedk& lekftd mRFkku e vrLFkyh; ekfRL;dh dh egÙkk A

e[; vfrfFk egkn;k u phu ,o vU; n'kk dk mnkgj.k nr g, Hkkjrh; eNvkjk dh thou ij viu fopkj çLrr fd;A mUgku lnjou {k= d eNvkjk dh thou ij çdk'k Mkyr g, dgk fd bl {k= d eNvkjk dk txyh tkuojk l vfèkd [krjk

[krjukd ?kfM;kyk l jgrk gA mUgku eNvkjk d ith vÆtr dju d rjhdk ij foLrkj l crk;kA lLFkku }kjk çdkf'kr Çgnh iLrdk dh ljkguk djr g, mUgku dgk fd Çgnh Hkk"kh {k=k dh vi{kk bl lLFkku e Çgnh dk çdk'ku vfèkd gkrk gA

bl ekd ij fof'k"V vfrfFk Mk- v'kkd dekj lDluk u dgk fd eNvkjk dk eRL; mRiknu eY; vPNk fey bld fy, eRL; mRiknu e lèkkj dh vko';drk gA fof'k"V vfrfFk egkn; u bl lLFkku dh miyfCèk;k ij çdk'k Mkyr g; lLFkku d fun'kd Mk- clr dekj nkl dh ljkguk dhA

rduhdh l=k d nkjku cMh l[;k e 'kkèk vkj ykdfç; y[kk dk çkIr fd;k x;kA blfy, y[k çLrrhdj.k d fy, nk rduhdh l= cuk; x,A bl nkuk rduhdh l=k e cMh l[;k e oKkfudk@'kkèk Nk=&Nk=k, ,o fgrèkkjdk u viu& viu y[k çLrr fd;A bruk gh ugÈ] bl volj ij ikLVj çn'kuh Hkh vk;kftr dh xÃA bl volj ij oKkfudk@'kkèk Nk=&Nk=k, u dy 23 ikLVjk dk çLrrhdj.k fd;kA fun'kd egkn; Mk- clr dekj nkl u lHkh çfrHkkfx;k dk èkU;okn nr g, dgk fd o"k 2019 d flrEcj ekg e Hkh bl rjg dh ,d dk;'kkyk vk;kftr dju dk çLrko gA

Library and Informatics

The Library and Informatics Section of ICAR-CIFRI is one of the oldest repertoire of fish and fishery related books, journals and other documents. With precious collections of more than 10,000 books, 5,000 journals and 5,000 other valuable documents, it facilitates knowledge sharing and enrichment among both internal and outside users. During 2018-2019, ICAR-CIFRI Central library located at Barrackpore added more than 110 numbers of documents including 50 scientific books, 7 complementary books and also subscribed 32 Indian journals (newly added e-planet, Aquaculture Spectrum and *Feere Asuk Sabuj*) to strengthen its resources. Other than documents received from outside, the library has also been enriched with books, leaflets, posters, bulletins, newsletters, roadmaps, policy papers, souvenirs etc. published by CIFRI. The Institute has also strengthened libraries of its six Regional Centres and Stations by procuring books and journals for them.

Library & Informatics Section has four distinct segments - scientific books, journals, CIFRI publications and Hindi books. Whole catalogue of books in Central Library is presently digitized under KOHA Open Source Library Management Software and available for online search through CIFRI website as well as through 'Agricat', a Union catalogue available to all NARS institute for online search. About 300 old documents like bulletins, annual reports, newsletters, policy papers, leaflets etc. have been scanned and uploaded in CIFRI website and 'Krishikosh' for easy download for users. Central library provides softcopy of foreign journals for our users through 'CeRA'. It is regularly updated whenever new books etc are added to the library holdings. CIFRI library has become an active member of 'CeRA' Consortium by sending 20 documents to different NARS institute through Document Delivery request (DDR) during the year. As per visitor's register maintained in HQ library, more than 1000 internal and more than 200 external users have consulted the Library at the Head Quarters during 2018-2019.

A "User Awareness Programme on Oxford Journals and How to publish with Oxford University Press" under CeRA consortium has been organized at HQ on 10.09.2018.

Staff Information

Staff position as on 31.03.2019

Category	Sanctioned Strength	Filled up	Vacant
R.M.P	1	1	-
Scientist	95	89	6
Technical	85	57	28
Administrative	67	42	25
Skilled Support Staff	130	46	84
TOTAL	378	235	143

Head office / centre – wise staff in-position as on 31.03.2019

Name of the Centre	RMP	Scientists	Technicals	Administrative	Skilled Support Staff	Total
Barrackpore	1	55	41	36	27	160
Kolkata	-	4	1	-	-	5
Vadodara	-	4	3	1	6	14
Allahabad	-	8	6	2	5	21
Bangalore	-	7	1	2	3	13
Guwahati	-	8	2	1	3	14
Kochi	-	3	2	-	2	7
TOTAL	1	89	56	42	46	235

Financial Up-gradation under MACP

Sl. No.	Name of the candidate with designation and grade	Benefits granted	Date of effect
1	Shri. R. Nagarrajan, SSS,	3rd MACP with grade pay of ? 2400/L-4	14.04.2018
2	Shri. Sarbeswar Kalita, SSS,	3rd MACP with grade pay of ? 2400/L-4	16.04.2018
3	Shri. Shabbir Ahmed, SSS,	2nd MACP with grade pay of ? 2000/L-3	23.04.2018
4	Shri. Sukhen Das, SSS,	2nd MACP with grade pay of ? 2000/L-3	09.06.2018
5	Shri. Prabodh Ranjan Mahata, SSS,	2nd MACP with grade pay of ? 2000/L-3	15.06.2018
6	Shri. Amarnath Prasad, SSS	3rd MACP with grade pay of ? 2400/L-4	07.11.2018
7	Ms. U.S. Ram, SSS	3 MACP with grade pay of ? 2400/L-4	07.11.2018
8	Shri. Prokash Chandra Pramanick	3rd MACP with grade pay of ? 2400/L-4	16.11.2108

Headquarter, Barrackpore
Director
Dr. B. K. Das
Head of Division
Dr. V. R. Suresh
Dr. B. P. Mohanty
Dr. U. K. Sarkar
Principal Scientist
Dr. S . Samanta
Dr. Malay Naskar
Dr. S. K. Nag
Dr. B. K. Behera
Dr. S. K. Manna
Dr. M. A. Hassan
Dr. A. K. Das
Dr. R. K. Manna
Dr. Md. Aftabuddin
Dr. Archana Sinha
Dr. Arun Pandit
Dr. Hemanta Chowdhury
Dr. A. K. Bera
Senior Scientist
Dr. A. K. Sahoo
Scientist
Shri P. Maurye
Shri Ganesh Chandra
Dr. (Ms.) Aparna Roy
Shri S. K. Sahu
Dr. (Ms.) Sajina A.M.
Dr. (Ms.) Soma Das Sarkar
Dr. Rohan Kumar Raman
Ms. Tanuja Abdulla
Dr. P. K. Parida
Ms. Prajna Ritambhara Behera
Shri Roshith C.M.
Shri Raju Baitha
Ms. Suvra Roy
Dr. (Ms.) Kavita Kumari
Shri S. K. Koushlesh

Scientist (Contd.........)
Shri M. H. Ramteke
Shri Shravan Kumar Sharma
Ms. Thangjam Nirupada Chanu
Dr. D. K. Meena
Dr. (Ms.) Suman Kumari
Shri Vikash Kumar
Dr. Lianthuamluaia
Ms. Gunjan Karnatak
Shri Mishal P.
Shri. Himanshu Sekhar Swain
Shri. Tasso Tayung
Ms. Pritijyoti Majhi
Ms. Anjana Ekka
Ms. Tanushree Bera
Ms. J. Canciyal
Dr. Dhruba Jyoti Sarkar
Ms. Piyashi DebRoy
Shri Rahul Das
Ms. Chayna Jana
Ms. Sukanya Som
Ms. Sangeetha M Nair
Ms. Manoharmayum Shaya Devi
Shri Santhana Kumar V.
Technical Staff
Dr. Sanjay Bhowmick
Ms. Keya Saha
Ms. K. Sucheta Majumder
Shri Raban Chandra Mandi
Shri Chandra Nath Mukherjee
Md. Quasim
Shri Sujit Chowdhury
Ms. Sunita Prasad
Shri Soumitra Roy
Shri Abhijita Sengupta
Shri L. R. Mahaver
Dr. Khaja Syed Shahul Hameed
Shri Samir Kumar Paul
Shri Asish Chakraborty

Technical Staff (Contd……)
Shri Arun Kumar Mondal
Shri Sudarsan Bandopadhyay
Shri Debasis Saha
Shri Ashis Roy Chowdhury
Shri Suvra Saha
Shri. Subrata Das
Shri Atanu Das
Shri Santosh Kumar Biswas
Shri Arijit Ghsoh
Shri Lokenath Chakraborty
Shri Yousuf Ali
Shri Manabendra Roy
Shri Sanjay Kumar Das
Shri Rabiul Sk.
Shri Subhendu Mondal
Shri Bablu Kumar Naskar
Shri T. K. Halder
Shri Giridhari Paramanick
Shri Asim Kumar Jana
Shri Anjon Kumar Talukder,
Ms. Sumedha Das
Ms. Sadrupa Bhowmick
Ms. Sangeeta Chakraborty
Shri Kausik Mondal
Shri Avishek Saha
Md. Naim
Shri Rakesh Pal
Ms. Ambily M. N
Administrative Staff
Shri Rajeev Lal
Shri NVRN Murty
Shri Sudipta Gupta

Administrative Staff (contd......)
Shri Biswajit Barua
Shri Sujit Ghosh
Shri S.S. Ghosh
Ms. Sefali Biswas
Ms. Paushali Mukherjee
Shri Subir Das
Shri Chandan Chakraborty
Shri Ganesh Chandra Barman
Shri Ashwini Kumar
Ms. Jolly Saha
Shri Pratyay Sarkar
Shri Santosh Sarkar
Shri Raushan Kumar
Ms. Shyamali Mitra
Shri Sukumar Sarkar
Shri Kishore Shaw
Ms. Ruma Ghosh
Shri M. Joarder
Ms. Swapna Chattopadhyay
Ms. Mousumi Banerjee
Shri Bijoy Roy
Shri Pradipta Sen
Shri Suranjan Singh
Shri Fazal Khan
Shri B. L. Dhanuk
Shri Ganesh Bhanja
Ms. Sohini Chatterjee
Shri Somenath Banerjee
Ms. Sreemanti Saha

Skilled Support Staff
Shri P. C. Paramanick
Shri D. K. Das
Shri A. N. Prasad
Shri U. S Ram
Shri Gopal Ch. Roy
Shri M. L. Sarkar
Shri Sukhen Das
Shri Anil Ch. Das
Shri Manabendra Dutta
Shri Shibani Bhattacharya
Shri P. R. Mahata
Shri Shabbir Ahmed
Ms. Bindu Singh
Ms. Kalyani Biswas
Shri Ravi Kumar Sonkar
Srhi B. K. Sahani
Shri Ratan Das
Shri Debshish Singha
Shri B. Shankar Reddy
Shr Tapan Kumar Bhattacharjee
Ms. Anita Ganesh Gawate
Shri Ashok Kumar Nishad
Shri Ajay Kumar Nishad
Shri Jayanta Pramanick
Shri Niranjan Kumar
Shri Divakar R.
Shri Anil Kumar

Allahabad Regional Research Centre
Scientist
Dr. R. S. Shrivastava (In-Charge)
Dr. Dharm Nath Jha
Md. Absar Alam
Shri S. C. Sukla Das
Shri Jeetendra Kumar
Shri V. Ramrao Thakur
Shri Vikas Kumar
Ms. Monika Gupta
Technical
Dr. (Ms.) Kalpana Srivastava
Shri S. R. Meena
Shri S. K. Srivastava
Shri Vijay Kumar
Shri Ram Sajiwan
Shri Jitendran Kr. Singh
Administrative
Ms. Divya Jain
Shri Manish Kumar Singh
Skilled Support Staff
Shri Gopal Chand
Shri Jairam Prasad
Ms. Laxmi Devi
Shri Munshi Ram Rana
Shri Kamlesh Kumar

Guwahati Regional Research Centre
Scientists
Dr. B. K. Bhattacharjya, Acting Head
Ms. Sona Yengkokpam
Dr. Dipesh Debnath
Dr. Shri Anil Kumar Yadav,
Shri Pranob Das ,
Ms. Niti Sharma
Shri Simanku Borah
Shri N. S. Singh
Technical
Shri Bipul Ch. Ray
Shri Amulya Kakati
Administrative
Shri Ranjit Kumar Roy
Skilled Support staff
Shri N. Deka
Shri S. Kalita
Shri Hemanta Das

Bangalore Regional Research Centre
Scientist
Dr. (Ms.) Preetha Panikkar (In-Charge)
Shri M. Feroz Khan
Shri M. Karthikeyan
Ms. Ramya V. L.
Ms. Sibina Mol
Shri Ajoy Saha
Ms. Jesna P. K.
Technical
Shri Vijay Kumar M. E.
Administrative
Ms. G. Vinodalaxmi
Ms. S. Sumithra Devi
Skilled Support staff
Shri M. Pennappa
Shri M. Mari
Shri R. Nagrrajan

Vadodara Regional Research Centre
Scientist
Shri. Kamble Suhas Prakash (In-Charge)
Dr. Dibakar Bhakta
Shri W. Anand Meetei
Shri Vaisakh G .
Technical
Shri R. K. Sah
Shri Solanki Jayesh K.
Shri Ram Prasad
Administrative
Shri C. D. Parmer
Skilled Support Staff
Shri R. N. Kantibhai
Shri H. J. Chetanbhai
Shri Machi Suresh Bhai Chimanbhai
Shri Tadvi Santibhai Chandubhai
Shri Dangar Arjan Valabhai
Ms. Harshaben A. Joshi

Kochi Research Station
Scientist
Dr. Rani Palaniswamy (In-Charge)
Dr. (Ms.) Thankam Theresa Paul
Dr. (Ms.) Deepa Sudheesan
Technical
Shri S. Monoharan
Ms. Usha Unnithan
Skilled Support staff
Shri P.V. Shajil
Shri T.V. Velayudhan

Salt Lake Research Centre
Scientist
Dr. S. K. Das (In-Charge)
Dr. Debabrata Das
Shri Pronob Gogoi
Shri K. Lohith Kumar
Technical
Shri Arunava Mitra

Appointment

Scientist

Ms. Sukanya Som, Scientist, Agricultural Extension joined the institute on 30 July 2018

Three ARS scientists of Fisheries Resource Management discipline joined ICAR-CIFRI
(Their date of joining are given in the parenthesis.)

Ms. Sangeetha M. Nair (06 Sept 2019)

Shri. Santhana Kumar V.(09.10.2018)

Ms. M. Shaya Devi (09.10.2018)

Lower Division Clerk (LDC)/ Stenographer

Sreemanti Saha, LDC (09.11.2018)

Syed Abol Kabi, LDC (13.11.2018)

Ms. Ankita Ghosh, LDC (14.11.2018)

Shri. Debasish Acharya, LDC (16.11.2018)

Shri. Aritra Datta, LDC (10.12.2018)

Sohini Chatterjee, Stenographer (16.03.2019)

Appointment

Technical

Shri Anjon Kr. Talukder (02.11.2018)

Ms. Sadrupa Bhowmick (02.11.2018)

Ms. Sumedha Das (02.11.2018)

Ms. Sangeeta Chakraborty (12.11.2018)

Shri Kausik Mondal (13.11.2018)

Shri Avishek Saha (07.01.2019)

Mohammed Naim (01.02.2019)

Shri Rakesh Pal (20.02.2019)

Ms. Ambily M. N. (27.02.2019)

Appointment

Skilled Support Staff (SSS)

Shri B. Shankar Reddy (12.10.2018)

Shri Tapan Kr. Bhattacharjee (12.11.2018)

Ms. Anita G. Gawate (15.10.2018)

Shri Ashok Kumar Nishad (15.10.2018)

Shri Ajay Kumar Nishad (15.10.2018)

Shri Jayanta Pramanik (22.10.2018)

Shri Niranjan Kumar (29.10.2018)

Shri Divakar Rajendran (10.11.2018)

Promotion

Scientist

Sl. No.	Name	Promoted	Effective from
1.	Dr. (Ms.) Sona Yengkopam	Senior Scientist	07.01.2017
2.	Dr. Dipesh Debnath, Scientist	Senior Scientist	26.02.2017
3.	Dr. Rohan Kumar Raman	Scientist (Sr. Scale)	01.07.2017
4.	Dr. Lianthuamluaia	Scientist (Sr. Scale)	01.01.2018
5.	Dr. Dibakar Bhakta	Scientist (Sr. Scale)	01.01.2018
6.	Dr. Amiya Kumar Sahoo	Senior Scientist	10.02.2018

Technical

Sl. No.	Name	Promoted	Effective from
1	Ms. Sunita Prasad	ACTO	04.10.2016
2	Shri Lokenath Chakraborty	TO	30.05.2017
3	Shri Asish Chakraborty	TO	18.02.2018
4	Shri J.K. Singh	STA	15.01.2018
5	Shri S.K. Das	STA	11.09.2018
6	Ms. Keya Saha	CTO	01.01.2017
7	Dr. Kalpana Srivastava	CTO	01.01.2017

Administrative

Sl. No.	Name	Promoted	Effective from
1	Ms. Mousumi Banerjee	Assistant	28.05.2018
2	Shri Bijay Roy	Assistant	28.05.2018
3	Shri Pradipta Sen	Assistant	28.09.2018
4	Shri Ganesh Bhanja	UDC	28.09.2018
5	Shri Somenath Banerjee	LDC	28.09.2018
6	Shri B. L. Dhanuk	UDC	03.10.2018
7	Shri Chandan Chakraborty	AAO	16.03.2019
8	Shri Ganesh Chandra Barman	AAO	16.03.2019

Transfers

Sl. No.	Name & Designation	From	To
Inter Institutional Transfer			
1	Shri. Lohith Kumar, Scientist	CIARI, Port Blair	ICAR-CIFRI, Kolkata
2	Ms. Chayna Jana, Scientist	ICAR-IISWC, Dehradun	ICAR-CIFRI, Barrackpore
3	Shri D. Karunakaran	ICAR-CIFRI, Barrackpore	ICAR-CIARI, Port Blair
4	Shri N. R. Naik	ICAR-CIFRI, Barrackpore	ICAR-CIFT, Kochi
5	Ms. Sandhya K.M.	ICAR-CIFRI, Barrackpore	ICAR-CIFT, Kochi
6	Shri N.V.R.N. Murty, SF&AO	ICAR-CIFA, Bhubaneswar	ICAR-CIFRI, Barrackpore
7	Shri Ashwini Kumar, A F&AO	ICAR-IINRG, Ranchi	ICAR-CIFRI, Barrackpore
8	Ms. Harshaben A. Joshi, SSS	ICAR-CIFT Veraval Research Centre	ICAR-CIFRI, Vadodara
9	Ms. M. G. Soudamini, SSS	ICAR-CIFRI, Kochi	ICAR-CIFT, Kochi
Intra Institutional Transfer			
1	Dr. Archana Sinha, Pr. Scientist	ICAR-CIFRI, Kolkata	ICAR-CIFRI, Barrackpore
2	Shri Vkas Kumar, Scientist	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Allahabad
3	Dr. Monika Gupta, Scientist	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Allahabad
4	Shri S.R. Meena, ACTO	ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Allahabad
5	Shri Anil Kumar, SSS	ICAR-CIFRI, Allahabad	ICAR-CIFRI, Barrackpore

Superannuation

Sl. No.	Name	Last place of posting	Date of Superannuation
1	Shri S. Govindarajan, SSS	ICAR-CIFRI, Kochi	30.04.2018
2	Shri K. C. Malakar, SSS	ICAR-CIFRI, Barrackpore	31.05.2018
3	Shri Sitala Prasad, SSS	ICAR-CIFRI, Allahabad	31.07.2018
4	Shri D. K. Biswas, CTO	ICAR-CIFRI, Barrackpore	30.11.2018
5	Shri K. K. Sharma CTO	ICAR-CIFRI, Guwahati	31.01.2019
6	Smt. Suvra Bhattacharya, UDC	ICAR-CIFRI, Kolkata	31.01.2019
7	Shri Swapan Kumar Das, Time Keeper	ICAR-CIFRI, Barrackpore	31.01.2019
8	Shri Santosh Kumar Biswas, TO	ICAR-CIFRI, Barrackpore	31.03.2019

Probation clearance of Scientists

Name of the Scientists	Discipline	Date of initial appointment	Date of completion of Probationary period (2 years)	Present place of posting
Shri Tasso Tayung	Aquaculture	01.01.2016	31.12.2017	ICAR-CIFRI, Barrackpore
Shri Pranab Gagoi	Fisheries Resource Management	01.01.2016	31.12.2017	ICAR-CIFRI, Kolkata
Shri Himanshu Sekhar Swain	Aquaculture	01.01.2016	31.12.2017	ICAR-CIFRI, Barrackpore
Shri Ramteke Mitesh Hiradas	Aquaculture	01.01.2016	31.12.2017	ICAR-CIFRI, Barrackpore
Ms. Piyashi DebRoy	Agricultural Economics	01.01.2015	31.12.2016	ICAR-CIFRI, Barrackpore
Ms. Jesna P. K.	Aquaculture	01.01.2015	31.12.2016	ICAR-CIFRI, Bengaluru
Shri Vikas Kumar	Agricultural Chemicals	01.01.2016	31.12.2017	ICAR-CIFRI, Allahabad
Ms. Prajna Ritambhara Behera	Fisheries Resource Management	01.01.2016	31.12.2017	ICAR-CIFRI, Barrackpore

Condolence

1) Shri P.S.C. Bose, Technical Officer (Retd.)- (Expired on 11th January, 2019) Condolence held on 28th January, 2019

2) Shri N. Subramani, SSS (Expired on 9th January, 2019) Condolence held on 10th January, 2019

3) Shri B.C.Bhattacharjee, Ex-Superintendent (Expired on 11th October, 2018) Condolence held on 23rd October, 2018

Publications

Research Paper

Alam NM, Jana C, Bharman D, Sharma B, Singh D, Mishra PK and Sharma NK (2018). Twentieth century rainfall trends of Uttarakhand, India: A spatio-temporal analysis. *Climate Change and Environmental Sustainability*, 6(2): 104-113.

Baitha R, Ray A, Karna SK, Chanu TN, Swain HS, Ramteke MH, Singh A, Manna RK and Das BK (2018). Length–weight relationships for four fish species from lower stretch of River Ganga, India. *Journal of Applied Ichthyology*, 34(5): 1195-1197.

Baitha R, Karna SK, Ray A, Chanu TN, Swain HS, Ramteke MH, Bayen S, Manna RK and Das BK (2018). Length–weight and length–length relationships of eight fish species from river Ganga, India. *Journal of Applied Ichthyology*, 34(4): 1052-1054.

Baitha R, Manna SK, Suresh VR, Paniprasad K and Naskar M(2018). Topographic distribution pattern of *Postho diplostomum* sp. *metacercaria*e on body surface of Cyprinid fishes of river Ganga. *Journal of Inland Fisheries Society of India*, 50 (2):73-78.

Behera BK, Bera AK, Paria P, Das A, Parida PK, Kumari S, Bhowmick S and Das BK(2018). Identification and pathogenicity of *Plesiomonas shigelloides* in Silver Carp. *Aquaculture*, 493: 314–318.

Behera BK, Das A, Paria P, Sahoo AK, Parida PK, Abdulla T and Das BK(2019). Prevalence of microsporidian parasite, *Enterocytozoon hepatopenaei* in cultured Pacific White shrimp, *Litopenaeus vannamei* (Boone, 1931) in West Bengal, East Coast of India. *Aquaculture International*, 27(2): 609-620.

Bera K, Tarun TK, Bhattacharya M, Dutta TK, Kar A, Chini DS, Patra S, Senapati D, Bera A, Ghosh S, Das BK and Patra BC (2018). Community based fish farming in low land paddy fields in Moyna, West Bengal, India. *Journal of Aquaculture*, 24 : 26-40.

Bhakta D, Meetei WA, Vaisakh G, Das SK and Manna RK(2018). Impacts of water regulation on *Tenualosa ilisha* in the Narmada estuary, Gujarat. *Indian Journal of Fisheries*, 6(1): 563-568.

Bhakta D, Meetei WA, Vaisakh G, Kamble S, Das SK and Das BK (2018). Finfish diversity of Narmada estuary in Gujarat of India. *Proceedings of the Zoological Society,* doi.org/10.1007/s12595-018-0263-1.

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Leaflets

Freshwater Ornamental Fish Keeping for Beginners

Hilsa Life Story

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Jalabhumite Jalabayu Sanbedanshil Matsya Abhijojan Prayukti: Gherar madhye Machh Chas

Fish health management in floodplain wetlands of Assam

Sirhind Canal in Punjab: A potential resource for fisheries development – ICAR-CIFRI initiative

Cage Culture of *Pangasianodon hypothalamus* in inland open water

Restoration and conservation of fisheries of river Ganga

Climate change impact on ecology and fisheries of Vembanad Lake, Kerala and adaptation strategy

Short Documentary Films

Dry fish through winter bagnet fishery – Adding livelihood to Sundarbans

Climate resilient pen culture for floodplain wetland fisheries

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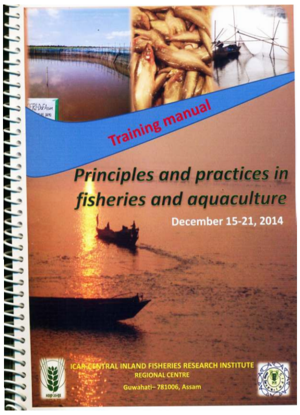
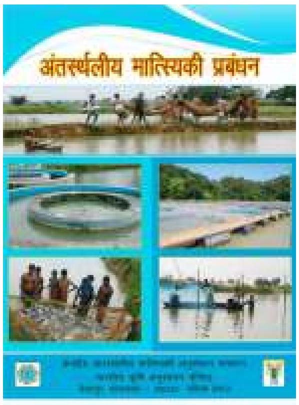
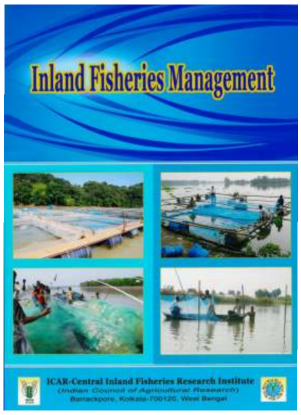
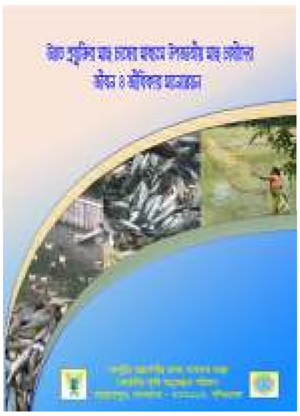
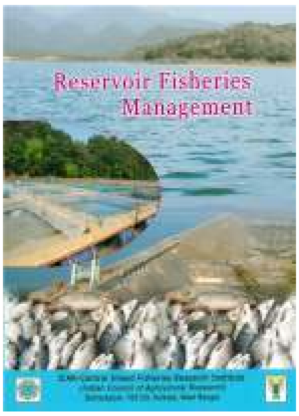
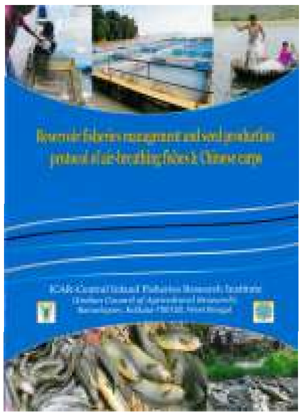










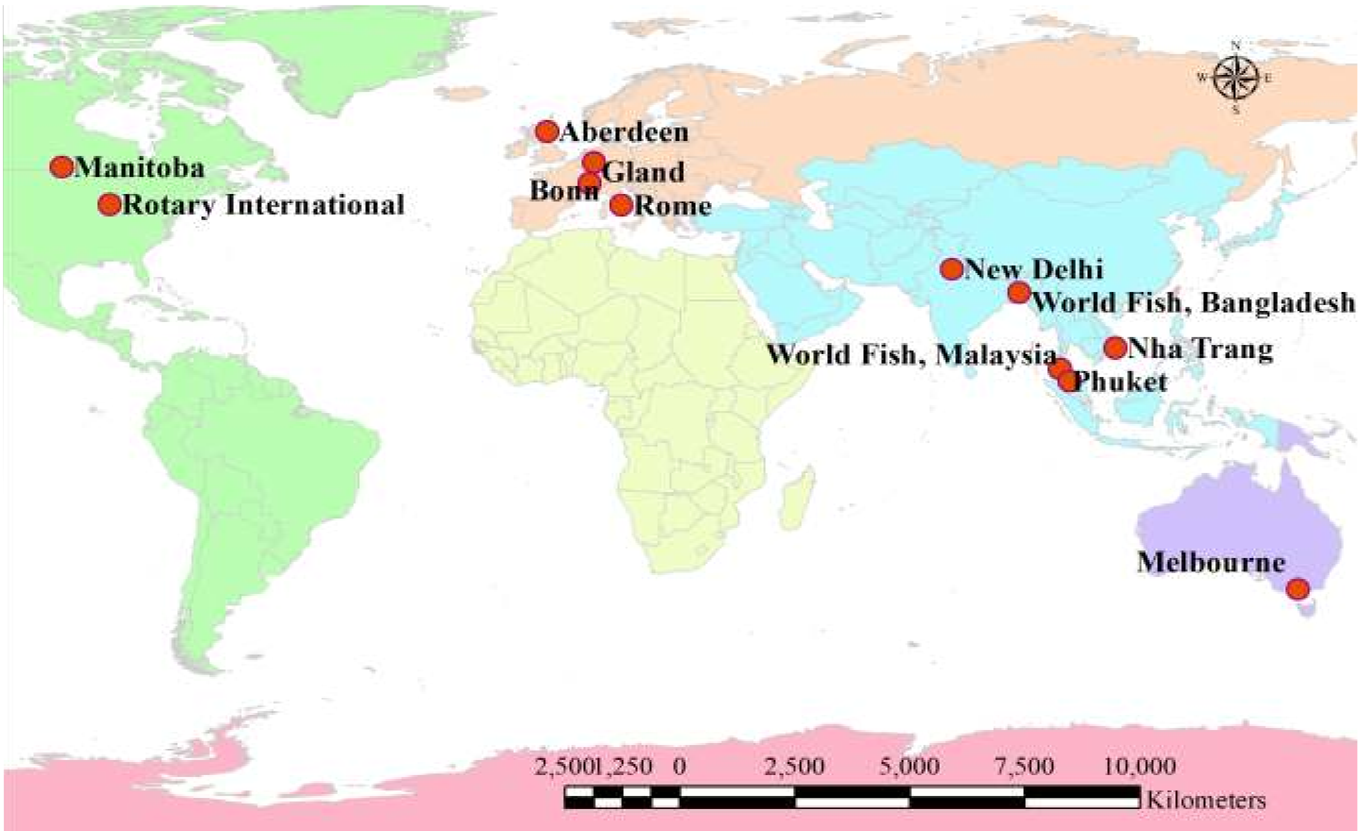


Linkages

Several organizations are involved in fisheries research and development in India and abroad and have intimate linkages with ICAR-CIFRI. Beside research and development, extension, outreach activities, seminars, workshops and publications the Institute has established its linkages through collaboration with several organizations during 2018-19.

International

- Bay of Bengal Large Marine Ecosystem, Thailand
- Food and Agriculture Organization. Italy
- International Union for Conservation of Nature, Switzerland
- RMIT university, Melbourne, Australia
- Rotary International
- The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
- University of Manitoba, Canada
- Wetland International, New Delhi
- WorldFish Centre, Malaysia
- WorldFish, Bangladesh
- World Wide Fund-India, New Delhi, India



National

University

- Assam Agricultural University, Jorhat, Assam
- Assam Fisheries Development Corporation Ltd., Guwahati, Assam
- Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal
- Bihar Animal Science University, Bihar
- Central University of Bihar, Patna
- Cochin University of science & Technology, Kerala
- College of Fisheries, Central Agricultural University, Lembucherra, Agartala
- Department of Zoology, University of Calcutta, West Bengal
- F. M. University Balasore, Odisha
- Garhwal University, Srinagar, Uttarakhand
- Indian Institute of Science Education and Research, Kolkata
- Indian Institute of Technology, Kharagpur
- Indian Statistical Institute, Kolkata, West Bengal
- Manipur University, Imphal, Manipur
- Naini Agricultural Institute, Allahabad, Uttar Pradesh
- Rajendra Agricultural University, Pusa, Samastipur, Bihar
- State Institute of Rural Development, Govt. of Assam
- University of Agriculture Science, Dharward
- University of Allahabad, Uttar Pradesh
- University of Kalyani, Kalyani, West Bengal
- Utkal University, Vari Vihar, Odisha
- Vidyasagar University, Midnapore, West Bengal
- Vinoba Bhabe Uiversity, Jharkhand
- Visva-Bharati University, Santiniketan, West Bengal
- West Bengal University of Animal and Fisheries Sciences, Kolkata, West Bengal

Central Organization

- Bureau of Indian Standards, New Delhi
- Central Water Commission, New Delhi
- Chaudhury Charan Singh National Institute of Agricultural Marketing, Jaipur, Rajasthan
- Chilika Development Authority, Bhubaneswar, Odisha
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi

- Ministry of Environment, Forest & Climate Change, Govt. of India, New Delhi
- National Fisheries Development Board, Hyderabad, Telengana
- National Institute of Oceanography (NIO), Dona Paula, Goa
- National Mission for Clean Ganga, Ministry of Water Resources, New Delhi
- National Water Academy, Pune, Maharastra
- Regional Medical Research Center, Bhubaneswar

ICAR Organization

- ICAR Research Complex for NEH Region, Umiam, Meghalaya
- ICAR-Agricultural Technology Application Research Institute, Kolkata, West Bengal
- ICAR-Agricultural Technology Application Research Institute, Umiam, Meghalaya
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai, Tamil Nadu
- ICAR-Central Institute of Fisheries Education, Mumbai, Maharashtra
- ICAR-Central Institute of Fisheries Technology, Kochi, Kerala
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha
- ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands
- ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala
- ICAR-Central Research Institute of Jute & Allied Fibre, Barrackpore, Kolkata, West Bengal
- ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Uttarakhand
- ICAR-National Academy of Agricultural Research Management, Hyderabad, Telangana
- ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka
- ICAR-National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh
- ICAR-National Institute of Animal Nutrition & Physiology, Bengaluru, Karnataka
- ICAR-National Institute of Natural Fibre Engineering & Technology, Kolkata, West Bengal
- ICAR-National Research Center on Pig, Rani, Assam

State Department

- Assam Fisheries Development Corporation Ltd.
- Assam Rural Infrastructure and Agricultural Services Society (ARIAS)
- Commissioner of Fisheries, Gujarat
- Department of Fisheries, Govt. of Arunachal Pradesh
- Department of Fisheries, Govt. of Manipur
- Department of Fisheries, Govt. of Tripura
- Department of Fisheries, Govt. of Uttarakhand
- Directorate of Fisheries, Goa

- Directorate of Fisheries, Govt. of Andhra Pradesh
- Directorate of Fisheries, Govt. of Assam
- Directorate of Fisheries, Govt. of Bihar
- Directorate of Fisheries, Govt. of Chattishgarh
- Directorate of Fisheries, Govt. of Himachal Pradesh
- Directorate of Fisheries, Govt. of Jharkhand
- Directorate of Fisheries, Govt. of Karnataka
- Directorate of Fisheries, Govt. of Kerala
- Directorate of Fisheries, Govt. of Madhya Pradesh
- Directorate of Fisheries, Govt. of Odisha
- Directorate of Fisheries, Govt. of Telengana
- Directorate of Fisheries, Govt. of Uttar Pradesh
- Directorate of Fisheries, Govt. of West Bengal
- Gujarat Forest Department, Ukai
- Narmada Control Authority, Ministry of Water Resourece, River Development & Ganga Rejuvenation, Govt. of India
- Narmada, Water Resources, Water Supply and Kalpasar Department, Gandhinagar, Gujarat

Industries/Corporation/State Board

- Assam Fisheries Development Corporation
- Farraka Barrage Authority, Murshidabad
- Gujarat Maritime Board, Bharuch
- Hotel & Restaurant Association of Eastern India
- Inland Waterways Authority of India
- Madhya Pradesh Fish Cooperative Federation
- National Bank for Agriculture and Rural Development
- National Biodiversity Authority
- National Hydro Power Company
- North Eastern Electric Power Corporation Limited
- Ramakrishna Mission
- Sardar Sarovar Narmada Nigam Limited
- Satluj Jal Vidyut Nigam Limited
- Sundarban Development Board, West Bengal
- Sundarban Dreams

ICAR-CIFRI in Media

Meeting/Workshop/Seminar Attended

Sl.No.	Name of the Program	Date	Participant	Venue
1.	Meeting for preparation of Regional Committee meeting	10 April, 2018	B. K. Das	ICAR-CIFA, Bhubaneswar
2.	Meeting with Director of Fisheries, Govt. of Odisha	10 April, 2018	B. K. Das	Cuttack, Odisha
3.	Meeting to sign MoU with Director of Fisheries, Govt. of Odisha	11 April, 2018	B. K. Das	Cuttack, Odisha
4.	Inauguration of Wetland Fisheries Development Projects in Champaran District	13 April, 2018	B. K. Das	Champaran District, Motihari, Bihar
5.	Awareness programme at TLD-III and TLD-IV, NHPC	16-19 April, 2018	B. K. Das	New Jalpaigudi
6.	Review meeting with Shri Chhabilendra Roul, Additional Secretary, Department of Agricultural Research & Education, Ministry of Agriculture	21 April, 2018	Preetha Panikkar	ICAR-NIANP, Bangalore
7.	Final consultation meeting for Framing of National Inland Fisheries & Aquaculture Policy in India	26-27 April, 2018	B. K. Das	ICAR-CIFE, Mumbai
8.	Meeting with World Bank team members at Rajiv Bhavan, Department of Water Resources	28 April, 2018	B. K. Das	Bhubaneswar
9.	Workshop on “Cage Culture”	30 April, 2018	B. K. Das	Ganjam, Odisha
10.	Brainstorming Session to discuss and evolve a plan for skilling fisheries sector under ICAR and DADF	02 May, 2018	B. K. Das	NFDB, Hyderabad
11.	12th Call for proposal of Biotechnology Industry Research Assistance Council (BIRAC) under Biotechnology Ignition Grant (BIG) Scheme	02 May, 2018	B. P. Mohanty	Centre for Cellular and Molecular Platforms (C-CAMP), Bangalore
12.	Meeting for a MoU, to be signed between ICAR and WorldFish with regards to work plan for the year 2018-19	03 May, 2018	B. K. Das	ICAR, Krishi Bhavan, New Delhi.
13.	Meeting on project presentations C-CAMP under BIRC/C-CAMP BIG 12 th Call REP Presentation	12 May, 2018	Preetha Panikkar	NCBS, Bangalore
14.	Meeting for preparation of Regional Committee meeting, June 2018	14 May 2018	B. K. Das, B. P. Mohanty	ICAR-CIFA, Bhubaneswar
15.	State Conclave on "Perspective Planning for Resurgent Agriculture & Allied Sector in Arunachal Pradesh”	18-19 May, 2018	B. K. Das	Arunachal Pradesh.
16.	3rd International Symposium on Aquaculture and Fisheries Education	18-19 May, 2018	Archana Sinha	ICAR-CIFE, Mumbai
17.	National Seminar on Recent Trends in Fishery and Ecological Sciences in memory of Prof N. C. Dutta	19 May, 2018	B. P. Mohanty	Rajabazar Science College, Calcutta University
18.	Meeting for signing MoU with Assam Fisheries Federation, Gov of Assam	21 May, 2018	B. K. Das	Department of Fisheries, Assam
19.	Workshop on Ganga and its biodiversity in 2025: Developing a road map for habitat and species conservation	22 May, 2018	B. K. Das	WWF-India Auditorium, New Delhi

Sl.No.	Name of the Program	Date	Participant	Venue
20.	Workshop on "E-flows under IEWP Priority Area 2 (India-EU water partnership) in river basin management	22 May, 2018	B. K. Das A. K. Sahoo	New Delhi
21.	Workshop on Carp polyculture in Village pond organized by ICAR-CIFA, Regional Research Centre, Anand	24 May, 2018	S. P. Kamble	Rajpipla, Gujarat
22.	Meeting with Deputy Director General (Fy. Sc.) and Director, ICAR-CIFA for preparation of Regional Committee meeting to be held in June 2018	25 May, 2018	B. K. Das	Bhubaneswar
23.	1st National Training on "Advanced Analytical Tools - Gas Chromatography Mass Spectrometry".	28 May-1 June, 2018	B. P. Mohanty Aparna Roy, H. S. Swain, Mishal P.	ICAR-CIFRI, Barrackpore.
24.	4th Meeting of the JWG between India and Bangladesh on Fisheries	04 June, 2018	B. K. Das	New Delhi.
25.	Meeting with commissioner cum secretary, Department of Fisheries for finalization of DPR , Subhadrapur	16 June, 2018.	B. K. Das	Bhubaneswar
26.	Meeting with ICAR Regional Committee, Zone – II	22-23 June, 2018	B. K. Das S. Samanta	OUAT, Bhubaneswar
27.	'AgriVikas 2018'	29-30 June, 2018	B. K. Das	National Institute of Agriculture Marketing (NIAM), Bhubhaneshwar
28.	1st Barrackpore Proteomic Workshop (BPW) held at ICAR-CIFRI	27June-2July, 2018	B. P. Mohanty, Mishal P,P.R. Behera,Aparna Roy	ICAR-CIFRI, Barrackpore
29.	Foundation day celebrations of ICAR-NIANP	05 July, 2018	Preetha Panikkar	ICAR-NIANP, Bangalore
30.	National Fish Farmer's day celebrations	10 July, 2018	Preetha Panikkar, Feroz Khan M, Ajoy Saha, Ramya V. L. Jesna, P. K, Sibinamol S	RRC of ICAR-CIFA, Bengaluru
31.	Meeting for preparation of DPR for Subhadrapur Aquaculture cluster near Chilka and Tampara in Ganjam Disrtict of Odisha	13 July, 2018	B. K. Das	Bhubaneswar.
32.	ICAR Foundation Day and Award ceremony	16 July, 2018	B. K. Das, Sunita Prasad	NASC, ICAR, New Delhi
33.	Meeting for deciding Cadre Strength of the Institute	16 July, 2018	B. K. Das	NASC Complex, ICAR, New Delhi
34.	ICAR-CIFRI-Worldfish workshop on "Theory of Change" Window-3 Programunder	16-19 July, 2018	B. K. Das, B.P.Mohanty, A.K.das, B.K Behera, A.K. Sahoo, P.Parida	ICAR-CIFA, Bhubaneswar
35.	Meeting with WorldFish	17-18 July, 2018	B. K. Das	Bhubaneswar
36.	Signing of MoU between ICAR-CIFRI and Directorate of Fisheries, Government of Odisha for installation of cages under State Plan Scheme "Infrastructure for Cage culture"	19 July, 2018	B. K. Das	Bhubaneswar

Sl.No.	Name of the Program	Date	Participant	Venue
37.	Meeting with Hon'ble Minister of Water Resources, RD & GR	25 July, 2018	B. K. Das	Transport Bhavan, New Delhi
38.	Synopsis presentations by Ph.D students	28 July, 2018	B. K. Das	ICAR-CIFE, Mumbai
39.	Workshop on "Application of Biosensor Technology in Inland Fisheries"	01 August, 2018	S. K. Das, S. K. Manna, B. K. Behera, Soma Das Sarkar, Kavita Kumari, Aparn Roy, K. Lohith Kumar, M. H. Ramteke, T. N. Chanu, S. K. Sharma, P. Gogoi, R. Baitha, P. R. Behera, Sibina Mol. S, Dhruba Jyoti Sarkar	ICAR-CIFRI, Barrackpore
40.	Meeting related to the World Bank Project on Blue Revolution : Harnessing the Potential of Aquatic Resources	07 August, 2018	B. K. Das	NITI Aayog, New Delhi
41.	Annual Review Workshop of NICRA Project	07-08 August, 2018	U. K. Sarkar, S. K. Nag	NASC, New Delhi
42.	Town Official Language Implementation Committee (TOLIC)	08 August, 2018	Preetha Panikkar	GPO, Bangalore
43.	Agriculture and Allied Sciences: The Productivity, Food Security and Ecology	13-14 August, 2018	Dibakar Bhakta	FACC, Kalyani (BCKV)
44.	Meeting for release of eDas in the reservoirs of Telangana	14 August, 2018	B. K. Das	Hyderabad
45.	Meeting for release of eDas in the reservoirs of Telangana	14 August, 2018	B. K. Das	Hyderabad
46.	Meeting with Commission-cum-Secretary, Fisheries & ARD Department, Government of Odisha on implementation of different schemes in fisheries sector	18 August, 2018	B. K. Das	Bhubaneswar
47.	Meeting with NHPC with regard to finalization of on-going consultancy projects.	20 August, 2018	B. K. Das	New Delhi
48.	Krishi India 2018 Expo	21 August, 2018	B. K. Das	Pragati Maidan, New Delhi
49.	Hilsa awareness program	21 August, 2018	B. K. Das, S. K. Manna, R. K. Manna, S. Samanta	State Fisheries Department, WB,Kolaghat
50.	Inception workshop of NMHS project on 'Up-scaling of climate-friendly pen aquaculture technology for improved livelihood, employment generation and enhanced income of wetland fishers of North-eastern India'	24 August, 2018	B. K. Das, B. K. Bhattacharjya and scientists of Regional Centre, Guwahati	ICAR-CIFRI, Guwahati
51.	TSP programme at Mayurbhanj and conducting techno feasibility study of Mitrapur quarries of Nilgiri block for cage culture	30 August, 2018	B. K. Das, P. Parida	Balasore, Odisha

Sl.No.	Name of the Program	Date	Participant	Venue
52.	Meeting with Secretary, Department of Fisheries, Govt. of Odisha for Pen culture in Odisha	31 August -01 September, 2018	B. K. Das	Bhubaneswar
53.	Meeting and submitted presentations on project proposals to National Water Mission, New Delhi	04 September, 2018	B. K. Das	National Water Mission, New Delhi.
54.	Interactive Seminar on "User Awareness Programme Oxford Journals and how to Publish with Oxford University Press" under CeRa consortium	10 September, 2018	All Scientists of ICAR-CIFRI, Barrackpore	ICAR-CIFRI, Barrackpore.
55.	Meeting with Deputy Director of fisheries, Palakkkad, Shri. M. Saji as a part of post flood survey on the impact of flood on fisheries	12 September, 2018.	Rani Palaniswamy, D. Sudheesan, T.T. Paul	SFD, Malampuzha
56.	16th Institute Management Committee (IMC) Meeting	14 September, 2018	B. P. Mohanty	ICAR-National Research Centre on Pig (NRC, Pig), Guwahati
57.	Hindi Workshop on "Kaaryaleen Sabdavali ka Parichay"	15 September, 2018	Staff, ICAR-CIFRI, Research Centre, Bangalore	ICAR-CIFRI, Bangalore
58.	Meeting with Deputy Director of fisheries, Kumali, Shri. P. Sreekumar as a part of post flood survey on impact of flood on fisheries	17 September, 2018.	D. Sudheesan, T. T. Paul	SFD, Kumili
59.	Training on Contemporary Techn iques in Fish Biotechnology/Biochemistry and Nutrition (for MFSc student, CIFE, Mumbai)	18-29 September, 2018	B. P. Mohanty	ICAR-CIFRI
60.	Workshop on SSAP- Water Sector for eastern States of the country	19 September, 2018	B. K. Das, V. R. Suresh, S. K. Koushlesh	Bhubaneswar
61.	Meeting to discuss on-going works at Department of Fisheries, Government of Odisha	20 September, 2018	B. K. Das	Bhubaneswar
62.	Inaugural programme of Rotary Foundation related to rural livelihood and literacy mission	24 September, 2018	B. K. Das	Soochana Bhavan, Bhubaneswar
63.	Workshop on "Health of Ramganga and Gomti Rivers – Issues and Way Forward" organised by Central Water Commission (CWC), Upper Ganga Basin Organization (UGBO)	28 September, 2018	S. K. Nag	Lucknow
64.	National Symposium of ISCAR on "Coastal Agriculture: Boosting Production Potential under Stressed Environment"	28 September - 01 October, 2018	S. K. Das	DBSKKV, Maharasthra
65.	Jury Member in the Young Scientists' Conference (YSC) at 4th India International Science Festival (IISF)	3-6 October, 2018	B. P. Mohanty	Indira Gandhi Praatishthan, Lucknow, Uttar Pradesh

Sl.No.	Name of the Program	Date	Participant	Venue
66.	Meeting with WorldFish-Odisha team for the collaborative project	06 October, 2018	B. K. Das	Bhubaneswar
67.	Meeting with Director, Department of Fisheries, Government of Odisha for the DPR of Subhadrapur Aquaculture	06 October, 2018	B. K. Das	Bhubaneswar
68.	1st steering committee meeting on Irrigated agriculture modernization project (TN-IAMP)	10 October, 2018	Rani Palaniswamy	Directorate of Fisheries, Chennai, Tamil Nadu
69.	Assessment Committee Member for assessment promotion of Techn ical Personnel (Category III) of ICAR-CMFRI.	15 October & 13 November, 2018	Preetha Panikkar	ICAR-CMFRI, Kochi
70.	Meeting on Expression of Interest for Setting up of Aquatic Animal Health Laboratory	16 October,2018	S. Samanta	National Fisheries Development Board, Hyderabad
71.	Workshop on 'The Global Food Safety and Regulatory Developments and Food Safety Validation and Verification' organized by IUFoST	23 October, 2018	B. P. Mohanty	CIDCO Exhibition Centre, Mumbai
72.	19th World Congress of Food Science and Technology (IUFoST, 2018)	23-27 October, 2018	B. P. Mohanty	CIDCO Exhibition Centre, Mumbai
73.	60th Foundation Day of Orissa Krushak Samaj	25 October, 2018	B. K. Das, M. H. Ramteke, B. K. Behera	Bhubaneswar
74.	Meeting at ASRB for scientist promotion	30 -31 October, 2018	B. K. Das	ICAR, New Delhi
75.	Swadeshi Science Congress	07-09 November, 2018	D. Sudheesan, T. T. Paul	NIIST
76.	MoU with Director, Department of Fisheries, Government of Odisha for installation of Pens in reservoirs of Odisha	10 November, 2018	B. K. Das	Bhubaneswar
77.	Southern Fisheries Ministers Conference	10-11 November, 2018	Preetha Panikkar	ICAR-CMFRI, Kochi
78.	Meeting with WorldFish-Odisha team for the collaborative project	12 November, 2018	B. K. Das	Bhubaneswar
79.	Farmers' Day programme	20 November, 2018	S. K. Das	ICAR-CSSRI RRS, Canning Town, 24 Paraganas (S), WB
80.	World Fisheries Day organized by Fisheries Research and Informatio n Centre	22 November, 2018	Preetha Panikkar	FRIC, KVAFS University, Bangalore
81.	Lake Conference 2018	23 November, 2018	Feroz Khan M	Indian Institute of Science, Bangalore
82.	National Facilitator's Development programme	25 November- 06 December, 2018	P. Deb Roy	CCS National Institute of Agricultural Marketing, Jaipur,Rajasthan
83.	World Fish Workshop	26.-27 November, 2018	B. K. Das	Penang, Malayasia
84.	Application of open source GIS Software for inland fisheries management	26-30 November, 2018	Aparna Roy	ICAR-CIFRI

Sl.No.	Name of the Program	Date	Participant	Venue
85.	National Interface Meet on "Innovative Approaches for Development of Freshwater Aquaculture in Manipur"	27 November, 2018	B. P. Mohanty	ICAR Research Complex for Northeastern Hill Region, Manipur Centre
86.	Farmers Meet and Awareness programme on scientific aquaculture practices in Manipur	28 November, 2018	B. P. Mohanty	ICAR Research Complex, Manipur Centre, Lamphelpat, Imphal, Manipur
87.	Workshop on Metagenomics in fisheries research	01-02 December, 2018.	B. K. Behera, R. Baitha, Kavita Kumari, S. K. Das, Aparna Roy, Dhruba Jyoti Sarkar	ICAR-CIFRI, Barrackpore
88.	Interactive meeting of the Directors and heads of Centres of ICAR Institutes at Bangalore with the Secretary (DARE) & DG, ICAR.	01 December, 2018	Preetha Panikkar	ICAR-IIHR, Bangalore
89.	Farmers First meeting with the Honorable DG, Directors of Institutes and Heads of Regional Centres of ICAR institutes at Bangalore	01 December, 2018	Preetha Panikkar	ICAR-NIANP Bangalore
90.	ISEE National seminar on “Integrated farming system for enhancing farmers’ income and nutritional security”	05-07 December, 2018	Arun Pandit, Aparna Roy, Sukanya Som, Dibakar Bhakta	Indian Society of Extension Education, New Delhi and WBUAFS, Kolkata
91.	‘India Water Impact Summit 2018’	05-07 December,2018	R. K. Manna	Vigyan Bhawan, Maulana Azad Road, New Delhi
92.	TSP programme at Mayurbhanj and conducting techno feasibility study of Mitrapur quarries of Nilgiri block for cage culture	07 -09 December, 2018	B. K. Das	Mayurbhanj, Odisha
93.	Meeting with WorldFish, Odisha	17 December, 2018	B. K. Das	Bhubaneswar
94.	17th Convocation of National Academy of Veterinary Sciences (NAVS) and National Seminar on Livestock Sector towards One Health, Food Security and Safety,	19-20 December, 2018	B. P. Mohanty	OUAT, Bhubaneswar
95.	Seminar on ‘Modern Technology of Pisciculture and problems of fishermen’	20 December, 2018	R. K. Manna	Kolaghat
96.	SUNDARBAN KRISHTI MELA	20–29 December, 2018	Dr. R. K. Manna	Kultoli, Sunderban
97.	Meeting with Mr. Bratya Basu, Minister, Science and Technology and Biotechnology, Govt. of West Bengal	21 December, 2018	S. Samanta	Salt Lake, Kolkata
98.	Meeting on Proposed action plan for doubling farmers income	22 December, 2018	Preetha Panikkar	ICAR-IIHR, Bangalore
99.	Mass awareness and scoping for TSP activities	26-28 December, 2018	B. K. Das, A. K. Das, Aparna Roy, P. Parida	Raipur, Birbhum, WB

Sl.No.	Name of the Program	Date	Participant	Venue
100.	Mass awareness programme	29 December, 2018	B. K. Das, A. K. Das, Aparna Roy, P. Parida	Gardanmari, Burdwan
101.	Scoping for TSP activities and attending Krishi Unnati Mela	30 December, 2018	B. K. Das, A. K. Das	RKM Sargachi
102.	Meeting on Annual Credit Plan for 2019-20 Seminar of NABARD, Kolkata	09 January, 2018	S. Samanta	Kolkata, West Bengal
103.	Rotary Conference	12-13 January, 2019	B. K. Das	Puri, Odisha
104.	National Seminar on Biotechnological Interventions Towards Stress Management, Department of Biotechnology	12 January, 2019	B. P. Mohanty	Rama Devi Women University, Bhubaneswar
105.	31st All India Congress of Zoology (31st AICZ) and National Seminar on "Climate Smart Aquaculture and Fisheries (CSAF)"	15 – 16 January, 2019	B. K. Das, B. P. Mohanty, A. K. Das, D. Debnath, D. Bhakta, Sona.Y, H. S. Swain, T. N. Chanu, P. Gogoi	College of Fisheries, CAU, Lembucherra.
106.	Conference on Sea and Inland Fish Processing: Krushi Odisha 2019	18 January, 2019	B. K. Das	Biju Patnaik Exhibition Ground, Bhubaneswar
107.	Visit to Mahanadi Delta under 'India-EU Water Partnership–IEWP Programme'	28 January, 2019.	B. K. Das	Bhubaneswar
108.	Brainstorming session	29 January, 2019	B. K. Das	NAAS, ICAR, New Delhi
109.	Director's Conference	31 January -01 February, 2019	B. K. Das	ICAR, New Delhi
110.	19th Indian Veterinary Congress, XXVI Annual Conference of IAAVR and National Symposium on "Innovative progress in animal health and production for sale and secure food under one health program perspective	1-2 February, 2019	B. P. Mohanty	WBUAFS, Belgachia, Kolkata
111.	Fisheries Directors' meeting	02 February, 2019	B. K. Das	SMD, ICAR
112.	XXV meeting of ICAR Regional Committee (VI)	04-05 February, 2019	Vaisakh, G.	Anand Agriculture University, Anand, Gujarat
113.	Meeting at College of Fisheries, (Under Bihar Animal Sciences University, Patna),	07 February, 2019	B. K. Das	Kishanganj
114.	Symposium on "Challenges for the freshwater systems: sensors and treatment technologies."	07 February, 2019	S. K. Manna, R. K. Manna	Bose Institute,Kolkata
115.	Meeting with the Executive Engineer of Kalpasar Department, Gujarat	07 February, 2019	S. Samanta, A. K. Sahoo, S. P. Kamble, D. Bhata, S. Som	Kalpasar Project Office,Vadadora

Sl.No.	Name of the Program	Date	Participant	Venue
116.	Interactive workshop on "Openwater fisheries management of NE region"	12 February, 2019	B. K. Das, Aparna Roy	ICAR-CIFRI Regional Centre, Guwahati
117.	International Conference on 'River Health: Assessment to Restoration (RHAR-2019) 'organised by Department of Civil Engineering,	14-16 February, 2019	S. K. Nag, Soma Das Sarkar	IIT (BHU), Varanasi
118.	Interactive Workshop on 'Openwater Fisheries Management of Manipur' in collaboration with Directorate of Fisheries, Department of Fisheries, Govt. of Manipur	18 February, 2019	B. K. Das, A. K. Das, D. Debnath, Sona.Y	Imphal, Manipur
119.	XIV Agricultural Science Congress	20-23 February, 2019	S. K. Manna,U.K.Sarkar, B. P. Mohanty, A. K. Das,S.Ali Dhruba Jyoti Sarkar	NASC & ICAR, NASC Complex, New Delhi
120.	Expert Member DPC Meeting for Promotion of Scientist	25 February, 2019	B. P. Mohanty	ICAR-NIASM, Baramati
121.	Meeting with the Sub-committee of Parliamentary Committee on Official Languages visiting Allahabad to supervise the activities related to Rajbhasha (Hindi) Implementation	26 February, 2019.	B. K. Das, S. Samanta, P. Putra, S. Chopra, S. Srivastava, D. N. Jha, Rajeev Lal	Allahabad centre of ICAR-CIFRI
122.	Ranching-cum-mass awareness programme	26 February, 2019	B. K. Das S. Samanta S. Srivastava	Sangam, Prayagraj
123.	Meeting with Director of Fisheries, Department of Fisheries, Government of Odisha for discussion on collaborative project	01-02 March, 2019	B. K. Das	Bhubaneswar
124.	Workshop on 'Climate change impact on inland open water fisheries: Status and Way forward'	15 March, 2019	S. K. Nag, Soma Das Sarkar, Chayna Jana, Kavita Kumari, Nirupada Chanu, P. Gogoi , M. H. Ramteke, Shravan Sharma, Arun Pandit, M. Karthikeyan, Ajoy Saha, Jesna P. K., Sibina Mol S, Aparna Roy, S. K. Das, Dhruba Jyoti Sarkar, Piyashi DebRoy	ICAR-CIFRI, Barrackpore

Sl.No.	Name of the Program	Date	Participant	Venue
125.	Hindi workshop on “Jibika-uparjan me antar sthaliya matsiki ki bhumika”	16 March, 2019	S. K. Manna, D. Debnath, D.Bhakta, Chayna Jana, Kavita Kumari, R. Baitha, R. K. Manna, A. K. Sahoo, T. N. Chanu, Lohith Kumar, P. Gogoi, M. H. Ramteke, S. Sharma, A. Sinha, M. Karthikeyan, A. Saha, Jesna P. K., Sibina Mol. S, A. Pandit, G. Chandra, S. K. Das	ICAR-CIFRI, Barrackpore
126.	Interaction meeting with farmers for deciding SCSP activities	21 March, 2019	B. K. Das	Jaleswar, Balasore, Odisha
127.	6th Evaluation and Monitoring Committee (EMC) Meeting, FSSAI	29 March, 2019	B. P. Mohanty	FDA Bhawan, New Delhi




Distinguished Visitors

- Dr. Jose T. Mathew, IFS, PCCF, RMD, Govt. of West Bengal (22.05.2018)
- Professor Abhijit Chakrabarti, Dean, Saha Institute of Nuclear Physics, Kolkata (30.06.2018)
- Professor Vipul Bansal, RMIT University, Australia (01.07.2018)
- Dr. Arun Padiar, Project Manager, Odisha WorldFish Project, Directorate of Fisheries, Cuttack, Odisha (03.07.2018)
- ShwuJiau Teoh, GIS Manager, WorldFish Headquarters, Malaysia (03.07.2018)
- Shri Sandeep Kumar Sultania, IAS, Secretary, Animal Husbandry and Fisheries, Telengana (06.07.2018)
- Shri G. Kalyan Kumar, OSD to Minister for Fisheries, Government of Telengana (06.07.2018)
- Dr. A. N. Roy, Director, ICAR - National Institute of Natural Fibre Engineering and Technology (erstwhile NIRJAFT) (10.07.2018)

- Prof. B. C. Mall, Vice Chancellor of JIS Group University, Kalyani (10.07.2018)
- Shri Swami Atmapriyanandji, Vice Chancellor, Ram Krishna Vivekanand University and Research Institute, Belur Math, West Bengal (10.07.2018)
- Professor Anjan Kr. Dasgupta, Department of Biochemistry, University of Calcutta (01.08.2018)
- Shri Radha Mohan Singh, Hon'ble Agriculture Minister, Ministry of Agriculture and Farmer's Welfare, Government of India (17.08.2018)
- Smt. Madhavi Agarwal, Member of BOG, Nehru Yuva Kendra Sangathan, Government of India (20.08.2018)

- Dr. J. K. Jena, DDG (Fisheries and Animal Sciences), Indian Council of Agricultural Research, New Delhi (24.08.2018)
- Prof. R. N. Goswami, Dean, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati (24.08.2018)
- Shri J. K. Samal, Deputy General Manager, National Bank for Agriculture and Rural Development, Guwahati (24.08.2018)
- Shri H. Biramani Singh, Director of Fisheries, Govt. of Manipur, Manipur (24.08.2018)
- Dr. Swaraj Rajkhowa, Director, National Research Centreon Pig, Guwahati (24.08.2018)

- Dr. C. K. Murthy, Joint Director of Fisheries (retd), Department of Fisheries, Govt. of Karnataka and Former Executive Director, National Fisheries Development Board, Hyderabad (27.08.2018 in Bangalore Centre)
- Mr. Ramakrishna, Joint Director of Fisheries (Inland), Karnataka (27.08.2018 in Bangalore Centre)
- Dr. Chandish R. Ballal, Director, ICAR-National Bureau of Agricultural Insect Resources (29.08.2018 in Bangalore Centre)
- Dr. B. V. Krishnamurthy, Chief Scientific officer, Inland Fisheries, University of Agricultural Sciences, Bangalore, (10.10.2018, In Bangalore Centre)

- Dr. Madhumita Nandi Ghosh, Assistant Director of Agriculture, North 24 Paraganas, West Bengal (15.10.2018)
- Professor Goutam Chowdhury, Shiv Nadar University, Gautam Budhha Nagar, Uttar Pradesh (20.11.2018)
- Dr. A.Gopalakrishnan, Director, ICAR - Central Marine Fisheries Research Institute, at Kochi Centre(14.11.2018)
- Ms. Madhabi Agarwal, Governing Body Member, Nehru Yuva Kendra, Kolkata (20.11.2018)
- Shri Pradipsinha Vaghela, Secretary, Bharatiya Janata Party, Gujarat (20.11.2018)
- Shri Nabin Kumar Naik, State Director, Nehru Yuvak Kendra Sangathan, West Bengal (20.11.2018)

- Shri Pradeep Bagela, Vice Chairman, Nehru Yuva Kendra(20.11.2018)
- Dr. P. K. Agarwal, ADG, National Agricultural Science Fund, Indian Council of Agricultural Research, New Delhi (01.12.2018)
- Dr. George John, Former Vice Chancellor, Birsa Agricultural University (03.12.2018)
- Dr. Sanjib Bandyopadhyay, DDG, Indian Meteorological Department, Kolkata (03.12.2018)
- Prof. Kalyani Ray, Head of Gynaecology and Obstetrics Department, West Bengal University of Animal and Fishery Sciences, Kolkata (WBUA&FS) (04.12.2018)
- Prof. K. C. Dora, Former Dean, College of Fisheries, West Bengal University of Animal & Fishery Science (04.12.2018)

- Professor S.K. Pal, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (05.12.2018)
- Shri Subhrata Mandal, Chief General Manager, National Bank for Agriculture and Rural Development, Kolkata (05.12.2018)
- Dr. S.C. Pathak, Retd. Chief General Manager, National Bank for Agriculture and Rural Development, Mumbai (15.12.2018)
- Dr. V.R. Chitranshi, Ex-ADG, Indian Council of Agricultural Research, New Delhi (15.12.2018)
- Dr. C. Vasudevappa, Vice Chancellor, National Institute of Food TechnologyEntrepreneurship and Management, Ministry of Food Processing Industries, Government of India (15.12.2018)
- Dr. Anil Rai, HoD and Coordinator, CABin, ICAR-Indian Agricultural Statistics Research Institute, New Delhi (01.12.2018 & 10.01.2019)
- Dr. L. M. Bhar, Director, ICAR-Indian Agricultural Statistics Research Institute, New Delhi (10.01.2019)
- Dr. J. K. Jena, DDG (Fisheries & Animal Sciences), Indian Council of Agricultural Research (ICAR), New Delhi (10.01.2019)
- Shri Narendra Chandra DebBarma, Hon'ble Minister of Fisheries, Govt. of Tripura (04.01.2019)

- Dr. Afroz Ahmad, Member, National Wetland Committee, Ministry of Environment and Forests, Government of India, Bidar, Karnataka (11.01.2019)
- Dr. S. M. Shivaprakasha, Director of Extension Karnataka Veterinary, Animal & Fisheries Sciences University (05.02.2019)
- Professor G. N. Chattopadhyay, Formerly at Viswa-Bharati University, Shantiniketan (05.02.2019)
- Professor B. Madhusoodana Kurup, Former Vice-Chancellor, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala(05.02.2019)
- Dr. H. C. Joshi, Former Head and Principal Scientist, Indian Agricultural Research Institute, New Delhi (05.02.2019)
- Dr. P. Jeneyferck, Deputy Director of Fisheries, Krishnagiri (05.02.2019, at Bangalore Centre, ICAR - CIFRI)
- Dr. Pravin Putra, ADG (Marine Fisheries), ICAR, New Delhi (05.02.2019)
- Shri Nitin Gadkari, Hon'ble Minister for Road Transport and Highway at Allahabad Centre(08.02.2019)
- Dr. A. K. Tripathi, Director, ICAR-Agricultural Technology Application Research Institute, Zone-VI, Guwahati (12.02.2019)

- Dr. Usha Moza, Former Principal Scientist of Fisheries Division, Indian Council of Agricultural Research, New Delhi (12.02.2019)
- Dr. S. C. Pathak, Former Chief General Manager, National Bank for Agriculture and Rural Development (Regional Office) at Regional Centre, Guwahati (12.02.2019)
- Dr. Yugraj Singh Yadava, Director, Bay of Bengal Inter-Governmental Organization (04.03.2019)
- Shri Intisar A. Siddiqui, Assistant Commissioner (Fisheries) Department of Fisheries, Ministry of Agriculture and Farmers' Welfare, New Delhi (04.03.2019)
- Dr. M. Prabhakar, PI, National Initiative on Climate Resilient Agriculture(NICRA), ICAR-Central Research Institute for Dryland Agriculture(CRIDA), Hyderabad(15.03.2019)

- Dr. VijayalakhsmiSaxena, General President, Indian Science Congress (16.03.2019)
- Dr. Ashok Kumar Saxena, Former General President, Indian Science Congress (16.03.2019)
- Dr. A. G. Ponnaiah, Former Director, Central Institute of Brackishwater Aquaculture (15.03.2019)
- Dr. N. Saha, Vice Chancellor, Burdwan University, West Bengal (17.03.2019)
- Shri Navin Nayak, Director, Nehru Yuva Kendra, West Bengal and Andaman& Nicobar Islands (17.03.2019)
- Shri Bablu Mazumdar, Awardee Fish Farmer (17.03.2019)
- Prof. B. N. Pandey, Working President, ZSI; Former Prof. & Head (Zoology) & Dean, Faculty of Science, Magadh University, Bodhgaya (02-05-2019)
- Prof. P. N. Pandey, President, ZSI & Former Prof. of Zoology, Ranchi University, Ranchi (02-05-2019)
- Dr. Dilip Kumar, Aquaculture, Fisheries and Rural Development Adviser, Govt. of India & Former Director, ICAR-Central Institute of Fisheries Education, Mumbai (02-05-2019)

Acronyms

ab Maneri1	Above Barrage Maneri1	**IISS**	Indian Institute of Soil Science
ADF	Assistant Director of Fisheries	**IMC**	Indian Major Carp
ADG	Assistant Director General	**IRC**	Institute Research Committee
AFDC	Assam Fisheries Development Corporation	**ISTM**	Institute of Secretariat Training and Management
AKMU	Agricultural Knowledge Management Unit	**ITK**	Indigenous Technical Knowledge
Ald rs	Allahabad	**ITMU**	Institute Technology Management Unit
ANOVA	Analysis of Variance	**IUCN**	International Union for Conservation of Nature
bl Maneri2	Below Barrage Maneri1	**Kanj**	Kannauj
BCKVV	Bidhan Chandra Krishi Vishwa Vidyalaya	**Kanp Ab**	Kanpur Above Barrage
Bijn. Ab	Bijnor Above Barrage	**Kanp bb**	Kanpur Below Barrage
Bijn. Bl	Bijnor Below Barrage	**l**	litre
BMI	Body Mass Index	**MDS**	Multi-dimensional Scaling
BMP	Better Management Practice	**MEI**	Morpho Edaphic Index
CABIN	Centre for Agricultural Bio-informatics	**Mg**	Mega gram
CBF	Culture Based Fisheries	**MGMG**	Mera Gaon Mera Gaurav
CCA	Canonical Correspondence Analysis	**MoEF & CC**	Ministry of Environment, Forest and Climate Change
CDA	Chilika Development Authority	**MSY**	Maximum Sustainable Yield
Chilasis	Chinyalisaur	**MT**	Metric Tonnes
CIBA	Central Institute of Brackishwater Aquaculture	**NAARM**	National Academy of Agricultural Research Management
CIFA	Central Institute of Freshwater Aquaculture	**Narora ab**	Narora Above Barrage
CIFE	Central Institute of Fisheries Education	**Narora bl**	Narora Below Barrage
CIFRI	Central Inland Fisheries Research Institute	**NASF**	National Agricultural Science Fund
CMFRI	Central Marine Fisheries Research Institute	**NBFGR**	National Bureau of Fish Genetic Resources
CPCB	Central Pollution Control Board	**NBSSLUP**	National Bureau of Soil Survey and Land Utilization Planning
CPUE	Catch Per Unit Effort	**NEH**	North-East Hill
CPWD	Central Public Works Department	**NFDB**	National Fisheries Development Board
CRIJAF	Central Research Institute for Jute and Allied Fibres	**NICRA**	National Innovations on Climate Resilient Agriculture
DAHDF	Department of Animal Husbandry, Dairying and Fisheries	**NIRJAFT**	National Institute of Research on Jute and Allied Fibre Technology
DARE	Department of Agricultural Research and Education	**NMCG**	National Mission for Clean Ganga

DDE	**Dichlorodiphenyldichloroethylene**	**NPP**	**Net Primary Productivity**
DDT	Dichlorodiphenyltrichloroethane	**OTA**	Over-time Allowance
DHA	Docosa Hexaenoic Acid	**OUAT**	Orissa University of Agriculture and Technology
e-DAS	Electronic Data Acquisition System	**PFZ**	Potential Fishing Zone
EHP	*Enterocytozoon hepatopenaei*	**PME**	Priority setting, Monitoring and Evaluation
eLDAS	Electronic Length Data Acquisition System	**PUFA**	Polyunsaturated Fatty Acid
EPA	Eicosa Pentanoic Acid	**RAC**	Research Advisory Council
FCR	Food Conversion Ratio	**REF**	Riverine Ecology and Fisheries
FEO	Fisheries Extension Officer	**RFD**	Results-Framework Document
FL	Fingerling	**RGCA**	Rajiv Gandhi Centre for Aquaculture
FREM	Fishery Resource and Environmental Management	**RS**	Research Station
FRL	Full Reservoir Level	**RRC**	Regional Research Centre
FSSAI	Food Safety Standards Authority of India	**RWF**	Reservoir and Wetland Fisheries
GADVASU	Guru Angad Dev Veterinary and Animal Sciences University	**SGR**	Specific Growth Rate
GaSI	Gastro-somatic Index	**SCSP**	Scheduled Caste Sub Plan
GEFC	Global Environmental Flow Calculator	**SHG**	Self Help Group
GIS	Geographic Information System	**SIF**	Small Indigenous Fish
GPP	Gross Primary Productivity	**Sring ab**	Srinagar Above Barrage
GSI	Gonado Somatic Index	**Sring bb**	Srinagar Below Barrage
Haridwar ab	Haridwar Above Barrage	**SSB**	Spawning Stock Biomass
Haridwar bl	Haridwar Below Barrage	**t**	Tons
HCH	Hexachlorocyclohexane	**Tehri ZP**	Tehri Zero Point
HPLC	High-performance liquid chromatography	**TDS**	Total Dissolved Solid
HRD	Human Resource Development	**TL**	Total Length
IARI	Indian Agricultural Research Institute	**TSP**	Tribal Sub-Plan
ICAR	Indian Council of Agricultural Research	**Vindh**	Vindhyanchal
ICDS	Integrated Child Development Scheme	**WBUAFS**	W.B. Univ. of Animal and Fishery Sciences
IHHNV	Infectious Hypodermal and Hematopoietic Necrosis	**WSSV**	White Spot Syndrome Virus